Australian Government

Department of Transport and Regional Services

Bureau of Transport and Regional Economics

workingpaper 59

ROAD SPEED LIMITS

ECONOMIC EFFECTS OF ALLOWING MORE FLEXIBILITY

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ISSN 1440-9707

ISBN 1-877081-38-8

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Printed by the Department of Transport and Regional Services

Desktop Publishing by Jodi Hood

FOREWORD

In managing speed on roads, governments have taken a regulatory approach, estimating what the best speed is for society as a whole, and then requiring drivers not to exceed that speed. Generally, speed limits apply 24 hours per day, 365 days per year, with the same limit applying to a wide range of roads. However, with modern technology, speed limits on some urban roads change at different times of the day, triggered by different conditions or events.

This brief paper outlines the economics of setting speed limits. Its particular focus is on high speed rural roads where noise and pollution externalities can generally be ignored.

Based on an early version of this paper, the Australian Transport Safety Bureau commissioned the Monash University Accident Research Centre to carry out a more detailed investigation of the issues raised. That paper (*Potential Benefits and Costs of Speed Changes on Rural Roads*, by Max Cameron, Monash University Accident Research Centre (MUARC)) is due for release shortly.

Quentin Reynolds drafted this report. Anthony Ockwell and Phil Potterton provided executive supervision.

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Canberra
September 2003

EXECUTIVE SUMMARY

On rural roads, the speed that a driver chooses will affect their travel time, vehicle operating costs and crash costs. Recent Austroads valuations of these costs are used in this paper to estimate the total economic cost to society of travelling at different speeds on roads with different crash rates. Critical in this analysis is estimating the change in crash cost that would result from a change in vehicle speeds. This report assumes a 10 km/h change in average speeds produces a 30% change in crash costs based on international evidence.

For a hypothetical mix of cars and trucks on a rural road with an average crash cost, the speed that produces the lowest total of travel time cost, vehicle operating cost and crash cost is between 90 and 100 km/h. On a hypothetical road with a low crash rate (and a crash cost one quarter of the average), the optimum speed is between 110 and 120 km/h.

Achieving different speed regimes is not just a matter of changing the posted speed limit. The paper concludes by suggesting that ITS technology could be used to vary and manage speeds.

ROAD SPEED LIMITS—ECONOMIC EFFECTS OF ALLOWING MORE FLEXIBILITY

On any particular road, *increasing the speed limit* for certain vehicles will generally:

- *increase* the number, severity and cost of road crashes;
- *decrease* the travel time for vehicles that go faster;
- *increase* the resources used in operating those vehicles and the noise impacts on the community (if speeds are above about 60 km/h).

In rural areas with speed limits between 80 and 110 km/h, *decreasing* the speed limit will have the opposite effects[1].

The main impacts (crash costs, the value of travel time and vehicle operating costs) are the principal elements that influence the economic cost of using transport infrastructure. A recent innovation is to use Intelligent Transport Systems (ITS[2]) to make changes to the speed limit, as well as to provide other information to drivers. ITS could play a greater role in this area.

Governments are faced with an ongoing challenge:

1. With increasing concerns about road fatalities, the community expects all measures to be used—vehicle design, speed limits, advertising, enforcement measures and the latest technology—in order to minimise the impact on society.
2. Changes that increase the cost of transport (especially for freight) decrease the competitive position of our goods and services in world markets, and so reduce Australia's overall standard of living (or equally result in lower growth than might otherwise occur).
3. The cost of technological advances continues to decline, making ever more sophisticated projects in the transport sector economically viable.

1 These general assessments apply in relatively high-speed environments. In low speed environments, travel time and crash costs maintain their trends. But vehicle operating costs (VOC) change: at both high and low speeds, VOC can be quite high and is at a minimum somewhere between 50 and 70 km/h, depending on vehicle type.

2 Principally, ITS systems constantly measure vehicle numbers and/or vehicle speeds and sometimes weather conditions. And when predetermined conditions are met, give advice to drivers. This can include warning information, alternative route information and changes in speed limits.

In meeting this challenge, there may be merit in undertaking a review of maximum speed limits in Australia and a broad assessment of the likely best locations to make better use of the latest ITS technologies.

People value their time. Austroads publishes valuations of travel time for different vehicles. Their latest advice on the value of travel time is shown in table 1. This data suggests that, in rural areas, the travel time for a private car is valued at $14.50 per hour; for a business car, $35.33 per hour; for a heavy 3 axle truck, $22.90 per hour; and for a 6-axle articulated truck, $32.66 per hour.

