Safe System Infrastructure National Roundtable Report

Blair Turner, Michael Tziotis,
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Research Report ARR 370

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ARRB Group Ltd
Research Report ARR 370
May 2009

Information Retrieval

TURNER, Blair, TZIOTIS, Michael, CAIRNEY, Peter & JUREWICZ, Chris (2009).

Safe System Infrastructure – National Roundtable Report, ARRB Group Ltd, Vermont South, Victoria, Australia. Research Report ARR 370. 35 pages, including figures, tables.

Abstract:

The Safe System approach has recently been adopted by all Australian jurisdictions as the guiding principle for delivering road safety outcomes. A national roundtable discussion was held to explore the implications of Safe System for the provision and management of road infrastructure. Developments at the national level and overseas were outlined. Individual jurisdictions from across Australia reported their progress towards implementing Safe System infrastructure. This was followed by a workshop session to determine infrastructure required to deliver Safe System outcomes, and to identify issues relating to implementation. This report provides a summary from this event and provides recommendations for the development of Safe System infrastructure into the future.

ARR 370
May 2009

ISBN 1 876592 51 6
ISSN 0158-0728

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Michael Tziotis
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Peter Cairney
Peter Cairney has over 25 years experience of research in road safety and traffic matters. His original training was in behavioural science, but he has become familiar with a wide range of traffic engineering and road design issues in the course of his career. He has worked in a number of driver behaviour and road safety areas, including analysis of driver behaviours leading up to accidents, truck safety, railway level crossing safety, pedestrian and cyclist safety, road surface condition and crash occurrence, and community road safety. Current work includes estimating the extent to which selected ITS technologies can contribute to the realization of Safe System objectives.

Chris Jurewicz
Chris Jurewicz is a Senior Research Engineer with ARRB Group Ltd in Melbourne. He has extensive engineering experience in road safety and in traffic and transport management. Chris has worked in state and local government and in consulting on a range of engineering projects, strategy and policy development and in research. His current areas of research include crash risk modelling and speed management research. Chris's passion lies in translating research into practical applications for transport engineers and planners. He has recently led a companion project which has examined the role of speed management in realising Safe System principles.

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SUMMARY

The Safe System approach to road safety has been adopted by each Australian jurisdiction. This approach suggests (amongst other things) road users will make mistakes, and that they have a limited tolerance for surviving such events, or avoiding serious injury. Therefore, there is a need for road infrastructure that is ‘forgiving’ of mistakes by road users.

Although the vision for this approach is clear, the actions that might be taken to achieve it are less obvious. ARRB instigated and organised a national roundtable event to examine infrastructure options that might help achieve Safe System outcomes.

Around 40 senior managers from Australia and New Zealand attended this event, discussing current progress towards implementing Safe System principles, and options for future implementation.

Several key messages emerged from this event, including:

- Good progress is being made in many jurisdictions, but there is a greater need to share good practice in Safe System implementation between jurisdictions.
- A useful distinction was made between ‘Primary’ and ‘Supportive’ road safety treatments. Primary treatments are those that directly provide a Safe System outcome, for example by reducing impact forces to safe levels or by separating different road users. Supportive treatments assist in delivering safety improvements, but in an indirect manner (e.g. hazard warning signs may reduce the incidence of crash occurrence, but should a crash occur, would not have an influence on the severity outcome). Both are of use, but more use needs to be made of Primary treatments, and effort made in developing such treatments in future in order to meet Safe System objectives.
- There is a need to provide ‘redundancy’ or ‘backup’ systems when installing safety treatments in case there are failures in one or more components.
- Speed management is a significant component of the Safe System approach, but there is a need to educate the public and policy makers about the reasons for lower limits in certain situations (including risks of different parts of the road environment).
- Development of a clear functional road hierarchy for speed management purposes is crucial for the implementation of Safe System infrastructure, and particularly a system that provides a self-explaining road for motorists.
- Risk assessment is an important tool in the implementation of Safe System infrastructure.
- The timeframe for implementation of Safe System infrastructure is an important consideration.
- Institutional management is crucial to the delivery of Safe System principles, and there is a need to create better internal and external links between stakeholders to assist in this.
- Intelligent Transport Systems (ITS) are expected to be a major contributor to the realisation of the Safe System.

Based on the workshop outcomes, the following recommendations are made:

1. Road safety targets and performance indicators need to relate to casualties, and particularly those with fatal or serious injury consequences.
2. Formal sharing of knowledge about Safe Systems between jurisdictions is required, including results from current demonstration projects.

3. There is a need for further development and greater use of Primary road safety treatments.
4. The public and policy makers need to be better informed about actual risks when using the road, and the need for lower speeds in certain road environments.
5. A functional hierarchy of urban and rural roads is required to assist in Safe System implementation. This needs to provide a clear distinction between different road classes in terms of their design, appearance and speed limits.
6. Improved knowledge is required about specific high risk locations on the road network. This should be based on a combination of crash history and risk assessment.
7. To deliver Safe System outcomes, road authorities need to improve linkages internally between various operating groups, with local councils and other external agencies, and with the community in general. Of particular importance is the need to improve the link between road safety departments, and those responsible for land use planning.
8. There is a need to assess the role of ITS in Safe System implementation. This assessment needs to consider infrastructure requirements to allow maximum benefits from these emerging technologies.
9. Road authorities need to take a strategic approach to establishing Safe System infrastructure into the future. The roundtable identified a suite of short to long term measures that will help in this approach. A major part of this strategic approach will be to ensure that staff are fully aware of Safe System principles and that they apply these in their practice.

1 INTRODUCTION

1.1 Background

The Safe System approach to road safety recognises that humans, as road users are fallible and will continue to make mistakes. In addition, humans are physically vulnerable, and are only able to withstand limited kinetic energy exchange (e.g. during the rapid deceleration associated with a crash) before serious injury or death occurs. Infrastructure is required that takes account of these errors and vulnerabilities so that road users are able to avoid serious injury or death in the event of a crash. Safe System principles aim to manage vehicles, road and roadside infrastructure, and speeds to eliminate death and serious injury as a consequence of a road crash. Based primarily on the Swedish Vision Zero and the Dutch Sustainable Safety approaches, the Safe System approach has been formally adopted by Austroads, and forms a key component of the Australian National Road Safety Strategy (Australian Transport Council 2008). A more detailed explanation of the Safe System approach is provided in Appendix A, while key references can be found in Appendix B.

Each Australian jurisdiction has adopted the Safe System approach, and is striving to meet the challenge it presents. New Zealand is also likely to adopt this vision as part of its new road safety strategy.

Although the vision is clear, the actions that should be taken to achieve it are less obvious. Improvements to the road system hold out great promise as a contributor to realising Safe System outcomes, but a consensus regarding possibilities and priorities has yet to develop. ARRB instigated a national roundtable to discuss current actions in member authorities aimed to give effect to a Safe System, and to explore possible actions for concerted action in the future.

This report provides a summary of the roundtable, and includes information from formal presentations, feedback from road authorities, and discussions at workshop sessions. The final interpretation of this information is that of the authors, and does not necessarily reflect the views or policies of each individual present at this workshop, or the organisations that they represent.

