# CURTIN - MONASH ACCIDENT RESEARCH CENTRE

# C-MARC

**FACT SHEET NO. 4**

# SAFER VEHICLES

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## 1. Purpose of this Fact Sheet

Vehicle safety is commonly assessed from two perspectives:

- crashworthiness (passive safety) - the protection provided to vehicle occupants in the event of a crash; and
- crash avoidance (active safety) - a vehicle's capacity to prevent a crash from occurring.

This paper has the following purposes:

- to review improvements in vehicle crashworthiness over the last thirty or so years;
- to assess safety benefits arising from crash avoidance technologies; and
- to identify means to promote the purchase of safer vehicles.

This paper has been restricted to issues pertinent to vehicle occupant protection. Safer vehicle issues affecting other road users – in particular, pedestrians – will be covered in a later paper.

## 2. Are modern vehicles more crashworthy than older vehicles?

As a rule of thumb, the more modern a vehicle, the greater the level of occupant protection.

Much of this improvement can be attributed to a series of Australian Design Rules (ADRs) ensuring that new vehicles manufactured in or imported into Australia meet specified occupant protection standards. Crashworthiness features covered by the Standards include: seat belts fitted to front seats, 'anti-burst' door latches and hinges, energy-absorbing steering columns, head restraints, improved location of seat anchorages, improved side door strength and major design improvements to protect against frontal and side impact crashes[1].

The Australasian New Car Assessment Program (ANCAP) has also contributed to improved vehicle crashworthiness. A primary purpose of ANCAP is to promote the purchase of new vehicles which provide maximum front-seat occupant protection, by producing consumer information in the form of a star rating system. Ratings are based predominantly on crashworthiness performance in several crash tests, whereby the greater the number of stars (up to five), the higher the safety rating. A full description of the ANCAP test protocols and scoring procedures used for most new vehicle models can be found at: http://www.ancap.com.au.

Since 1992, the Monash University Accident Research Centre (MUARC) has produced vehicle crashworthiness ratings, in this instance for cars already being driven on the road[2]. MUARC's Used

Car Safety Ratings (UCSRs) are an estimate of a driver's risk of being killed or admitted to hospital, once involved in an on-road crash where at least one person was injured or at least one vehicle was towed away. Ratings have now been collected for 427 individual vehicle models manufactured since 1982, although older models have been progressively dropped from the brochures also to promote the purchase of safer vehicles: the 2009 brochure for example, presents ratings only for vehicles manufactured from 1992 onwards.(For more details, see http://www.monash.edu.au/muarc/projects/crashworthiness.html.)

(Most recently, a new method of presenting the ratings for consumer information has been introduced. Vehicles are now given a total secondary safety rating, a combination of crashworthiness and aggressivity ratings – with the latter being a measure of the injury risk the rated vehicles poses to drivers of other vehicles and unprotected road users such as pedestrians, cyclists and motorcyclist.)

Figure 1 shows the relationship between crashworthiness measures (also showing 95% confidence limits) and year of vehicle manufacture, based on MUARC's UCSRs. It also shows the dates of the major ADRs for passenger vehicles and the years when the ANCAP and MUARC crashworthiness ratings commenced – the most recent example shown being ADR 69, which has had an impact on both airbags and seat belt reminder systems.

