SETTING SPEED LIMITS FOR A SAFE SYSTEM

Prepared by: Jim Langford
Monash University Accident Research Centre

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1. A BRIEF STATEMENT OF THE ISSUE

The strong message emerging from the research is that reduced travel speed following lowered posted speed limits, will result in reduced road trauma, almost regardless of the specific crash causes. Despite this finding, Australian and (to a lesser extent) New Zealand roads and streets have amongst the highest posted speeds in the world.

This paper describes the safety benefits if Australasian jurisdictions were to adopt harm reduction criteria in setting speed limits and suggests a possible way forward, based on a current Austroads research project.

2. AN EXTENDED ASSESSMENT OF THE ISSUE

Australian Standard AS 1742.4[1] provides guidelines for the regulatory management of traffic speeds across Australia, taking account of road environment factors including abutting development, road cross section and traffic composition. The Standard's speed limit designations for Australia's urban and rural roads, are shown over the page in Tables 1 and 2, respectively

Land Transport Rule: Setting Speed Limits 2003 provides the rules and guidelines for setting speed limits in New Zealand. The default urban speed limit in New Zealand is 50 km/h, while the default rural limit and the limit on motorways is 100 km/h. However, the following speed limit variations are allowed:

- 20, 30 and 40 km/h limits may be applied on urban roads where there is a mix of vehicles traffic and pedestrians or cyclists and where mean operating speeds are within 5 km/h of the speed limit
- 60 km/h limits may be set for highly developed urban arterial roads where the infrastructure surrounding the road and the road geometry allow for these higher speeds
- 70 km/h may be set where there is intermediate roadside development, for instance, on the edge of a town
- 80 km/h speed limits may be posted in rural areas where there is some increased activity, and in rural areas within greater urban areas where 100 km/h limit is not appropriate.

Table 1: Hierarchy of speed limits on urban roads described in Australian Standard 1742.4

Speed Limit km/h	Applicable Road Function	Typical Application
10	Local street	Zone shared by vehicles and pedestrians
40	Local street or traffic route	(a) School zone installed within a 60 km/h or 70 km/h zone. (b) Speed limit applicable to a linear or area speed zone established in a local street or local area in combination with physical constraints on existing speed behaviour (i.e., a speed environment) which from speed measurements suggests 40 km/h is an appropriate limit.
50	Local street or local area	(a) generally applicable to a linear or area speed zone established in a local street or local area where a lower limit is not warranted
60	Local street Traffic route	(a) Speed zone on an undivided road having closely spaced access points to abutting development. (b) School zones installed within 80 km/h or 90 km/h speed zones.
70	Traffic route	Speed zone applicable to higher standard routes, generally either: (a) divided roads having provision for safe storage of turning or crossing vehicles but with direct access from abutting development; or (b) undivided roads having low levels of direct access from abutting development
80	Traffic route or freeway	Speed zone applicable to higher standard routes, generally either: (a) divided roads having provision for safe storage of turning or crossing vehicles but with direct access from abutting development; or (b) undivided roads having low levels of direct access from abutting development.
90	 Freeway Traffic route	Speed zone for use: (a) on lower standard urban freeways; or (b) in limited situations on outer urban arterial roads
100	Freeway	Speed zone for high standard urban freeways.
110	Freeway	Speed zone for limited length of very high standard urban freeways.

Note: The Standard has not been updated to reflect the adoption of 50 km/h default urban speed limits in most states.

Table 2: Hierarchy of speed limits on rural roads described in Australian Standard 1742.4

Speed Limit km/h	Typical Application
60	School zone within an 80 km/h or 90 km/h speed zone.
80, 90	Speed zones through small settlements with some abutting development, but not warranting consideration as a built-up area.
100	General rural speed limit or speed zone, applicable in the absence of any other speed zone.
110	(a) High standard rural freeways (b) High standard rural arterial roads or highways

Despite the fact that Australian Standard AS 1742.4 allows for low speeds especially in urban areas, it remains that Australian roads and streets still have amongst the highest posted speeds in the world. New Zealand's current speeds are generally lower than Australia's but above those of many overseas countries.

3. A REVIEW OF THE RESEARCH

3.1 Different approaches to setting speed limits

The relationship between a vehicle's travel speed, the risk of a crash and the severity of outcome once involved in a crash, has been explored in a previous Handbook paper[2]. The research presented in the present paper targets those issues associated with a system approach to setting speed limits.