The roundtable event and this report are seen as a starting point in the discussion on Safe System infrastructure. It is intended that this event and report will result in an increased dialogue on this subject within and between jurisdictions. To assist in this dialogue, feedback on the contents of the report would be welcome.

1.2 Objectives

The objectives for this event were to:

- consider recent international approaches to Safe System development
- present information on current progress towards Safe System infrastructure in Australia
- gain a common view as to how infrastructure is defined in a Safe System
- identify short to long term Safe System infrastructure options.

1.3 Method

A roundtable session was held at ARRB's Melbourne office on Friday 27 March 2009 (Figure 1). Approximately 40 invited senior level delegates from around Australia and New Zealand attended this event. Most representatives were from state road authorities. A number of Austroads panels were also represented at the event. Although a large number of the attendees work within the area of road safety, it was the deliberate intention to include a broader range of participants covering different aspects of road management. A list of attendees is provided in Appendix C.

The event comprised three stages:

- presentation of information on the national context for Safe System implementation, the international context, and on a complementary project being conducted by ARRB for Austroads on 'Safe System and speed'
- an update from each jurisdiction regarding current Safe System infrastructure initiatives being undertaken.
- a discussion that focused on key questions related to Safe System infrastructure. A group discussion was held to help define what is meant by 'infrastructure' in the Safe System context. Individual groups then identified what Safe System infrastructure could look like in relation to various crash types (specifically run-off-road, intersection, head-on, pedestrian, and motorcyclist/cyclist crashes). Information was sought from each group on short and long term options for implementing a Safe System. Groups were also asked to discuss challenges to implementing these options, as well as how to measure progress against delivery of Safe System infrastructure. Following these discussions, each group reported back its findings.

This report is structured around each of these three stages.

Figure 1: Attendees at the Safe System Roundtable in Melbourne

2 SAFE SYSTEM CONTEXT - PRESENTATIONS

A number of presentations were provided which placed the Safe System in the national and international context. A copy of these presentations can be downloaded from the ARRB website (http://www.arrb.com.au/index.php?option=com_content&task=view&id=386).
The following provides a summary of the key points from each of the presentations.

2.1 The National Context

Jeff Potter, Senior Manager for Safety at the National Transport Commission (NTC) provided an update on initiatives at the national level. In May 2008 the Australian Transport Council (ATC) agreed to endorse the consistent, national application of a Safe System approach to road safety.

Current efforts at the national level involve:

- identifying which groups impact aspects of the Safe System
- identifying current examples of best practice
- a stocktake of existing Safe System resources.

It was suggested that responses to the challenge of implementing Safe System principles have varied across jurisdictions, and range from mention of the Safe System in policy through to the establishment of Safe System working groups for major projects.

2.2 The International Context

Eric Howard from Eric Howard and Associates presented information on the Safe System in the international context. He is the key contributor for a new OECD document titled *Towards zero: ambitious road safety targets and safe systems* (OECD 2008). This document and the presentation identified the following issues:

- there is a lack of long term vision in delivering safety
- there is a focus on individual interventions rather than what is necessary for a fundamentally safer road transport system
- the Safe System approach is not yet widely understood or implemented
- institutional management arrangements are not adequate
- little has been done to date to inform the public about the benefits of a Safe System approach
- the Safe System approach aims for a 5 star driver (including that they not speed or be impaired and that they wear a seatbelt) in a 5 star car, travelling on a 5 star road with a 5 star speed limit
- ‘The safe system manager is prepared to step into environments where safety analyses and targets may be challenged by and challenge other aspects of social and economic life’
- ‘..System designers to accept responsibility for the safety of users of the road transport system and explain the safety constraints within which users need to operate.’
- there is a need to maximise mobility consistent with safe travel, and not (as has traditionally been the case) to improve safety while maintaining desired mobility
- there is a need to actively develop safety performance indicators to drive progress.

2.3 Safe Systems and speed limits

Chris Jurewicz, Senior Research Scientist from ARRB Group presented an overview on current research on the Safe System and speed limits. Speed limits are a critical element of the Safe System approach. A current Austroads project (ST1433) aims to revise the principles of speed limit setting in light of the Safe System approach. Research conducted to date identified the following:

- Lowering a speed limit by 10 km/h results in a much smaller reduction in mean speed, about 2.5 km/h on average.
- The same reduction in mean speed will produce a greater percentage casualty crash reduction on rural roads than on urban roads.
- There are several infrastructure features affecting driver speeds. Some of the 'accelerants' were: higher design speed, medians, turn lanes and wider pavements/traffic lanes.
- Data analysis confirmed and explained many relationships between road features, speed and crashes, e.g. crash rates vs. traffic lane widths, access control, frequency of curves, the effect of lane width on observed mean speeds, etc.
- The national workshop on speed limits for the Safe System concluded that:
  - driving speed = impact speed, i.e. speed dissipation should not be counted on prior to impact
  - ultimately, Safe System speeds should equal safe speed limits (30/40/50/70)
  - the aim should be to prevent crashes from occurring at impact speeds exceeding the Safe System speeds (infrastructure improvements), or dissipate/redirect energy prior to impact if crashes cannot be prevented (infrastructure improvements)
  - safe speed limits should be considered wherever each of the key crash types may occur (lower speed limits)
  - crash risk reduction and/or severity mitigation measures should be considered in the short to mid term (low cost infrastructure improvements and lower speed limits)
  - safe speed limits should be implemented where the road function does not prevent it.

3 CURRENT PROGRESS – CASE STUDIES

A number of formal and informal presentations were provided by representatives from each Australian jurisdiction (with the exceptions of Tasmania and the Northern Territory) and New Zealand. These provided information on current initiatives supportive of Safe System infrastructure. Key initiatives are summarised in the section below.

3.1 New South Wales

- New South Wales has moved to 'mainstream' road safety with the establishment of the Centre for Road Safety in the RTA. There is no core budget for safety, but rather the role of the centre is to influence others in how they do work (both within and outside of the RTA), making safety one of the core considerations.
- All directorates are now responsible for specific road safety outcomes. This has involved several specific initiatives or actions including:
  - the introduction of road safety impact statements
  - development of key performance indicators
  - each area of business is required to report back to the Executive Road Safety Management Committee on how it will improve safety.
- The focus is on casualties and not crashes.
- Systems thinking is required in Safe System design. Thought needs to be given to future road use. As an example, there is a need to design infrastructure to assist police in their enforcement efforts (e.g. locations where they can monitor speed).

3.2 Victoria

- There is a need to consider the Safe System for all road users (e.g. including motorcyclists).
- Guidelines are currently being revised to incorporate Safe System thinking.
- VicRoads has produced a CD to help raise awareness of Safe System principles internally.
- There is a need to consider future direction for systems thinking, including the role of ITS, development of performance indicators, and the use of route-based approaches.