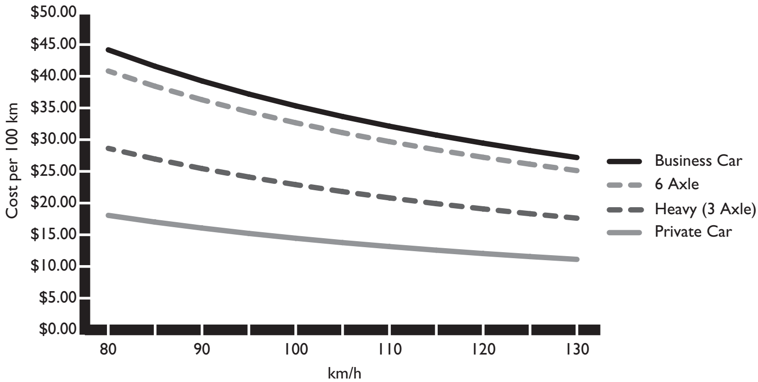
Table 1: Economic value of travel time (valuations as at September 2000).

	Rural		Urban		Freight Travel Time	
Vehicle Type	Occupancy Rate *(Persons/ vehicle)*	Value per Occupant *(Per hour)*	Occupancy Rate *(Persons/ vehicle)*	Value per Occupant *(Per hour)*	*(Value per vehicle-hour)* Rural	Urban
Cars						
Private Car	1.7	$8.50	1.6	$8.50	$0.00	$0.00
Business Car	1.3	$27.18	1.4	$27.18	$0.00	$0.00
Rigid Trucks						
Light Truck (2 axle 4 tyre)	1.3	$17.79	1.3	$17.79	$0.49	$0.96
Medium (2 axle 6 tyre)	1.2	$18.13	1.3	$18.13	$1.32	$2.60
Heavy (3 Axle)	1	$18.62	1	$18.62	$4.28	$8.43
Articulated Trucks						
4 Axle	1	$19.28	1	$19.28	$9.73	$19.16
5 Axle	1	$19.28	1	$19.28	$12.41	$24.43
6 Axle	1	$19.28	1	$19.28	$13.38	$26.35
Combination Vehicles						
B Doubles	1	$19.60	1	$19.60	$19.36	$38.14
Double Road Train	1	$20.42	1		$25.88	
Triple Road Train	1	$20.91	1		$38.14	

Source: Austroads AP-R218 – Economic evaluation of road investment proposals, 2003 (valuations as at September 2000).

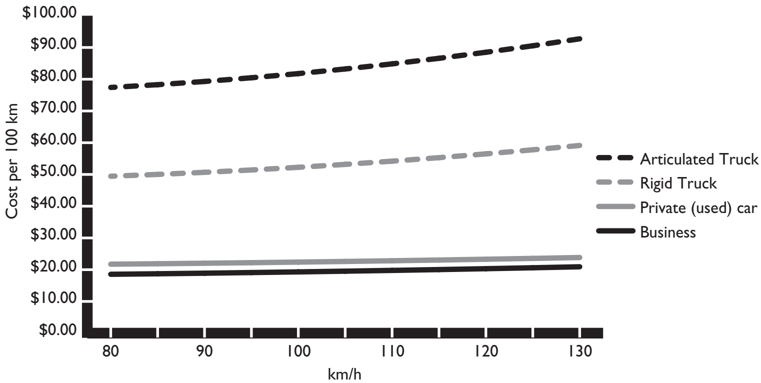
Leaving aside speed limits and perceptions of safety, in terms of travel time alone then the faster the trip the lower the cost, as in figure 1.

Figure 1: Travel time cost Vs speed



These curves are based on the values of travel time in table 1 above. But as freeway speeds go up, so do vehicle operating costs, as in figure 2.