A survey of countries around the world has shown that there are many different philosophies underlying the setting of speed limits. The two approaches that most closely represent the current situation in Australasia are:

- Engineering philosophy – whereby speed limits are set in response to a range of factors, including the type and amount of roadside development, prevailing traffic speeds, crash data, road geometry and the number of type of road users. Consideration of these factors allows engineers to designate a road design speed with an estimated safety outcome
- Drivers' choice of speed – otherwise known as the "basic law limit", which allows drivers to determine what constitutes a reasonable and safe travel speed. In practice, most applications of this philosophy result in a speed limit initially based upon the majority of drivers' travel speed (usually set at the 85th percentile speed). As a second step, the 85th percentile speeds are usually modified in light of various engineering considerations.

The optimum speed limits philosophy represents a third approach, based on a wider social perspective. It recognises that drivers do not always choose a speed that takes into account for the full set of costs to society: for example, the costs associated with increased risk of crashing and serious injury or with added fuel consumption and higher pollution caused by driving at inappropriate speeds. As such there is a divergence between the desired speed of the driver and the socially optimal speed[3].

As an example of this approach, the Australian Transport Safety Bureau recently funded a project to calculate the optimum speed on Australian urban residential streets with a posted 60 km/h speed limit[4]. 'Optimum speed' was defined as the travel or cruise speed which leads to the total cost of road trauma, travel time, vehicle operating costs and air pollution emissions being at a minimum. It was subsequently calculated that the optimum speed on residential streets for all motorised vehicles was either 55 km/h (using the "human capital" approach to costing road trauma) or 50 km/h (using the "willingness to pay" approach).

Equivalent calculations have also been made for Australian rural roads[5], as summarised in Table 3.

The optimum speed limits philosophy puts a fiscal cost on human trauma. An alternative philosophy argues that life and health cannot be components of any cost-balancing exercise but must be regarded as absolute goals in safety calculations. Two applications of the harm minimization approach are the Swedish Vision Zero and Dutch Sustainable Safety strategies, both of which have been described in a previous Handbook paper[6]. In essence, both Vision Zero and Sustainable Safety accept the need to develop a safe, crashworthy system, wherein individual road users will be protected from death or serious injury in the event of any errors.

Table 3 Estimated optimum speeds for Australian rural roads[5]

Road types	Optimum speed (km/h) (Speed which minimizes total economic cost)		
	All vehicles	Cars, light commercial vehicles	Trucks
Rural freeways:			
Basic scenario[1]	120	125	100
reduced travel time not valued	110	115	100
'willingness to pay' values of road trauma	110	120	95
trucks limited to 100 km/h	n.a.	125	100
Rural divided roads:			
Basic scenario[1]	110	120	95
reduced travel time not valued	105	110	95
'willingness to pay' values of road trauma	105	110	90
trucks limited to 100 km/h	n.a.	120	95
Rural two-way undivided roads[1]:			
Standard 7.0 sealed, no shoulder-sealing	95	100	85
As above, curvy with cross-roads/towns	85	85	85 maximum
Shoulder-sealed 8.5 roads	105	105	90
As above, curvy with cross-roads/towns	85	90	85

Note: [1]Reduced travel time and road trauma valued by the 'Human Capital' approach.

The development of a safe system entails an examination of the complete driving environment (vehicles, roads, the surrounding physical environment, traffic mix, different road users and their behaviour and so on). The principle challenge is to manage crash energy so that no user is exposed to possible impact forces capable of causing death or serious injury. Thus vehicles cannot travel at speeds where in the event of a crash, the release of kinetic energy can produce a serious or fatal injury.

A safe system strategy does not imply that crashes are caused solely (or even mainly) by speed and recognizes that any given crash event is likely to be the result of an interplay of many factors. Accordingly, a safe system approach requires all aspects of the transport system to work together for the safest possible outcomes, with speed representing but one component, albeit a critical one. This is perhaps most evident in the Sustainable Safety system, which comprises three key elements:

- a road network and infrastructure that is predictable and should more or less elicit the correct safe behaviour, including choice of a safe travelling speed
- vehicles that are designed and equipped to simplify the human task and afford protection to occupants when errors occur
- road users that are well informed and educated.