3.3 Queensland

- Queensland Transport and Main Roads were being combined to form the Department of Transport and Main Roads. A safety strategy team will be established within this new department with one role being awareness raising for the Safe System.
- There is an intention to mainstream road safety (similar to the RTA NSW approach) within this new structure.
- Queensland is developing various strategies with a Safe System focus (e.g. motorcycles and speed).
- There have been various speed limit initiatives, including lower speeds at intersections and approaching level crossings, variable speed limits, and a 40 km/h limit for Brisbane's CBD.
- Proactive assessments have been made of new road design (e.g. North East Highway, Toowoomba) using AusRAP.

3.4 Western Australia

- Safe System working groups have been established for several major projects e.g. New Perth Bunbury Highway.

- A target of zero deaths for first 5 years of operation has been set for this project.
- A Vision Zero Logical Framework has been developed to assist in this target. This includes key criteria for preventing serious injury and death based on survivable speeds.
- Projects have been risk assessed prior to construction using AusRAP methodology.
- In some cases wire rope barrier has been used to protect motorists from all major hazards – even when these are outside the clear zone.

3.5 South Australia

- It is recognised that there is a gap between a safe speed, and what is currently considered a safe speed.
- Wire rope barrier is being trialled in the centre of the road on a 1.8 km section of road.
- A $100m investment is being made in the Adelaide to Melbourne corridor. Consideration is being given to 'point to point' speed camera enforcement provision.
- A distinction was made between 'primary' and 'secondary' road safety treatments. Primary treatments are those that meet Safe System objectives (e.g. energy dissipation through the installation of barriers). Secondary treatments are those that have some safety benefit, but do not necessarily reduce trauma to Safe System levels. More primary treatments are required rather than focusing solely on signs and lines.

3.6 ACT

- The road system in ACT is relatively small, but provides a good hierarchy.
- Point to point speed cameras are being investigated as are 40 km/h zones.
- A balance is being sought between the needs of different road users.
- The ACT Road Safety Strategy and Action Plans adopt and complement the principles of recent National Road Safety Action Plans, and similarly reflect the Safe System approach.

3.7 New Zealand

It was noted that New Zealand has not formally adopted Safe System principles in managing road safety, but that this is likely to occur through the development of the next national road safety strategy.

4 SAFE SYSTEM INFRASTRUCTURE

This section presents findings from a workshop involving all participants. Initially discussions were held with all attendees to define what is meant by infrastructure in a Safe System context. The attendees were then split into groups to identify Safe System treatments for various crash types for use in the short to long term, challenges that might be faced in implementing these measures, and how progress might be measured towards Safe System implementation. The results presented here are based on a summary of these discussions, and do not necessarily represent the views of all individual attendees or the report authors. Detail of the issues discussed by each group can be found in Appendix D.

4.1 How do we define infrastructure in a Safe System context?

In order to deliver Safe System infrastructure, there is a need to define what is meant by infrastructure. At the outset of the discussion, examples were provided of aspects that could be considered for inclusion as part of Safe System infrastructure. The following list was provided to stimulate discussion, and was not intended as an exhaustive list:

- type and function of the road, e.g. arterial, freeway, urban/outer, urban/rural, local
- planning context, e.g. commercial area, mixed housing/industrial, high/low density, future growth, separation of different uses
- design features, e.g. access control level, intersection types, median, turning lanes, roadside hazards/clear zones, bike lanes, footpaths, crossings
- traffic systems, e.g. ITS, VSL, speed limits, incident management systems, in-built enforcement technology, driver information systems.

Although discussion was intended to firm up a working definition of infrastructure, no consensus on a definition was reached. However, the following key points were made.

- Infrastructure tends to be thought of as roads and roadsides. However, in this context a broader definition is required. Use of the term infrastructure was questioned, as issues of importance extended to more than the physical road environment.
- There is a need to consider the ‘virtual road network’ as well as the actual one. This includes electronic infrastructure, such as speed limit and infrastructure layers for GPS navigation systems.
- There is a need to acknowledge that the community does not understand the term ‘infrastructure’. What is important is how the community perceives the road environment, and provision of appropriate information to road users (e.g. through self explaining roads[1]). There is currently little understanding of road infrastructure risks, for example, those associated with roadside hazards or intersections.
- Much of community perception is driven by media, and there is a need to engage the press/public to improve understanding of Safe System thinking.
- There are temporal issues involved, and there is changing use of infrastructure over time.
- Although there is a need to think more broadly about what we mean by infrastructure, it is also important to recognise those who have control over different parts of the system. There is a need to separate and assign issues for action on this basis.

[1] A ‘self-explaining road’ is a term from the Netherlands which describes a road which is designed in such a way that drivers will automatically understand what is required of them, including speed choice.

4.2 How do we provide Safe System infrastructure?

To address this issue, key crash types were identified prior to the workshop which are likely to result in high severity outcomes. Crash types were:

- run-off-road
- head-on
- intersection
- pedestrian
- motorcyclist/cyclist.

This section identifies examples of Safe System infrastructure that could be used to address each of these crash types. Where such infrastructure cannot be implemented in the short term, other interim safety treatments were also identified. These interim treatments do not necessarily deliver safety benefits that minimise the chance of fatal or serious outcomes, but they do provide some (and in some cases significant) safety benefits. Therefore, this section provides sub-headings for ‘Primary’ and ‘Supportive’ Safe System treatments. Primary treatments are those that could be expected to result in improvements in safety that prevent or minimise death and serious injury (either by preventing key crash types, or by dissipation of energy to such low levels that fatal and serious injury cannot occur). Supportive treatments are those that deliver a safety benefit, but not necessarily Safe System outcomes. They act by reducing the likelihood and/or severity of crashes. Both are seen as important under the Safe System approach, especially given the need for ‘redundancy’ in system design (see Section 5 for further discussion on this issue).

Some of the treatments identified in the following section can be implemented in the short term, while others will require more careful planning and implementation, and so may be more suited to long term implementation.

4.2.1 Run-off-road

Primary Treatments

Three key approaches were identified in providing infrastructure to prevent death and serious injury occurring as a result of this crash type. The first option would be to ensure no objects are present that would result in fatal or serious injuries when road users do run off the road (i.e. clear zone provision), the second involves actions that would prevent vehicles from leaving the road and/or striking these objects, while the third required appropriate maximum speeds in situations where this crash type might occur and thereby limiting high severity outcomes.

Provision of an adequate clear zone implies a need to remove hazards (at least those that will result in high severity outcomes) where this is possible. This includes strategies such as removal of trees (although there are various issues with this approach, some of which are outlined in Section 4.3) and undergrounding of utility poles. It was also recognised that there are limitations in terms of knowledge regarding current clear zone policy (this policy is based on dated research).

There are several mechanisms which can be used to limit the chance of vehicles leaving the road and/or striking roadside objects. The most successful of these is the provision of roadside and centre-of-road barriers. In the long term, ITS vehicle control systems were seen as being of major benefit in preventing vehicles from running off the road.

Speed management was seen as a further option. With a maximum survivable side impact speed of 50 km/h, it was thought that a speed environment of 50 km/h would be most appropriate where impact with hazardous roadside objects was possible.

Supportive Treatments

Other options that would deliver a safety benefit (although not necessarily a Safe System) were also suggested, including a concentration on high crash locations (e.g. run-off-road crashes per km), lower interim speed limits (i.e. higher than the long term objective of 50 km/h), improved education of the public and professionals as to the risks of this crash type, and implementation of treatments that assist in the reduction of run-off-road crashes (e.g. improved shoulder provision, audio tactile edgelines, delineation etc.).