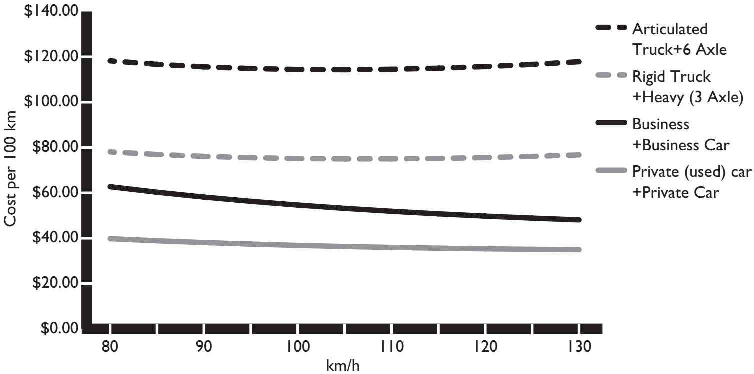
Figure 2: Vehicle operating cost Vs speed



Source: Austroads AP-R218 – Economic evaluation of road investment proposals, 2003 (valuations as at September 2000).

For various reasons relating to the source data, the vehicle categories in figures 1 and 2 do not correspond exactly. However, combining the above operating costs and travel time costs for appropriate pairs gives the results shown in figure 3.

Figure 3: Travel time cost plus vehicle operating costs Vs speed



If the above data are correct, then this last figure shows that the average rigid or articulated truck should operate at about 100 to 110 km/h to produce the minimum of travel time cost plus operating cost[3]. For trucks, travelling significantly below these speeds or significantly above these speeds will result in higher costs. The data for cars suggests that a higher speed would minimise the sum of these costs (the minimum is off the scale to the right).

Crash incidence, crash severity and average crash costs increase with speed. As speed increases, the amount of time available for drivers to react decreases, braking distances increase, impact speeds increase and crash energy increases. Empirical evidence in Europe and in Australia suggests that, in general, for each 1 km/h change in mean speed, there will be a change in the order of 2 to 3 percent in the number of injury crashes[4]. At highway speeds, a 10 km/h change to average speeds could change accident costs by about 30%.

Many site specific differences in travel conditions (vehicle types, vehicle numbers at various times of the day, road types, weather

3 This is based on resource costs. For particular drivers, various taxes will distort the curves, as will various contractual obligations that they may have entered into. Their financially optimum driving speed may be higher or lower.

4 Similar comments are in a report for the Managing Speeds of Traffic on European Roads project, on the internet at http://www.vtt.fi/rte/projects/yki6/master/sum411.htm (*Recommendations for Speed Management Strategies and Tools,* by V-P Kallberg, R E Allsop, H Ward, R van der Horst & A Varhelyi).

conditions, visibility, trip purpose, school holidays, etc) all combine to add such complexity so as to make a general overview of crash potential virtually inapplicable at any particular site. Despite this, some indicative analysis can be undertaken.

Austroads publishes performance measures for Australian roads which, when adjusted to the latest BTRE value of life estimates[5], suggests that the cost of serious casualty crashes is about $6 m per 100 million vehicle kilometres travelled. On roads with excellent road conditions, like freeways, crash costs are about one quarter of the average figure[6]. On a hypothetical road with a low ($1.5 m) crash cost[7], a 10 km/h *increase* in average speeds might *increase* crash costs by up to $0.5 m. On roads with average ($6 m) crash cost, a 10 km/h *decrease* in average speeds might *decrease* crash costs by up to $2 m. These changes in crash cost are about the same size as the travel time and vehicle operating costs changes. And this suggests the opportunity for lowering transport costs: by increasing average speeds on roads with well below average accident potential; and by decreasing average speeds on roads with an accident history that is average or above.

To show this possibility, two hypothetical roads being used by a hypothetical mix of vehicles (40% private cars, 40% business cars, 10% rigid trucks and 10% articulated trucks—the same vehicle groups as in figure 3) are considered. On one road there is an average crash rate and on the other a low crash rate ($6 m and $1.5 m crash costs at average speeds of 100 km/h, as above). Figure 4 combines the vehicle operating cost and travel time cost that results from this mix of vehicles, plus the costs of crashes. On this data, 'best' speeds are 90 to 100 km/h for roads with average crash rates and 110 to 120 km/h for roads with a low rate. With fewer trucks, the 'best' speeds would be higher.[8]

