AusRap Star Ratings for the Australian National Network

Smith, G., Daly, P. & McInerney, R.
Australian Automobile Association; RACV; ARRB Group

ABSTRACT

AusRap, or the Australian Road Assessment Program, produces maps showing the risk of road crashes that cause deaths and life-threatening injuries and rates roads for safety. It highlights improvements that could be made to roads to reduce the likelihood of crashes—and to make those that do happen survivable.

AusRap has two standard protocols: risk mapping, and star ratings using a Road Protection Score (RPS). In 2004 and 2005, AusRap published colour coded ‘risk maps’ which draw on traffic flow and crash data to show the relative road safety performance of the AusLink National Network. This paper focuses on the second AusRap protocol, star ratings using the RPS.

The RPS is an innovative approach to assessing the inherent safety of a road. It involves a “drive through” inspection in specially equipped vehicles that capture video images of the roads. From this information, inspectors assess each road and assign star ratings based on major safety features and hazards. The star ratings, which have been developed by the Australian automobile clubs in partnership with the ARRB group, draw extensively on the research underpinning ARRB’s Road Safety Risk Manager.

This paper describes the star rating methodology in some detail and presents the selected results of the first major application of the methodology to the open highway lengths of the AusLink National Network.

INTRODUCTION

Every year around 1,700 people are killed and 22,000 are seriously injured on Australian roads. Preventing the escalation—and indeed reducing—this toll, will require not only the continuation of tried and true road safety programs, but also the development of new, innovative approaches to road safety. Apart from this overarching goal of addressing the road toll, there are numerous other imperatives also driving change.

The Australian Road Assessment Program (AusRap) is an approach to road safety being lead by the nation’s State based motoring clubs and their national association, the Australian Automobile Association (AAA). The program is closely aligned with the European equivalent, EuroRap, which has been operating for a number of years.

Currently, reasonably objective and accepted measures exist of what constitutes a safe road user (essentially someone who is responsible and obeys the law) and a safe vehicle (one which rates well under ANCAP). AusRap represents the completion of “safe system” approach to road safety by providing an objective measure of the safety performance of roads. In doing so, AusRap aims to increase awareness among road users the risks they face when driving on various roads and the role that infrastructure improvements (such as the installation of safety barriers) can play in reducing risk.

This paper provides a description of the research being undertaken by AusRap.
It begins with a brief discussion about motorists’ attitudes towards road safety, risk and the ways in which road safety might be improved. The research discussed in this section forms a significant part of the underlying justification for the establishment of AusRAP. Following this, the two protocols under development by AusRAP—risk mapping, and star rating—are described, and selected results provided.

MOTORISTS’ ATTITUDES TO ROAD SAFETY

AAA and RACV have been monitoring the attitudes and priorities of motorists for many years through both qualitative and quantitative surveys. Recent surveys consistently show that although road safety is recognised as being an issue of concern in the community, the true extent of the problem is not well recognised. People vastly underestimate the number of people killed on roads each year. In the most recent (unpublished) survey conducted by RACV, one in four (23%) respondents were unable to even guess a figure for the annual number of deaths on Victorian roads.

Many in the community have become ‘de-sensitised’ to road safety statistics. Crashes are now a standard component of daily traffic reports (and are reported as traffic problems) and so to many, they have become just a part of life. If crashes do not involve a new angle or involve personal loss, they do not grab community attention.

Most people attribute the causes of road crashes almost exclusively to way people drive. A telling finding of the latest RACV research was that respondents almost exclusively spontaneously mentioned one or other aspect of driver behaviour as one of the three biggest causes of road crashes. Accordingly, the most popular strategies for reducing road crash deaths and injuries involve more driver education and training, and cracking down on aggressive and speeding drivers.

Motorists are becoming increasingly well informed about safety of new cars, and can readily expound on the features that assist in preventing crashes—like ABS brakes, roadworthy tires and stability control—and features that help to protect occupants when a crash does occur—airbags, seatbelts and crumple zones.

But by comparison with behaviour and vehicle safety, motorists’ concept of a safe road is barely developed. Motorists tend to think in terms of road condition and upkeep, and certainly not in terms of forgiving roads, particularly in relation to the roads they drive on. Blackspots are recognised and accepted as dangerous, but they are thought to be remote and reasonably scarce.

These findings contrast with research underpinning Australia’s National Road Safety Strategy. The target of the Strategy is to reduce the annual road fatality rate per 100,000 population by 40 per cent between 2001 and 2010. It shows that by 2010 we can save 700 lives every year by improving the safety of the roads (332 lives), improving the safety of vehicles (175 lives), improving driver behaviour (158 lives), and adopting smarter safety technology (35 lives). Thus, nearly half of the targeted improvement in road trauma can be achieved by upgrading Australia’s roads.