It was highlighted that in addition to crash analysis of locations for treatment, some form of risk assessment would also be important, as previous crash locations are not likely to predict the location of all future fatal and serious crashes involving run-off-road crashes.

It was considered that a number of safety initiatives are required to prevent fatal and serious outcomes from this crash type, and that some form of 'redundancy' is needed to provide back-up in case one component 'fails'.

4.2.2 Head-on

Primary Treatments

Safe System solutions to reduce head-on crashes involve separation of traffic travelling in different directions or speed reduction where this is not possible.

Separation can be attained through duplication, or by way of centre-of-road barriers (Figure 2). Recent trials of centre-of-road wire rope barrier have proved very successful. Separation can also be achieved (at least in urban environments) through the instigation of one-way road systems.

Figure 2: Centre-of-road wire rope barrier, NSW

ITS was seen as delivering some benefits in the longer term, especially with the introduction of collision avoidance systems (including those that alerted motorists that other vehicles were in the wrong lane).

Speed management was also seen as important, with a survival speed of 70 km/h in a head-on crash. This is the appropriate speed environment were there is a possibility of head-on crashes.

Supportive Treatments

A number of other measures that may assist in improving safety by reducing the incidence of head-on crashes were also suggested. These included vehicle design improvements, shoulder sealing, increased separation between vehicles travelling in opposing directions (i.e. wider medians), provision of overtaking lanes, audio-tactile edgelines and centrelines, improved skid resistance, vehicle activated warning signs at curves, provision of rest areas and other forms of fatigue management, improved delineation, and ensuring a more consistent and improved road alignment.

4.2.3 Intersection

Primary Treatments

Separation of traffic and speed management were identified as Safe System approaches to intersection crashes.

Grade separation was seen as a long term Safe System solution, but it was recognised that it would not be possible to use this in many instances. Where grade separation is not possible, it is vital that speeds be reduced to an appropriate level (i.e. at or below 50 km/h) for death and serious injury to be minimised. Whether the installation of speed limits alone provides marked safety benefits at intersections still needs to be established, but when coupled with other improvements, there seems to be good evidence of safety improvements. It was also suggested that a ‘self explaining road’ intersection should not need a speed limit, as the required speed should be obvious to motorists.

Consideration needs to be given to all road users at intersections. Vulnerable road users have different survivable tolerances, and so speed environments of less than 50 km/h may be required in some circumstances.

Roundabouts were seen as a useful option, particularly as they act to slow speeds (amongst other benefits). Greater use of these might be appropriate, particularly in high speed environments. However, it is crucial that these act to reduce speeds on approach to the roundabout for them to be effective. Concerns were also raised about the safety effect on vulnerable road users (particularly cyclists).

Source: Schermers, G 1999, *Sustainable Safety - A preventative road safety strategy for the future*. Transport Research Centre, Dutch Ministry of Public Works and Water Management.

Figure 3: Raised platform at intersection on rural access road – the Netherlands

Platforms at intersections have been successful at slowing vehicles in low speed environments, and there are now various applications successfully in use at higher speed locations (Figure 3 shows an example from the Netherlands of a raised platform in a high speed environment). This option needs to be explored further.

ITS was seen as an option with great potential in the future, particularly systems that recognised high risk situations (e.g. high speed travelling into an intersection) and that applied some form of vehicle control.

Separation in time is also a useful mechanism to improve safety at intersections, typically through the installation of traffic signals. There was some debate about whether signals currently meet Safe System criteria, as it is possible for high severity outcomes to occur even at seemingly well designed signalised intersections. Perhaps if combined with some form of vehicle collision avoidance technology (see below) then the chance of this occurring would be minimised. To improve safety, turns at signalised intersections can also be fully controlled.

Another form of separation in time involves the installation of pedestrian (and cyclist) signalised crossings. Adequate provision of a pedestrian phase will help improve the level of compliance. Recent trials of ‘dwell on red’ signals (or ‘rest on red’) have successfully slowed speeds (particularly at night) by providing an ‘all red’ phase, with a green phase activated by vehicles on approach.

Network planning is required to maximise safety outcomes at intersections. For example, well designed intersections can be compromised by the introduction of new traffic generators in the vicinity, while an increase in intersections on major roads also has adverse safety effects.

Supportive Treatments

Other measures to improve safety at intersections include restrictions in the use of particular intersections, either through route guidance, closing of intersections or restriction of movement at intersections. ITS might also assist in reducing intersection conflicts by providing additional warning to road users (e.g. vehicle activated speed limit signs).

4.2.4 Pedestrians

Primary Treatments

Provision of Safe System infrastructure for pedestrians included physical separation, and provision of lower speed environments.

Physical separation included provision of grade separation for pedestrians, as well as separate facilities (e.g. footpaths and pedestrian malls).

It was recognised that survivable speeds for pedestrian-vehicle conflicts were around 30 km/h, and that there is a need to physically restrict vehicles to these sorts of speeds to achieve Safe System outcomes (i.e. provision of traffic calming). Raised crossing points (i.e. Wombat crossings – see Figure 4) were also suggested as providing a safe crossing solution. It was noted that facilities for pedestrians need to be safe and convenient for them to be used.

Figure 4: Raised pedestrian or 'Wombat' crossing

Land use planning was seen as important in providing Safe System infrastructure for pedestrians. This included providing an adequate functional road hierarchy (e.g. by-passing high pedestrian areas so that low speed environments could be provided, reducing exposure by positioning commercial premises so as to reduce the necessity for pedestrians to cross the road, off-road drop-off facilities).

Supportive Treatments

Other initiatives that will help deliver safety improvements (although not necessarily to Safe System levels) include interim speed limits (e.g. 40 km/h – a speed that is above what is generally considered survivable, but would deliver a benefit over current 50 km/h limits), pedestrian signals (including dwell on red systems, signal linking), pedestrian fencing, provision of medians or refuge islands, electronic warning signs or systems, improved lighting, improved skid resistance, and parking restrictions.

4.2.5 Motorcycle/cycle

Primary Treatments

Some form of separation was suggested as the most effective Safe System improvement for both motorcyclists and cyclists (see Figure 5 for an example of an off-road cycle path). However, given the current level of motorcycle usage, these were thought hard to justify for motorcyclists. Other suggestions that might provide improvements for motorcyclists include the provision of one-way streets in urban areas, providing motorcycle-friendly barriers and lower speed limits.

Figure 5: Separation for cyclists through an off-road cycle path

Supportive Treatments

Suggested ways of providing some improvement in safety for motorcyclists, included an improved road surface (e.g. through improved maintenance, and sealing of side roads), improved clear zones, improved curve alignment, protected right turns (fully controlled), and fixed speed cameras.

Initiatives to provide some improvement for cyclists included on-road cycle lanes, lower interim speed limits (e.g. 40 km/h), and an improved road surface.

4.3 What are the challenges to implementation?

During discussions for each of the crash types identified above, challenges to implementation were also identified. Many of these are the same for each crash type, so this section generally combines them.