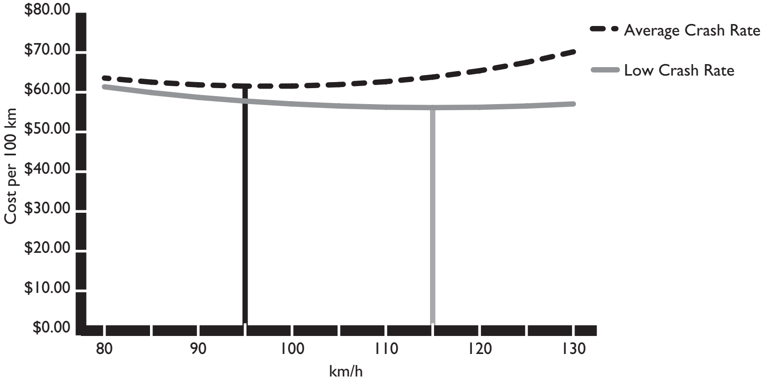
5 On the internet, at http://www.algin.net/austroads/ASP/2_8.asp, Austroads suggests average crash costs of about $3 million per 100 million vehicle kilometres travelled, based on old valuations of crash costs. Using BTRE's latest valuations (Bureau of Transport Economics, Report 102, *Road Crash Costs in Australia,* May 2000), the number used here is $6 million per 100 million vehicle kilometres travelled.

6 Various sources support this ratio. For example the 1999 edition of the Economic Analysis Manual of the Roads and Traffic Authority of NSW (table 9) advises that average accident costs on Local/Sub-arterial roads is $5.5 m, on Freeways is $1.25 m and the weighted average across all (NSW) roads is $4.5 m (these have been converted to the same units as used in this paper - per 100 million vehicle kilometres travelled).

7 All crash costs here are per 100 million vehicle kilometres travelled. $1.5 m is one quarter of the $6 m average.

8 Travel by rigid plus articulated trucks represents about 9% of all vehicle kilometres travelled outside capital city and provincial urban areas in Australia (ABS, *SMVU*, 2003, catalogue number 9208.0). In contrast, along interstate freight corridors, heavy vehicles can be over 40% of the traffic.

Figure 4: Average crash rate road and Low crash rate road (with mixed traffic) Vs speed



Within the two road categories shown there may be the possibility to differentiate roads further, based on crash histories. What this suggests is the potential to reduce overall transport costs by a few percent by varying speeds according to crash potential. In Australia, there are likely to be many more roads that would warrant a lower average speed than the number that would warrant a higher speed regime. This is due to the high accident rate on unsealed roads and the fact that many road alignments were determined when the maximum speeds of vehicles were much lower than today.

But achieving different speed regimes is not just a matter of changing the posted speed limit. Drivers react to many influences in choosing their speed and ITS technology could be used to modify speeds to a higher degree than that achieved by normal signage.

Current examples of ITS in Australia include:

- variable message signs—warning of lane closures (either current or future), vehicle breakdowns, weather conditions, or warnings about enforcement, safety and fatigue issues, etc;
- variable speed limits—generally reducing speed limits as increasing traffic volumes approach unstable flow levels;
- integrated traffic signal systems—which coordinate groups of traffic signals to achieve a smooth, stable flow of vehicles, depending on demand.

Future examples are likely to include variable speed limits based on a compound mix of vehicle types, numbers and speeds as well as road, sunlight and weather conditions; communications with in-vehicle devices to display lane closures, vehicle breakdowns or other warnings; communications with in-vehicle devices to change cruise-control settings; and perhaps eventually to limit maximum speed.

For the present, more wide-spread use of existing ITS technology should be able to reduce transport costs on Australian roads. The recent introduction of 50 km/h speed limits on a ***trial basis*** in the ACT seems a good model to follow. Consideration should be given to:

- Tasking Austroads to establish an expert panel to collect data on travel speeds and crash rates.
- Where improvements (including ITS) should lead to a reduction in transport costs, encourage jurisdictions to implement such improvements in consultation with stakeholders.
- Any such schemes introduced should be reviewed after a few years before deciding to make them permanent.

On those roads with low crash rates, the expert panel should advise whether higher speed limits or variable speed limits might promote faster, safe travel on those roads[9]. On those with high crash rates, the expert panel should advise whether lower speed limits, variable speed limits and/or different speed compliance strategies might promote slower, safer travel on those roads, without sacrificing business efficiency too much.

9 Higher speed limits are almost certain to require more stringent compliance measures, like lower tolerance thresholds for mobile police enforcement, or speed cameras for automatic enforcement.

ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
Austroads	Austroads Incorporated (the association of Australian and New Zealand road transport and traffic authorities), Sydney
BTE	Bureau of Transport Economics
BTRE	Bureau of Transport and Regional Economics
ITS	Intelligent Transport Systems
SMVU	Survey of Motor Vehicle Use