3.2 Implications for setting speed limits in Australasia

Despite the demonstrable safety benefits of reduced travel speeds, Australasian roads and streets still have amongst the highest posted speeds in the world. This is most apparent when the predominant default speed limits in Australia and New Zealand are compared to the speed limits based on harm minimization principles. For example:

	Main speed limit (km/h):			
Road Type	**Sweden**	**Netherlands**	**Australia**	**New Zealand**
Local streets	30	30	50+	50
Other urban streets	50	50	60+	50
Undivided roads (low quality)	70	80	100	100
Undivided roads (good quality)	90	100	100-110	100
Motorways/divided roads	110	120	100-110	100

It needs to be recognized that the above comparison involves some generalization: in Queensland for example, some local streets and other urban streets (or sections thereof) may be posted as low as 40 km/h and undivided roads vary between 60 and 100 km/h. However as a general finding, the comparison emphasises the high speed limits frequently found on Australia's urban road network. In addition, the common practice in setting 110 km/h limits along many of the nation's undivided rural highways, is in contrast to overseas practices.

The speed differences can be readily explained. In both Sweden and the Netherlands, speeds have been set to ensure that no road user will be exposed to crash forces that can either kill or seriously injure him or her. Speed limits thus need to ensure that the specified threshold impact speeds for common crash types are never exceeded, as shown in Table 4.

Table 4 Proposed maximum travel speed based on biomechanical tolerance[7]

Type of possible crash	Possible travel speed (km/h)
Car-pedestrian crash	30km/h
Car-car (side impact)	50km/h
Car-car (frontal impact)	70km/h
Impact with road infrastructure only	100+km/h

Note: These travel speeds assume best practice in vehicle design and 100% restraint use.

Australasia has traditionally adopted a transportation model representing a balance between safety and mobility, thereby allowing higher speeds than those stipulated by harm minimization criteria. It remains however that lower speeds, and particularly lower urban speeds, could be introduced under Australian Standard 1742.4 or New Zealand's Land Transport Rule: Setting of Speed Limits 2003. Australian Standard 1742.4 would allow for example, the following scenarios:

- local streets with a limit as low as 10 km/h, where the zone is shared by vehicles and pedestrians
- local streets with a 40 km/h limit, if supported by appropriate traffic and speed control devices.

3.3 A possible way forward for setting Safe System speed limits in Australasia

An Austroads project aimed at devising a method for setting speed limits in Australasia based on harm reduction principles, is currently underway, with a Stage 1 report having already been released[8]. Since the release of the report, the project has further developed its directions, to cover the following issues.

- **Support for speed limits based on harm minimization principles**

It was recognized that substantial speed reductions would inevitably result in initial opposition from motorists and others. However it was argued that Australian jurisdictions through their commitment to the current national road safety strategy and to the new Austroads Safe Systems approach may have already indicated sufficient support for safety as a key component in setting speed limits, to justify aiming at a full harm minimization model. The extent to which this support holds up in practice however has yet to be determined.

- **The new speed limits are not a substitute for infrastructure improvements.**

Speed changes arising from the new approach are not to be used as an automatic substitute for physical improvements to the road infrastructure. If a road were assessed as having an unsatisfactory safety profile, the first priority would be to improve that profile through appropriate changes to the road infrastructure. Any changes to speed limits should occur only when infrastructure changes were, for whatever reasons, not feasible or until infrastructure improvements could be made.

- **Setting the speed limits**

Where infrastructure improvements cannot be made in the short term, a possible starting point to considering default speed limits would be not the road design features, but foreseeable types of crashes likely to occur along different types of streets and roads. Speed management could then be used as a primary (but not exclusive) factor in either preventing the main and most damaging crash types or reducing the severity of those crashes which do occur.

An example of this approach[7, 9] is to target three major crash types and associated maximum permissible speeds:

- where head-on crashes or crashes into a rigid object were possible, the maximum permitted speed would be 70 km/h
- where side-impact crashes were possible, the maximum speed would be 50 km/h
- where crashes into pedestrians or bicyclists were possible, the maximum speed would be 30 km/h.

This approach would most immediately affect the urban road network and in an Australasian context, would cover three main categories of roads and streets:

- through-traffic routes (which broadly correspond to divided multi-lane arterial roads), where speed between intersections is mostly at 70 km/h and through intersections at 50 km/h
- 50/30 streets (which broadly correspond to single-lane collector roads), where speed is mainly at 50 km/h, except at designated pedestrian and bicycle crossings
- 30 streets (which broadly correspond to residential streets), where speed is limited to a maximum of 30 km/h.

The above categorisation of road types does not take into account undivided multi-lane arterial roads. To be consistent with harm minimization principles, speed limits on these roads would need to be set at 50 km/h.