Cost was identified as one of the main challenges to implementing a Safe System. Many of the key infrastructure improvements are also the most costly (e.g. grade separation). In addition, with increased infrastructure, there is also often a need for increased maintenance, and there is a cost attached to this. It was considered that although the implementation of a Safe System is likely to be expensive, lack of safety is more costly.

The timeframe in which to implement Safe System infrastructure is important, as funding levels will require that it is delivered over some years. If a long term perspective is taken, it becomes more feasible to implement more significant improvements. If the costs can be shared over many years, perhaps there would be less requirement for an overall increase in expenditure on safety to implement a Safe System.

There is a requirement for better understanding of current assets and asset condition. This information is needed in measuring our progress towards Safe System implementation (see Section 4.4), and this implies some form of data collection. There is also a need for improved knowledge of how assets and asset condition impact on safety.

Community and government acceptance is likely to be a barrier to implementing a Safe System. In order to deliver a Safe System there is a requirement to reduce speeds on many parts of the road network, and different groups will require convincing about the benefits of this. It was considered that the public generally trust road designers and that they assume the road network is inherently safe, or at least safer than it actually is. Therefore, there is a strong need to the make the public and decision makers more aware of the risks associated with using the road. Similarly, there is a need to debunk some of the myths surrounding lower speed limits, including the impact that lower speed limits have on travel times. In order to change public and political perceptions on these and other issues, it will be important to engage with the public, politicians and the media.

Various governance and organisational challenges were identified. These included the need to work across various departments internally, and externally. There will be a strong need for inter-agency planning and coordination in delivering a Safe System.

Engagement at the network planning stage is particularly important, including addressing issues such as access control and land use planning.

There is a possibility of an incompatibility between travel modes when introducing Safe System infrastructure. Infrastructure designed to improve the safety for one mode may produce a reduction in safety for another mode.

Other specific challenges were identified for specific treatments. These included:

- access issues related to the introduction of wire rope barrier
- environmental and heritage issues (e.g. clear zones require removal of trees).

4.4 How do we measure progress towards achieving a Safe System?

A number of useful suggestions were made regarding how progress towards meeting a Safe System could be measured. Many of these centred around monitoring the effects of interventions on crash outcomes. These included changes in:

- total crash numbers
- high severity crashes (e.g. serious and fatal)
- specific crash types (e.g. run-off-road, head-on)
- proportion of specific crash types to total crashes
- crash rates (e.g. crashes divided by traffic volume or per kilometre).

A number of recommendations centred on the monitoring of infrastructure, or infrastructure improvements. Examples included the percentage of the network treated to some Safe System standard, including:

- the installation of central barriers
- kilometres of bike track
- intersections that are grade separated
- infrastructure that met a certain AusRAP star rating (e.g. 4 star or 5 star).

A number of these suggestions were qualified by reference to some sort of functional hierarchy or based on volumes. A functional hierarchy is one that is based on a consideration of the role of specific routes or parts of the network. Some parts of the network may serve a travel function, and so need to cater for high speed traffic. Others serve mainly a local use function, and so should have a slower speed environment. Others fit somewhere in between these two extremes.

Similarly, some measures included monitoring of the percentage of travel on a Safe System network. It was also suggested that a performance criteria might only need to be met if it applied to high volume roads. However, there was not general agreement on this issue. It was concluded that regardless of the type of road, road users deserved infrastructure that would be survivable.

Measurement of speeds featured highly, either targeted at specific crash types (e.g. speed through intersections), or through general monitoring of speed trends. Similarly, others suggested some assessment of traffic offences, including speeding.

Other suggestions included:

- a measure of community acceptance and understanding of safety issues
- impact of treatments on efficiency of the network
- expenditure and cost benefit analysis
- assessment of other health outcomes – e.g. from increased cycling, walking.

5 CONCLUSIONS AND RECOMMENDATIONS

This section provides some of the key findings from the discussions. These are based on the interpretations of the report authors, and do not necessarily reflect the views of all individual attendees.

5.1 Key Messages

Change of focus

The shift from crashes to casualties as the focus for road safety improvements is important. More specifically, under the Safe System approach there is a need to reduce fatal and serious injury outcomes. Therefore, the focus for safety improvements should be on a reduction in fatal and serious injuries. This should be reflected in performance targets.

Current position

Good progress is being made in road authorities in the implementation of a Safe System. Various approaches are being taken, and each jurisdiction is at a different point in terms of implementation. There is a need to monitor this implementation, and assess outcomes to determine best practice. There is also a need to share this information (both positive experiences, and approaches that are not so successful) so that jurisdictions can learn from each other.

Current demonstration projects being undertaken in various jurisdictions will be very informative and should help form guidance about the successful implementation of a Safe System. Monitoring and evaluation of these projects is essential to realise the full potential of these projects, and to help establish and promote best practice.

Infrastructure

There is a need to think of infrastructure in a broad sense, rather than constrict perspectives to a traditional definition of infrastructure. As an example, the 'virtual' road network will have an important role in delivering Safe System outcomes, for example by providing information to motorists about likely hazards.

Safety Treatments

The distinction between Primary and Supportive road safety treatments is a useful one. Primary treatments are those that directly provide a Safe System outcome, for example by reducing impact forces (e.g. through the provision of barriers), or by separating different users (e.g. by providing pedestrian facilities, or grade separation). Supportive treatments assist in delivering safety improvements, but in a more indirect manner (e.g. by providing information to motorists about the route ahead through signs and line markings). Both are of use, but more use needs to be made of Primary treatments in future in order to meet Safe System objectives.

There is scope to assess treatments that are currently Supportive to determine if adjustments can be made so that they become Primary. For example, doubt was expressed as to whether signalised intersections were Primary treatments based on current design. Redesign, for instance through the use of raised platforms to ensure vehicle speeds of no more than 50 km/h through the intersection, might help deliver Safe System outcomes.

There is a need to provide 'redundancy' when installing safety treatments. 'Backup' systems are required, as often there will be failures in one or more components. For example, a sign indicating a severe bend ahead is often not adequate to reduce crashes. Under a Safe System framework, more is required to prevent motorists running off the road, or head-on into other vehicles at such locations.

Speed management

Speed management is a significant component of the Safe System approach, working with other components of the road environment to help reduce mistakes made by road users, and delivering safe outcomes when mistakes are made. In addition, if specific Safe System infrastructure cannot be provided (e.g. provision of a safe roadside), management of speeds is a key way to reduce trauma. Understanding the reasons for lower limits is required to achieve public and political support.

Network planning

Engagement at the network planning stage is particularly important, including addressing issues such as access control and land use planning. There is a need for information and education in Safe System principles for those involved in planning.

Road hierarchy

Development of a clear functional road hierarchy for speed management purposes is crucial. A separate urban and rural hierarchy is required. Both require the identification of roads that serve a 'through traffic' function, a 'mixed' function, and a 'local access' function. Speed limits, and the design of the road environment need to be harmonised and consistent on each part of the hierarchy so as to provide a self-explaining road for motorists. It is also likely that different performance indicators would apply on each.