By giving roads across Australia a safety rating, AusRAP aims to make the risk of death and injury on different roads more meaningful and stimulate public discussion—and action. It aims to help road users understand how risk can vary according to changes in the road environment. Risk-aware road-users will be more likely to adapt their driving to reduce their risk of a crash.
The ratings will also provide road planners and engineers with vital benchmarking information to show them how well, or badly, their roads are performing compared with others.

AusRap Protocols

AusRap uses two methods—or protocols—for assessing the safety of roads. AusRap’s first protocol, risk mapping, is based on a road’s history of crashes and traffic flow. The second protocol—star ratings—provide a measure of the inherent safety of a road.

Risk Mapping

In 2005, AAA published the second AusRap report titled How Safe Are Our Roads? This report used risk-maps to provide a measure of the safety performance of the AusLink National Network.

Two types of risk maps were presented. The first type plotted the annual average number of casualty crashes per kilometre on highway links for the period 1999-03. This type of map is referred to as the ‘collective’ risk map and presents the ‘crash density’ on highways.

An alternative measure of risk is based on the number of crashes per vehicle kilometre travelled. This is referred to as the ‘individual’ risk map, since it essentially shows the risk for individual drivers, and is calculated by dividing the frequency of crashes per annum by the distance travelled on each road link per annum. Figure 1 below presents the individual risk map for Victoria for the period 1999-03.
The collective and individual risk measures are most useful when used together to "tell a combined story." Roads that score poorly on both measures—those having high collective and high individual risk—might be considered as candidates for investment. The star ratings (discussed later) and further cost-benefit analysis will assist in determining the appropriate road treatment and priority.

However, risk cannot be eliminated from roads through infrastructure improvements alone. Nor should it be. The road user must always share responsibility for a safe road system. The AusRAP risk maps strengthen the connection between infrastructure and personal responsibility by highlighting sections of road where improvements are warranted, but also where road users may need to take extra care to minimise their risk until road improvements are made.
STAR RATINGS

Between 1 and 5-stars are awarded to road links depending on the level of safety which is ‘built-in’ to the road. The star ratings involve an inspection of design elements such as lane and shoulder width and the presence of safety barriers, which are known to have an impact on the likelihood of a crash and its severity.

Star rating a road is a proactive approach to road safety. It enables sections of road that are likely to be ‘risky’ to be identified before a crash occurs.

Whether a road is safe or not depends to an extent on whether safety has been built-in to it through the inclusion of design elements such as wide lanes and shoulders and safety barriers, which are known to have an impact on the likelihood of a crash and its severity.

The best roads are likely to be straight, dual divided carriageways with good line-marking, with wide lanes and sealed shoulders, safe roadsides and few, if any intersections.

The least safe roads are likely to be single lane carriageways with lots of curves in mountainous terrain, with narrow lanes and sealed shoulders, poor line marking and severe roadside conditions such as trees and poles.

This relatively new approach to road safety assessment of star rating based on design elements is increasingly being taken up internationally. Similar types of road inspection programs are now undertaken by EuroRAP in countries such as Sweden, Germany, Austria, Britain, Iceland, Netherlands, Spain and Switzerland. In many countries, the star rating process is driving the development of innovative engineering for safer roads.¹

How the data is collected

AusRAP star ratings are based on a detailed visual inspection of a road’s design elements. AusRAP used an innovative approach to undertake these inspections by obtaining State and Territory road authorities’ “video” data of road networks, which is usually collected for asset management purposes.

The data was collected using specially equipped vehicles (see Figure 3) which record digital photographs, or images, of a road (generally at 20m to 100m intervals) using an array of cameras aligned to pick up various views of the road (forward, rear, side-left and side-right). The vehicles are able to drive along the road at almost normal speed while collecting this information.

¹ For a comprehensive set of European star ratings, see www.eurorap.org
The digital images are “streamed” together to form a “video” of the road network. Analysts then undertake desk-top inspections by taking a virtual ‘drive through’ of the road network (see Figure 4), at highway speed or on a frame-by-frame basis, depending on the complexity of the road. The software used by the analysts enables accurate measurements to be made of elements such as lane widths, shoulder widths and distance between the road edge and fixed hazards, such as trees or poles (see below).
What road design elements are inspected?

A road’s star rating is based on an inspection of design elements which are known from extensive research to influence the likelihood of crashes occurring and the severity of those crashes that do occur.

The focus of the star ratings is on the three most common and severe types of crash on rural highways: run-off road crashes (which account around half of all crashes), head-on crashes and crashes at intersections. Together, these three crash types account for around three quarters of all crashes on rural highways.

The design elements that influence run-off road and head-on crashes and which AusRAP inspects include:

- whether opposing traffic lanes are separated by a physical barrier or wide median (that is, divided or undivided road);
- lane widths;
- sealed shoulder widths;
- alignment (that is, number and sharpness of curves);
- terrain;
line marking;
- whether roadides free of hazards like trees and poles or have safety barriers in place;
- traffic speeds; and
- overtaking requirements.