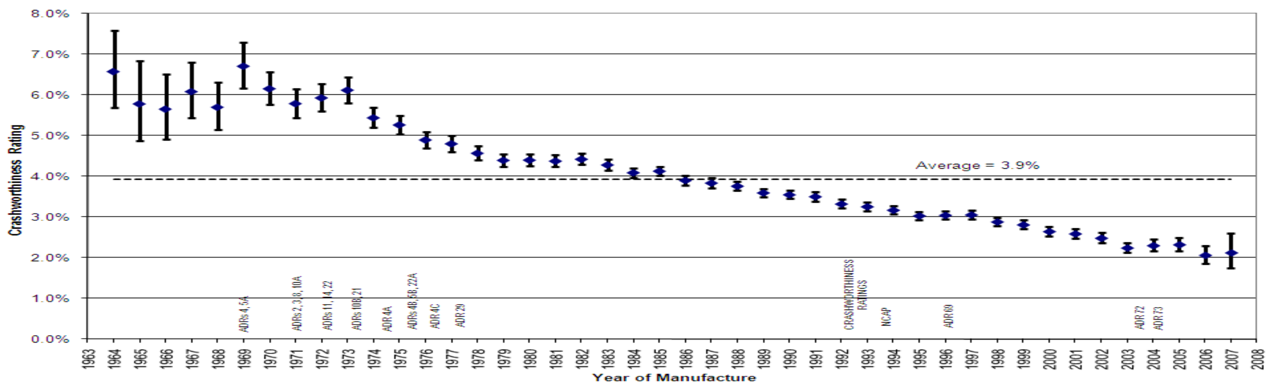


**Figure 1: Vehicle crashworthiness by year of manufacture, 1964-2007[2].**

Vehicles manufactured between 1964 and 1973 had an average crashworthiness rating of 6.0 percent, meaning that there were six drivers killed or admitted to hospital per 100 crash involvements. For vehicles manufactured between 2003 and 2007, the crashworthiness rating had fallen to 2.2 percent: put another way, current vehicles as a group are almost three times safer than vehicles manufactured thirty or more years earlier.

However this strong trend in improved occupant protection is not shared by all vehicle models. For example, the least safe model has almost three times the risk of death or serious injury in a tow-away crash, compared to vehicles with average crashworthiness – and around 10 times the risk, compared to the safest model. These differences in crashworthiness makes it important that vehicle purchasers be fully aware of the different safety levels.

Both ANCAP ratings and UCSRs are based on the overall capacity of vehicles to protect occupants in the event of a crash (specific crash types for ANCAP and all crash types for the UCSRs). The ratings do not indicate the presence of individual safety features in the vehicles being assessed, although the more features present, the more likely the vehicle is to receive high safety ratings. (In the case of ANCAP, bonus points for some specific safety features such as seat belt reminders may make a modest contribution to the overall rating.) Table 1 provides a list of leading individual crashworthiness features and their availability[3].

**Table 1. Leading individual vehicle crashworthiness features[1]**

| Technology | Availability[2] | | Technology | Availability[1] |
|---|---|---|---|---|
| Seatbelt Pretensioners | A | | Thorax (side) Airbags | B |
| Seatbelt Load Limiters | A | | Head and Thorax Airbags | A |
| Motorised Seatbelts | C | | Curtain Airbags | B |
| Anti-Whiplash Seats | B | | Tubular Airbags | B |
| Active Head Restraints | B | | Knee Airbags | B |
| Frontal Airbags | A | | Knee Bolsters | B |
| Dual Stage Airbags | B | | Anti-Submarining Airbags | C |

[1]Given the objectives of this paper, only technologies relating to occupant protection have been considered.
[2] Availability: A - standard in many vehicles
B - available in some vehicles
C - mainly at development stage

With sophisticated seatbelt systems already standard in many vehicles, more vehicles are also providing a wide array of airbag options. However many of these features have not been extensively evaluated against crashes to quantify their effectiveness.

## 3. Possible safety benefits arising from current and expected crash avoidance technologies

Most crash avoidance technologies have short histories and currently are restricted to a small range of vehicles. This situation however is steadily changing and increasingly, features such as Electronic Stability Control (ESC) and various collision warning systems are becoming standard vehicle features. Table 2 lists and describes some of the individual crash avoidance features currently on the market or mainly at development stage[4]. The list is not intended to be exhaustive and many of these technologies are known under a variety of commercial names.