Risk Assessment

Risk assessment will be an important tool in the implementation of a Safe System. It is not adequate to rely on crash history to predict locations where fatal or serious incidents will occur (although of course this information is useful in making such assessments). Knowledge about current assets and traffic volumes is also required to make such an assessment.

Implementation

The timeframe for implementation of Safe System infrastructure is an important consideration. A step process will most likely be required, and over a long term period (e.g. 20 years). Some initiatives can be implemented immediately, but others will require longer. With a focus on longer term objectives, totals costs can be divided over a larger number of years. The total cost per year may not be substantially more than amounts currently spent on safety (including through maintenance and major project budgets) although likely costs still need to be determined.

Institutional management

Institutional management is crucial to the delivery of a Safe System. Delivery of a Safe System must involve all key players, including those within other sections of roading agencies, and other government bodies (e.g. local government, police, health etc.). Also important is engagement with the private sector and members of the public. There are currently some good examples of intra-agency working. For example, the RTA NSW has recognised that safety related budgets are held primarily by those outside of safety teams (e.g. maintenance, major projects). They have therefore positioned themselves to help deliver safety outcomes across the whole of the RTA. There is, however, a need for all road authorities to increase linkages with external agencies and with the community to deliver Safe System outcomes.

Intelligent Transport Systems

Intelligent Transport Systems (ITS) are likely to be a major contributor to the realisation of Safe System. These are likely to have profound implications for Safe System into the future. Many forms of ITS are likely to be self-contained within the vehicle (e.g. roadway departure warning systems). Other forms of ITS are likely to be embedded in the road infrastructure, and provided by the road authority (e.g. the extension of the all-red time at signalised intersections when a possible 'red runner' is identified, or the use of variable message signs to impose speed limits at rural intersections when vehicles are detected on the intersecting roads). Road infrastructure based systems are likely to be particularly important over the next few years while comprehensive in-vehicle systems are developed and rolled out to cover most of the vehicle fleet.

ITS is likely to have a major impact on the management of vehicle speeds, including increased use of point-to-point speed enforcement capabilities, and intelligent speed adaptation (ISA). Although some barriers remain to be overcome, these technologies have the potential to effect a widespread improvement in compliance with speed limits.

In the very long term, ITS may be able to provide a very high degree of protection to the travelling public. If its full promise is realised this may have profound implications for the level of protection required from the infrastructure to achieve a Safe System. Its use offers the possibility of a Safe System that is realisable across all road types, no matter how remote or lightly trafficked. However, it will be a long time before ITS provides a high degree of protection to road users. Even when it does, the principle of redundancy discussed above will require a high standard of infrastructure safety to be provided in a wide range of circumstances.

5.2 Recommendations

Based on the above conclusions, the following recommendations are made:

1. Road safety targets and performance indicators need to relate to casualties, and particularly those with fatal or serious injury consequences.
2. Formal sharing of knowledge about Safe Systems between jurisdictions is required, including results from current demonstration projects.
3. There is a need for further development and greater use of Primary road safety treatments.
4. The public and policy makers need to be better informed about actual risks when using the road, and the need for lower speeds in certain road environments.
5. A functional hierarchy of urban and rural roads is required to assist in Safe System implementation. This needs to provide a clear distinction between different road classes in terms of their design, appearance and speed limits.
6. Improved knowledge is required about specific high risk locations on the road network. This should be based on a combination of crash history and risk assessment.
7. To deliver Safe System outcomes, road authorities need to improve linkages internally between various operating groups, with local councils and other external agencies, and with the community in general. Of particular importance is the need to improve the link between road safety departments, and those responsible for land use planning.
8. There is a need to assess the role of ITS in Safe System implementation. This assessment needs to consider infrastructure requirements to allow maximum benefits from these emerging technologies.
9. Road authorities need to take a strategic approach to establishing Safe System infrastructure into the future. The roundtable identified a suite of short to long term measures that will help in this approach. A major part of this strategic approach will be to ensure that staff are fully aware of Safe System principles and that they apply these in their practice.

This national roundtable event on Safe System infrastructure appears to have been successful in meeting its objectives and in identifying future directions for developing infrastructure that will deliver Safe System outcomes. Discussions on Safe System outcomes and speed management have already commenced at the national level with a successful Austroads workshop held in February. In order to ensure that Safe System benefits are maximised, it is suggested that there is a need to hold similar events to examine the other important complementary aspects of Safe System implementation. Of particular importance is an examination of how Safe System outcomes can be delivered through safer road users (e.g. education, licensing and enforcement) and safer vehicle design.

APPENDIX A SAFE SYSTEM SUMMARY

The Safe System approach reflects a holistic view of the combined factors involved in road safety. A Safe System protects responsible road users from death and serious injury by taking human error and frailty into account, and has four essential elements:

- alert and compliant road users
- safe roads and roadsides
- safe speeds
- safe vehicles.

The Safe System approach entails a focus on crash prevention and shared responsibility for road safety. However, it also recognises the limits of human performance – that we all make mistakes. Humans cannot physically tolerate violent forces beyond certain thresholds which are often exceeded in crashes. Therefore a safe road system must be forgiving of human error that leads to a crash, so that when crashes do occur, deaths and serious injury are avoided. The Australian Transport Council (ATC) has developed a diagram that represents the Safe System approach to road safety (Figure A.).[2]

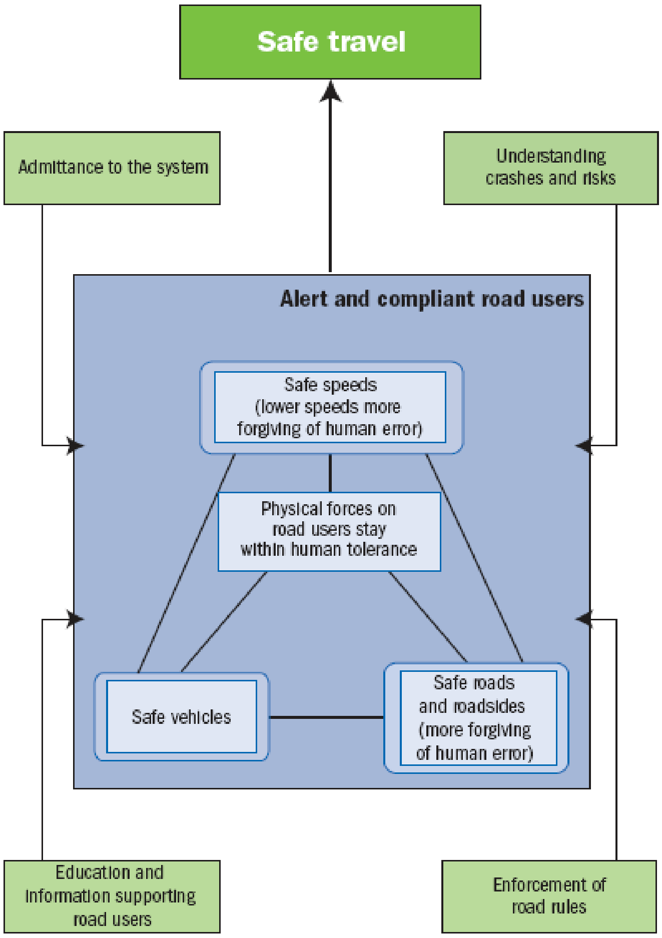

Figure A.1: Diagrammatic representation of the Safe System approach

[2] National Road Safety Action Plan; http://www.atcouncil.gov.au/documents/pubs/ATC_actionplan0910.pdf

The Safe System approach to road safety requires that[3]:

- Roads and roadsides are designed and maintained to reduce risk to as low as reasonably practical.
- Speed limits are set according to the safety of the road and roadside.
- Road users are advised, educated and encouraged to comply with road rules, and be unimpaired and alert, and drive according to the prevailing conditions.
- Consumers are encouraged to purchase vehicles with primary safety features (that reduce the likelihood of a crash, such as electronic stability control) and secondary safety features (that reduce injury severity in a crash, such as side curtain airbags).