The design elements that influence intersection crashes and which AusRAP inspects include:

- type of intersection (for example, over- or under-pass, T, cross roads or railway);
- number of vehicles using intersecting roads (or trains);
- alignment of intersecting roads;
- sight distances; and
- right and left turn provision.

**The Road Protection Score (RPS)**

Central to the star ratings is the Road Protection Score (RPS). The RPS approach to assessing a road was developed by ARRB Consulting and the Australian motoring clubs. It builds on work undertaken by the European Road Assessment Program (EuroRAP) and draws extensively on the research conducted by AustRoads and ARRB in the development of the Road Safety Risk Manager.²

This research enables a relative risk score to be determined for each of a road’s design elements. As a simple example, the risk of being involved in a crash on a road with narrow lanes (less than 2.8m wide) is 50 per cent higher than on a road with wide lanes (greater than 3.6m wide). That is, other things being equal, a road with wide lanes is safer—and therefore receives a better score—than a road with narrow lanes. Narrow lanes leave little room for error.

As another example, the risk of being involved in a crash on a road with no sealed shoulders is 60 per cent higher than on a road with wide sealed shoulders (greater than 2.4m). That is, other things being equal, a road with wide sealed shoulder is safer—and therefore receives a better score—than a road with no sealed shoulders.

Figure 4 below provides a broad illustration of the evaluation conducted by analysts in determining the RPS.

---

² For more details on Road Safety Risk Manager, visit www.arrb.com.au
A Road Protection Score (RPS) is calculated for each of the three crash types: run-off road crashes, head-on crashes and intersection crashes. The scores are based on the various design elements listed earlier and weighted according to the relative contribution which each design element makes to likelihood of a crash. The scores are further adjusted according to the likely severity of a crash should one occur.

The final RPS is determined by combining the run-off road RPS, head-on RPS and intersection RPS for sections of road that are generally homogenous. These sections can be as short as 200 metres or as long as 100km, depending on the frequency of changes in the road’s design.
Star ratings

The RPS can be plotted in chart form for every highway (for one example, see Figure 5). Along the horizontal axis is the distance in metres from the start of a highway and on the vertical axis is the RPS. The chart highlights the fact that as a motorists drive along a highway, the crash risk they face changes constantly as the road design elements vary.

In circumstances where highways are dual divided carriageway, a RPS is calculated for both directions (for an example, see pink line at 20000-35000m point on axis of Figure 5).

The scores are allocated to one of five star rating 'bands'. These are shown in colour-coded format in Figure 5. The star rating system reflects the typical Australian practice of recognising the best performing category as 5-star and the worst as 1-star.3

Figure 5: Road Protection Scores (RPS) and star rating thresholds

The star ratings are presented in map form. For the purpose of mapping, highways have been split into shorter links which are generally defined by using two criteria. First, the links should be meaningful and distinct to road users (that is, start and end at identifiable locations). Second, links should consist of predominantly a single star rating.

In actual practice, risk scores—and thus star ratings—often fluctuate over a given length of road, as is illustrated in Figure 5. Therefore, within any given link there is likely to be a distribution of star ratings.

The typical road stereotypes for roads with different star ratings are shown in Table 1.

---

3 Significant sensitivity testing was undertaken to ensure the RPS and associated star ratings are appropriate and the impact of changes in road design elements and intersection frequency and condition were appropriate to the model.
Table 1: Typical roads in each star rating category

<table>
<thead>
<tr>
<th>Rating Scale</th>
<th>Typical road</th>
<th>Undivided Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Straight with good line-marking, wide lanes and sealed shoulders, forgiving roadside and occasional over- or under-pass intersections.</td>
<td>No undivided roads can achieve a 5-star rating.</td>
</tr>
<tr>
<td>4</td>
<td>Minor deficiencies in some road features such as lane width, shoulder width, curves or roadside.</td>
<td>Straight with good overtaking provision, good line-marking and forgiving roadside.</td>
</tr>
<tr>
<td>3</td>
<td>Major deficiencies in some road features such as poor median protection against head-on crashes, many minor deficiencies and/or poorly designed intersections at regular intervals.</td>
<td>Minor deficiencies in some road features such as bends and roadsides and/or poorly designed intersections at regular intervals.</td>
</tr>
<tr>
<td>2</td>
<td>Many major deficiencies such as poor alignment, poor roadside and median protection and poorly designed intersections at regular intersections.</td>
<td>Major deficiencies in some road features such as poor roadside environment and/or many minor deficiencies such as insufficient overtaking provision and narrow lanes, and/or poorly designed intersections at regular intervals intersections.</td>
</tr>
<tr>
<td>1</td>
<td>Many curves, in mountainous terrain, narrow lanes and shoulders, severe roadside conditions and many major intersections.</td>
<td>Many curves, in mountainous terrain, narrow lanes and sealed shoulders, poor line marking and severe roadside conditions.</td>
</tr>
</tbody>
</table>
Results

At the time of writing, star ratings for the open highway sections of the AusLink National Network—generally defined by having a speed limited of 90km/h or more—were being finalised. Because of this, and because of limited space, a sample of the results is produced here. Full results will be presented at the conference in October 2006.