**Table 2. Some leading crash avoidance technologies**

| Technology | Description | Availability[1] |
|---|---|---|
| Anti-lock Braking | Prevents wheels from locking up and skidding during hard braking or on slippery surfaces. This assists in maintaining more traction to the road and thus control of the vehicle. | A |
| Brake Assist/ Forward Crash Mitigation | Optimizes braking performance when the vehicle senses an imminent collision and/or when driver applies emergency braking. FCM automatically initiates hard braking when a crash is imminent. | A |
| Electronic Stability Control (ESC) | Compares the driver's intentions (reflected in steering and braking) to the vehicle's actual response. If the vehicle is starting to travel in a different direction to that intended, it will intervene to correct the vehicle’s path by applying brakes to individual front or rear wheels and/or reducing excess engine power to put the vehicle back on the appropriate path. | B |
| Adaptive Cruise Control | An extension of normal cruise control which automatically slows the vehicle to produce a safe following distance when a vehicle ahead is travelling more slowly than the chosen cruise speed. | B |
| Intersection Collision Warning | Warns the driver when on imminent collision course with another vehicle, through vehicle-to-vehicle or road-to-vehicle communication . Initial systems can provide warnings to drivers on Variable Message Signs. | D |
| Following Distance Warning | Warns the driver when following a vehicle too closely. | D |
| Forward Collision Warning System | Warns the driver of imminent forward collisions with vehicles in front. | B |
| Reverse Collision | Warns driver when reversing if crash with rear object is inevitable. | B |

| Technology | Description | Availability[1] |
|---|---|---|
| Warning System | | |
| Intelligent Speed Adaptation | Alerting ISA warns the driver when exceeding the posted speed limit. Limiting ISA actively intervenes when the vehicle exceeds the speed limit. | D |
| Lane Departure Warning | Provide visual, audible or haptic warnings if the driver is drifting from the intended lane. The more sophisticated systems can judge whether the vehicle was meant to change lanes or not. | D |
| Fatigue Detection | Warns driver in advance, that it is inevitable they will fall asleep at the wheel. | C/D |
| Driver Distraction Warning | Monitors drivers' eyes off the road time and issues warning if eyes off the road for longer than some pre-defined time. | D |
| Vision Enhancement | Enables driver to see objects in the dark or in low visibility conditions, through special display. Predicted but unknown benefits. | B |

Notes: [1] Status code: A - standard in many vehicles
B - available in some vehicles
C - available mainly as a post-sale purchase
D - mainly at development stage

Early evaluation evidence for some of the technologies suggests substantial safety benefits. Table 3 shows the estimated crash and cost savings of key crash avoidance technologies, based on Victorian crash data[5].

**Table 3. Estimated safety benefits of key crash avoidance technologies**

| Technology | Casualty crash scenarios | Estimated impact on appropriate crash types if in all vehicles |
|---|---|---|
| Intelligent Speed Adaptation | Single-vehicle, head-on, same-direction rear-end, intersection and pedestrian crashes. 20% of above likely to be potentially affected. | 10.8% reduction (saving $155 million per annum) |
| Forward Collision Warning | All rear-end crashes likely to be potentially affected. | 7.0% reduction (saving $40 million per annum) |
| Lane Departure Warning | Rural single-vehicle off-path and rural multi-vehicle sideswipe crashes. 50% of above likely to be potentially affected. | 5.2% reduction (saving $17 million per annum) |
| Fatigue Monitoring System | Single-vehicle crashes. 50% of above to be potentially affected. | 4.3% reduction (saving $64 million per annum) |

There is a steady growth in the evaluation evidence supporting the safety benefits of many of these technologies, limited data and some methodological difficulties notwithstanding. For example, researchers from the Insurance Institute for Highway Safety[6] have found that ESC reduces fatal multiple-vehicle and single-vehicle crash risks by 32 percent and 56 percent respectively. The researchers estimated that if all vehicles were equipped with ESC, almost one-third of all fatal crashes in a given year could be avoided annually. These findings are in general accordance with other evaluations. An Australasian study[7] for example, found that fitment of ESC to vehicles in Australia and New Zealand was associated with a 32 percent reduction in the risk of single-vehicle crashes in which the driver was injured – with the crash reduction for 4WD vehicles being considerable higher at 68 percent. The study was not able to determine the effect of ESC on multiple-vehicle crashes.