The Safe System approach also encourages a better understanding of the interaction between the key elements of the road system: road users, vehicles, roads and roadsides, and travel speeds.

[3] Safe System at the Local Level; http://www.roadwise.asn.au/safesystemapproach/Documents/safesystematlocallevel

APPENDIX B LIST OF RESOURCES

B.1.1 Australian documents

Australian Transport Council 2008, National road safety action plan: 2009 and 2010, ATSB, Canberra, ACT. Available at www.atcouncil.gov.au/documents/actionplan_0910.aspx

Austroads 2006, Guide to Road Safety Part 1: Road Safety Overview. Austroads, Sydney, Australia. Available from www.austroads.com.au

Austroads 2008, Guide to Road Safety Part 3: Speed limits and speed management. Austroads, Sydney, Australia. Available from www.austroads.com.au

B.1.2 Various state road safety strategies

South Australia(http://210.247.132.180/alt-host/assets/pdf_file/0014/32423/rd_safety_action_plan.pdf)

Victoria (http://www.vicroads.vic.gov.au/Home/RoadSafety/)

Western Australia (http://www.officeofroadsafety.wa.gov.au/index.cfm?event=strategiesNewStrategy2008-2020)

B.1.3 International documents

Global Road Safety Partnership (2008) Speed management: a road safety manual for decision-makers and practitioners. Global Road Safety Partnership, Geneva, Switzerland.

Organisation for Economic Co-operation and Development (2008), Towards zero: ambitious road safety targets and the safe system approach. Organisation for Economic Co-operation and Development (OECD), Paris, France.

Tingvall, C 1998 The Swedish 'Vision Zero' and how parliamentary approval was obtained. Road Safety Research, Policing, Education Conference, 1998, Wellington, New Zealand.

Wegman, F & Aarts, L (eds.) 2006, *Advancing sustainable safety: National Road Safety Outlook for 2005-2020.* SWOV Institute for Road Safety Research. http://www.swov.nl/rapport/DMDV/Advancing_Sustainable_Safety.pdf. Viewed 8th December, 2006.

APPENDIX C LIST OF ATTENDEES

Name	Organisation
David Quinlan	ACT TAMS
Blair Turner	ARRB Group
Chris Jurewicz	ARRB Group
Gerard Waldron	ARRB Group
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Peter Cairney	ARRB Group
Peter Croft	ARRB Group
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Julie Holmes	DTEI, South Australia
Marcia Bienke	DTEI, South Australia
Martin Small	DTEI, South Australia
Phil Allan	DTEI, South Australia
Stephen Pascale	DTEI, South Australia
Eric Howard	Eric Howard & Associates
David Moyses	MRWA
Des Snook	MRWA
Courtney Krause	NTC
Jeff Potter	NTC
Lea Morgan	NTC
David Eyre	NZ Ministry of Transport
Colin Brodie	NZTA
Lyndon Hammond	NZTA
Delia Atkinson	QDMR
Jon Douglas	QDMR
Owen Arndt	QDMR
Pam Palmer	Queensland Transport
Peter Daly	RACV / AAA
Michael de Roos	RTA NSW
Pat Kenny	RTA NSW
David Healy	TAC
David Barton	VicRoads
Ed McGeehan	VicRoads
James Holgate	VicRoads
Jamie Favaloro	VicRoads
Ken Hall	VicRoads

APPENDIX D SYNDICATE GROUP FEEDBACK

Questions for consideration:

- What should Safe System infrastructure look like (to prevent fatal or serious injuries) for the following key crash types – short to long term options?
  - Run-off-road
  - Intersection
  - Head-on
  - Pedestrians
  - Motorcyclists/Cyclists
- What are the challenges to implementation?
- How do we measure progress?

D.1 Run-off-road

D.1.1 What should Safe System infrastructure look like for this crash type?

Long term vision

- provision of a hazard free roadside environments, or a roadside where there are no unprotected hazards in clear zones. If a vehicle did leave the road it would not result in death or serious injury (stage 1)
- vehicle technologies that prevent the vehicle leaving the road. Need to ensure that there is a back-up so as to not rely on the one system (stage 2)
- urban:
  - underground power poles
  - apply speed limits maximum of 50 km/h where there are roadside hazards
  - provide protection for ‘significant’ trees, otherwise a lower speed limit.

Short term options

- urban
  - apply appropriate lower speed limits
  - establish traffic calming treatments
  - targeted removal of roadside hazards
  - develop and install ‘crash cushions’
- rural
  - targeted treatment of sections of road with high run-off-road crashes/km
  - removal or shielding of hazards within clear zone
  - lower speed limits if unable to remove or shield roadside hazards – need to make this understandable to the public through public/professional education
  - target sections of road with ‘moderate’ run-off-road crashes with:
    - audio-tactile edgelines
    - shoulder sealing
    - low cost median treatments
    - speed limit reduction
  - based on ‘risk’ remove, relocate or shield roadside hazards

- ensure road geometry, delineation and signage requirements are applied to assist keep the vehicle on the road
- align speed limits with crash risk and casualty crash outcomes.

D.1.2 What are the challenges to implementation?

- political will
- finance (especially assets)
- government and community acceptance
- environmental issues and mobility demands
- evaluation and feedback
- data collection
- debunking travel time myths
- adopting willingness to pay
- public transport at intersections
- gaining a better understanding of asset condition and safety
- public utilities in road reserve
- cultural issues - silo mentality
- changing actual speed when speed limit changes.

D.1.3 How do we measure progress?

- 'before' and 'after' implementation analysis of crash rates
- trauma outcomes
- track and compare run-off-road crashes with all crashes
- examine the impact on the efficiency of the road network
- proportion of travel on 'safe system' roads.

D.2 Intersection crashes

D.2.1 What should Safe System infrastructure look like for this crash type?

Long term vision and short term options.

- implement collision avoidance technology (long term)
- high volume intersections – remove potential conflict at intersections to avoid fatal or serious injury crashes (short to long term)
- avoid all conflicts resulting in fatal/serious injuries (short to long term)
  - grade separation
  - traffic signals (e.g. dwell on red phase, low speed limits, enforcement, grade separation, and full control of movements)
  - ITS solution linked to vehicle controls (e.g. breaking control)
  - roundabouts – improved design
  - platform (raised) intersections
  - route guidance to assist avoidance of intersections
  - restrict movements at intersections
  - design for the user – road hierarchy

  - network planning to reduce the number of intersections
- speed limits and speed management (short to long term)
  - active (e.g. 'Slow Down') vehicle actuated signs
  - to suit all road users (e.g. self-explaining roads, pedestrians and cyclists)
  - infrastructure informing speed limits.