This approach has not been directly applied to the rural road network. However, using the principle of reducing the severity of foreseeable crash types, preferably through infrastructure but if not immediately possible, through speed management, it would be reasonable to expect the following:

- undivided roads of low quality where speed is mostly set at 70 km/h
- undivided roads of high quality (with as a minimum, crashworthy mid-barriers and clear or crashworthy road sides), where speed is mainly set at 90 km/h
- motorways/divided roads (with as a minimum, crashworthy mid-barriers and clear or crashworthy road sides), where the set speed is limited to a maximum of 110 km/h.

- **Varying the default speed limits**

The new approach readily allows for variations to the main speeds in response particularly to the quality of the road infrastructure. Through-traffic routes can be posted at 90 km/h if the alignment and intersections are of a high standard and if there are long distances between intersections – but may be reduced to 30 km/h if there are designated but unprotected pedestrian or cyclists crossings. A single-lane collector road used by cyclists but without sufficient width to allow a 2-metre two-way cycle track, needs to be lowered to from the customary 50 km/h to 30 km/h.

The need to vary the basic designated speeds is determined predominantly by the probability of crashes occurring at speeds likely to result in serious injury or death. While changes in roadside development may contribute to this probability, the changes themselves do not constitute a reason for speed variation.

4. POLITICAL, SOCIAL AND OTHER FACTORS

Motorists in Australia particularly, are accustomed to relatively high travel speeds. The introduction of a full harm minimization approach to set speed limits in Australia and New Zealand would involve substantial reductions in speed limits over much of both countries' road networks. At least in the short to medium term, it is likely that the new posted speed limits will meet with considerable resistance, which in turn will give rise to major compliance issues. Subsequent issues needing to be addressed will include how to ensure compliance without unrealistically large funding either to boost enforcement compliance or to provide physical treatments to force speed reductions.

In addition, an approach to setting speed limits which places a stronger emphasis on safety outcomes is likely to be resisted by some engineers used to placing greater importance upon traffic flow, reduced traffic congestion and general travel and mobility efficiencies. Further, many engineers traditionally manage speed only by changing the speed environment rather than by considering changing the speed limit where lower speeds are desirable but the environment cannot be changed for some time. Such resistance may produce implementation issues within road authorities, unless accompanied by appropriate staff training.

Further, the default speed limits based on safe system principles as outlined in the previous section undoubtedly pose a range of practical difficulties which will need to be overcome. For example, the need for reduced travel speed through intersections is problematic, given the need to avoid excessive numbers of changes in posted speeds across the road network. As another example, alterations to the physical road environment to encourage lowered speeds particularly in residential areas may disadvantage various forms of public transport. In addition, any alterations in speed setting practices need as far as possible to be consistent with standard engineering practices, such as ensuring minimal numbers of speed limit changes, restricting the amount of variation in limits and ensuring that speed limit changes are appropriate to the general speed environment.

Some opposition can also be expected especially from commercial freight operators who are likely to associate any reduced speeds with increased travel times and hence disruptive to existing freight schedules. While the full implications of any changes in speed limits in this context need to be carefully evaluated, care must be taken not to exaggerate the possible impact. For instance, in urban areas, speed and travel time are largely determined by traffic volume and traffic management, with motorists' speed choice having little effect on their ultimate journey time. In rural areas, while travel times are more likely to be influenced by travel speed, time savings are still dependent on opportunities to travel at the chosen speed. In addition, it can be questioned whether savings in travel time necessarily transfer to productivity gains. Savings in travel time for truck drivers for example, must lead to more trips and faster service of their goods to market if they are to result in genuine cost savings. Similarly, for commercial travellers, faster travel times back to base must translate to real improvements in sales or work throughput, if time saved is to have a financial value. It cannot be assumed that any or all of a reduction in travel time is directly translated into productivity improvement.

Prolonged political and community support will be critical if this new approach is to overcome these factors and is to have an impact on speed setting practices. Education programs alerting motorists to the dangers of speeding may have a role in promoting the benefits of reduced speeds and encouraging more ready compliance without the need for sustained intensive enforcement.

5. CONCLUSIONS

A reduction in travel speed will result in reduced road trauma, almost regardless of the specific crash causes. Given that Australia and to a lesser extent, New Zealand, have amongst the highest posted speed limits in the world, there is ample scope to reduce road trauma through adopting a different philosophy for setting speed limits. This paper outlines a way forward.

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