In total, 18,336 carriageway-kilometres (as opposed to lane kilometres) of the National Network was analysed. Of this, 1 per cent of the network was rated 2-star (red), 51 per cent 3-star (yellow) and 47 per cent 4-star (light green). There were no 1-star (black) or 5-star (dark green) sections of highway. This includes highways in all States and Territories except NSW.

Table 2: Percentage of the National Network in each star rating category

<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>3</td>
<td>51%</td>
</tr>
<tr>
<td>3</td>
<td>47%</td>
</tr>
<tr>
<td>3</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 3 below provides a ‘snapshot’ of the National Network. The elements listed in the table are generally those that have the greatest influence on the star ratings. The table shows that 16 per cent of the network which was analysed is divided carriageway, 97 per cent has good alignment, 57 per cent has roadsides that are not likely to result in serious injury in the event of a run-off road crash (either by being clear of hazards or by safety barriers), and there is an average of 1 intersection every 5km.

Following Table 3, Figure 5 presents the star ratings in map form.

Unfortunately, the NSW Road and Traffic Authority (RTA) did not supply the necessary data. We look forward to the RTA’s participation in star rating roads in the future.
Table 3: Snapshot of the AusLink National Network

<table>
<thead>
<tr>
<th>Feature</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>18,366km</td>
</tr>
<tr>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>4</td>
<td>51%</td>
</tr>
<tr>
<td>5</td>
<td>47%</td>
</tr>
<tr>
<td>Divided</td>
<td>16%</td>
</tr>
<tr>
<td>Good alignment</td>
<td>97%</td>
</tr>
<tr>
<td>Safe roadside</td>
<td>57%</td>
</tr>
<tr>
<td>Intersections</td>
<td>1 every 5km</td>
</tr>
</tbody>
</table>

Figure 5: Star ratings for the AusLink National Network (highways zoned 90km/h and above)

The results also enable data to be presented on a highway by highway basis, or by highway links. As an example, a snapshot of the highways in the Northern Territory is shown below in Table 4 (noting that no sections of highways received 1 or 5-stars).
Table 4: Snapshot of highways in the Northern Territory

<table>
<thead>
<tr>
<th>Highway</th>
<th>From-to</th>
<th>Length (km)</th>
<th></th>
<th></th>
<th></th>
<th>Divided</th>
<th>Good alignment</th>
<th>Safe roadside</th>
<th>Intersections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barkly Highway</td>
<td>Stuart Hwy to QLD border</td>
<td>440</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
<td>61%</td>
<td>1 every 40km</td>
</tr>
<tr>
<td>Berrimah Road</td>
<td>Stuart Hwy to Berrimah</td>
<td>12</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>40%</td>
<td>76%</td>
<td>21%</td>
<td>1 every 1km</td>
</tr>
<tr>
<td>Stuart Highway</td>
<td>Darwin to SA border</td>
<td>1843</td>
<td>0%</td>
<td>39%</td>
<td>61%</td>
<td>3%</td>
<td>100%</td>
<td>66%</td>
<td>1 every 7km</td>
</tr>
<tr>
<td>Victoria Highway</td>
<td>Stuart Hwy to WA border</td>
<td>469</td>
<td>0%</td>
<td>60%</td>
<td>40%</td>
<td>0%</td>
<td>100%</td>
<td>58%</td>
<td>1 every 10km</td>
</tr>
</tbody>
</table>

CONCLUSION

AusRAP provides an objective measure of the safety performance of roads, and represents the completion of "safe system" approach to road safety, together with safe road users and safe vehicles. It takes the principles of EuroRAP and applies these to Australian roads in a form which takes account of the differences between European and Australian road networks.

AusRAP has two protocols, risk maps and star ratings. Both of these have now been fully developed and methodologically reviewed. Risk maps have been published by AAA for Australia's Auslink (national) highways in 2004 and 2005 and it is expected that the first star ratings will be published in the second half of 2006.

Through this process, AusRAP aims to increase awareness among road users of the risks they face when driving on various roads and the role that infrastructure improvements can play in reducing risk. As a result, and in parallel advocacy directly to governments, AusRAP can play an important role in addressing Australia's road safety problems and ensuring safe road infrastructure is provided for the travelling public.