D.2.2 What are the challenges to implementation?

- community acceptance of reduced speeds
- raising awareness of risks
- cost
- network planning
  - access control
  - abutting development
- capacity constraints
- sustainability
  - choice of mode; more walking or cycling; public transport
  - mode priority.

D.2.3 How do we measure progress?

- reduction in casualty crashes at intersections
- number of intersection types/treatments
- percentage of intersections fully controlled
- speeds through intersections
- (safety) star ratings.

D.3 Head-on

D.3.1 What should Safe System infrastructure look like for this crash type?

Long term vision

- one-way road system
- use of ITS technologies:
  - collision avoidance and lane departure
  - advance warning of vehicle in wrong lane
  - advance warning of significant distance
- vehicle design (i.e. crash compatibility)
- separation of all vehicles (e.g. light and heavy vehicles)
- duplicate carriageways
- for undivided (high speed) roads install centre of the road barriers (including 2+1) to separate opposing streams of traffic
- improved road geometry (e.g. vertical and horizontal road alignments)
- improved skid resistance.

Short term options

- time/space for all vehicle types (e.g. heavy vehicle and motorcycles)

- use of wire rope barriers (including 2+1)
- provision of wider medians
- provision of overtaking lanes
- speed reduction/management:
  - use of vehicle activated speed advisory signs or similar
  - application of lower speed limit, e.g. reduction to 70 km/h
- improved curve treatments - delineation
- fatigue management, e.g. increased provision of rest areas, use of tactile edge and centre of the road linemarkings
- improve skid resistance
- seal road shoulders
- install advisory (warning) signs at high-risk areas.

D.3.2 What are the challenges to implementation?

- cost (including on-going maintenance)
- risk awareness
- compatibility of treatments for all road users
- access issues associated with heavy and emergency vehicles
- institutional challenges and political will
- community objection, understanding, education and challenging culture
- land acquisition
- environment and heritage
- increase in travel time
- risk of crash migration
- prioritizing actions.

D.3.3 How do we measure progress?

- crash record / crash reduction
- percentage of the road network treated
- crash risk
- changes in speeds / speed trends
- infrastructure changes and amount of travel on a Safe System
- attitudinal surveys (i.e. institutional, political, pedestrians, riders and drivers)
- observational surveys of behaviours
- expenditure - cost benefit analysis
- AADT monitoring and analysis to calculate crash rates
- development of KPI's for the above.

D.4 Pedestrian

D.4.1 What should Safe System infrastructure look like for this crash type?

Long term vision

- physical separation (i.e. grade separation or separate off-road paths)
- separate facilities
- reduction in exposure to crash risk by providing by-pass routes
- land use plans that obviate the need for pedestrians to cross roads
- speed limits
  - reduce to 30 km/h on local roads
  - physically restrict
- provision of facilities that provide safe and convenient pedestrian movement
- management of pedestrian travel patterns/conflicts with motorised vehicles
- improved visibility of school bus stops on rural roads
- design for an ageing population (e.g. kerb transition, traffic signal timings and pedestrian perceptions).

Short term options

- reduce speed limit to 30/40 km/h on local roads
- provide a 'Stop' rule at stopped buses (similar to that of trams)
- installation of/or retrofitting of pedestrian facilities to provide:
  - pedestrian crossings
  - puffin/pelican or wombats
- for signalised intersections:
  - apply all-pedestrian 'scramble' crossing phase
  - dwell on pedestrian phase
  - provide wide crossing walk lines
  - provide for an automatic pedestrian phase introduction and extension of green walk
  - link or coordinate traffic signals
  - establish pedestrian facilities across all legs
- provision of medians wide enough to store pedestrians
- provide pedestrian signage
- install electronic warning signs/systems (e.g. flashing LED on crossings)
- install pedestrian fencing
- establish pedestrian shared zones/malls
- restrict parking
- implement in a consistent manner LATM treatments
- separate pedestrian facilities from cyclists
- provide off-road pedestrian drop-off facilities
- improve lighting
- improve skid resistance.

D.4.2 What are the challenges to implementation?

- cost
- institutional challenges and political will/conceptions
- community objection, understanding, education and challenging culture
- environment and heritage
- increase in travel time
- risk of crash migration
- increase in congestion (i.e. increase greenhouse emissions and driver frustrations)
- town planning (i.e. their willingness and skill to encourage safe roads and roadsides)
- inter-agency planning (including local government)/coordination
- conflicting priorities.

D.4.3 How do we measure progress?

- crash record / crash reduction
- percentage of the road network treated
- crash risk
- changes on speeds / speed trends
- infrastructure changes and amount of travel on a Safe System
- attitudinal surveys (i.e. institutional, political, pedestrians, riders and drivers)
- observational surveys of behaviours
- expenditure - cost benefit analysis
- AADT monitoring and analysis to calculate crash rates
- development of KPI's for the above.

D.5 Motorcyclists/Cyclists

D.5.1 What should Safe System infrastructure look like for this crash type?

Long term vision

- provision of 'generous' clear zone and forgiving barriers on both sides of the carriageway
- establishment of one way routes
- improved skid resistance - road surface patching
- provision of sealed side roads
- (acceptable) separation of cyclist from other road users – levels of separation by speed and cyclist type (i.e. professional to child)
- 'de-motorize' the road
- (lower) speed limit for motorcyclists
- ban motorcyclist/cyclists from high risk routes
- utilisation of rail reserves as cyclist paths.

Short term options

- for motorcycle:

  - ban on high risk roads
  - reduce speed limit and increase enforcement (on known high speed/crash risk routes)
  - retrofitting barriers to reduce their impact
  - improve curve alignment/delineation
  - ensure pavement reliable/maintenance (pavement, gravel on roads, etc.)
- continue to invest in bike paths
- separate bike lanes on roads and reduced speed limits
- provision of protected (fully controlled) right turn at signalised intersections
- retrofit facilities for cyclists
- use of fixed speed cameras
- provide motorcycle friendly roadside furniture posts, guard fence, paint
- speed monitoring to encourage lower speeds.

D.5.2 What are the challenges to implementation?

- cost
- political will/political perception
- user objection
- cultural issues – risk taking
- media pressure
- town planning (i.e. willingness and skill to encourage safe roads and roadsides)
- inter-agency planning (including local government)/coordination
- conflicting priorities.

D.5.3 How do we measure progress?

- less trauma
- number of kilometres of on-road and off-road bicycle tracks
- utilization of on-road and off-road bicycle facilities
- (improved) health outcomes from increased cycling
- number of motorcyclist registrations
- traffic offence numbers (e.g. speeding).

Research Report

ARR 370

Safe System Infrastructure National Roundtable Report

Research Report ARR 370
ISSN 0158-0728
ISBN 0 876592 51 6

ARRB GROUP

www.arrb.com.au