## 4. Promoting the purchase of safer vehicles

It is considered that there are two main mechanisms for developing a safer vehicle fleet in Australia.

The first is through encouraging consumer demand for safety features in vehicles, based logically on the ANCAP and MUARC Used Car crashworthiness ratings. Australia has one of the oldest vehicle fleets in the world and if each motorist could be persuaded to upgrade their vehicle to the safest in its class, road trauma would drop immediately by one-third[8].

The second mechanism is to ensure that safety be a paramount concern to fleet managers when purchasing new vehicles. Since 1986 the majority of new cars in Australia have been sold as fleet vehicles, with Ford and Holden each selling almost three-quarters of their new cars to fleets[9]. If fleet managers selected only vehicles with the maximum safety technologies, the benefits would soon spread throughout the total vehicle fleet – and along the way give a further inducement to vehicle manufacturers to include safety technologies as standard features.

These two mechanisms can be stimulated through a variety of means, including public education efforts and policy initiatives aimed at influencing government (and other) fleet managers. Other means which might arguably prove more effective but which government and insurance agencies seem reluctant to take up, include reduced registration and insurance costs for vehicles meeting specified safety criteria.

## 5. Summary and conclusions

Based on the available evidence:

- current vehicles as a group, are almost three times more crashworthy than vehicles manufactured thirty or more years ago;
- individual crash avoidance technologies promise substantial safety benefits –for example, ESC, which may reduce fatal crashes by almost one-third.

As always, there are limits to the research evidence supporting these claims. For example, it is acknowledged that the ANCAP ratings represent only a modest range of crash types and are based on damage done to test dummies where biofidelity is probably less than complete. Further, the claims made for many crash avoidance features currently outstrip the available evidence and it is too early to reach definitive conclusions about at least some features.

However, while the extent of improvement and magnitude of safety benefits may be debated, there is little doubt that vehicle safety is steadily increasing – to the extent that Volvo have promised an injury-proof car by 2020:

> (Volvo) already offers ignitions that won't operate if a driver is intoxicated, sensors that assess alertness and sound an alarm if the driver is dozy or drifting, and Global Positioning Systems to help prevent drivers from rushing to their destinations. Should all this fail to avert a crash, the car takes steps such as tightening its seat belts and priming air bags to minimize injury. The car of the future will have even more foresight. Radar, sonar and other sensors will extend its so-called "deformation zone" until it becomes, in essence, a huge electronic bumper reaching out on all sides to gather information to feed back to the vehicle. In a crash situation, where many drivers freeze, the car will be able to take over and steer or brake on its own …. .[10]

The challenge is to ensure that current and emerging safety features, once proven, are spread as rapidly and as comprehensively as possible throughout the vehicle fleet.

## 6. References

[1] Newstead, S, Cameron, M and Langford, J (2003). 'Promoting Vehicle Crashworthiness.' Volume 2 of the Austroads Road Safety Handbook. See: http://www.austroads.com.au/handbook.html.

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[7] Scully, J and Newstead, S (2007). Preliminary Evaluation of Electronic Stability Control Effectiveness in Australasia. Monash University Accident Research Centre Report No. 271, Monash University Accident Research Centre, Clayton, Victoria.

[8] See: http://www.officeofroadsafety.wa.gov.au/documents/TowardsZeroRecommendationFinal.pdf

[9] Haworth, N, Tingvall, C and Kowaldo, N (2000). Review of the Best Practice Road Safety Initiatives in the Corporate and/or Business Environment. Monash University Accident Research Centre Report No. 166, Monash University Accident Research Centre, Clayton, Victoria.

[10] See: http://www.abc.net.au/news/stories/2008/05/01/2232557.htm?site=news'

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