THE MAGICAL PROPERTY OF 60 KM/H AS A SPEED LIMIT?

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ABSTRACT

Kloeden et al (1997) found that *"in a 60 km/h speed limit area, the risk of involvement in a casualty crash doubled with each 5 km/h increase in free travelling speed above 60 km/h."* The findings were at odds with previous research and understanding of speeding and the road environment. Hence Lambert (2000) reviewed the Kloeden et al (1997) data, and concluded that the data supports that risk of crashes is best represented by a U shaped curve around mean speeds, with crash risk rising for very low speeds, and for high speeds. It further suggested that the current speed enforcement tolerances are appropriate.

Further analysis shows that Kloeden et al (1997) report must now be considered to be seriously flawed that the analysis:

- Does not support that there are any magical properties of the number 60 as in 60 km/h
- Fails to highlight that outcomes only apply to free travelling speed crashes (about 28% of serious crashes)
- Fails to recognise that a high BAC applies to the whole trip whereas free travel speed applies to only part
- Fails to adjust for the impact of black spots and black links on the findings, and
- Fails to recognise that speed enforcement does not take place at the crash sites included in the study.

This further work supports higher penalties for offences of exceeding the limit by 15 km/h or more **provided that enforcement is undertaken close to intersections**

INTRODUCTION

The *"Travelling Speed and Risk of Crash Involvement"* report (Kloeden et al. 1997) found that *"in a 60 km/h speed limit area, the risk of involvement in a casualty crash doubled with each 5 km/h increase in free travelling speed above 60 km/h*

Lambert (2000) reviewed the Adelaide data differently, and concluded that the data supports that risk of crashes is best represented by a U shaped curve around mean speeds, with crash risk rising for very low speeds, and for high speeds. It further suggested that the current speed enforcement tolerances are probably appropriate.

This paper considers further factors including

- Consideration of the ability to speed
- Speeding and speed enforcement behaviour.
- High BAC driving versus speeding;
- The impact of black spots and black links on the findings; and
- Estimations of the impact of speeding reduction on total serious crashes

HYPOTHESIS

The hypothesis used in developing this paper is that:

- different speeds are appropriate for different sites in 60 km/h zones,
- speeds above or below site-specific mean speeds are dangerous and result in crashes and
- For responsible drivers, driving is a very safe activity reflecting that most drivers are good decision makers in regard to safe speeds of travel.

Estimations of the impact of speeding reduction on total serious crashes

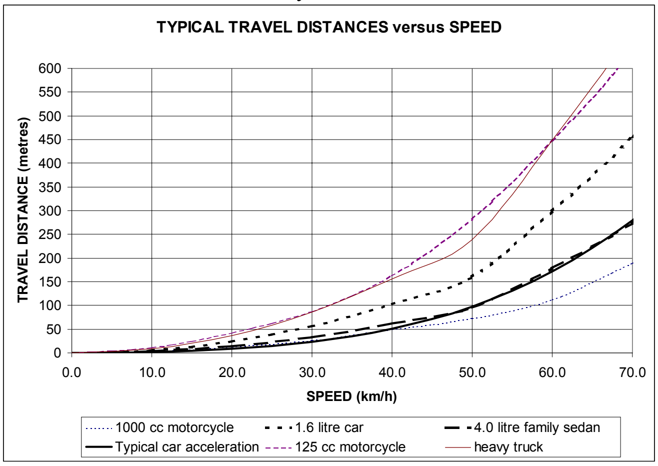
In Kloeden et al (1997) 952 crashes were attended. Of the 952 crashes, 325 did not involve ambulance transport and hence were not serious crashes. This left 627 serious crashes. And of these for 99 there was insufficient information to reconstruct the crash, leaving 528 crashes. Hence the 148 valid crashes represent 28% of serious crashes.

The average speed measured at crash locations on local roads was 55.4 km/h, and on main roads 59.3 km/h. Application of a 50 km/h speed limit to local streets, would have an effect similar to a 5 km/h speed reduction. Application of a reduced enforcement tolerance would have a similar impact on main roads. Hence the expected reduction in crashes would be 15% * 28% or 4.2%, and in injuries 13.1% * 28% or 3.7%.

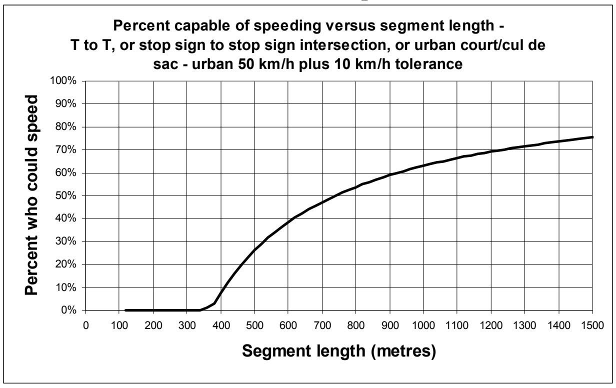
Finding: The outcomes of the Kloeden et al (1997) study apply to 28% of serious crashes. And the estimated effect of reduced enforcement tolerances and a local road limit of 50 km/h would be to reduce in crashes and injuries by about 4%.

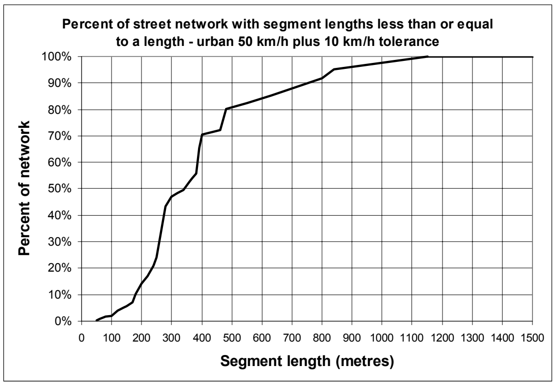
Consideration of the ability to speed, and likelihood of speeding
As discussed in Lambert (2000) the speed of a vehicle at a particular point and at a particular time is determined by vehicle factors, road factors, environmental factors, driver factors, legislation/ regulation and other factors. Drivers are constantly adjusting their speeds, even in a 60 km/h zone, to limit risks of crashes or injury to very low levels.

The Kloeden et al (1997) study only considered dry weather cases. This study uses typical dry weather vehicle acceleration times to determine how far a vehicle must travel before it exceeds the enforcement limit. The writer undertook observations of the acceleration of light vehicles from traffic lights to determine typical accelerations. He then used the design acceleration curves in the *Guide to Traffic Engineering Practice Part 7: Traffic signals* to develop a travel distance versus speed graph below. As can be seen, from a stationary position the typical light vehicle takes about 175 metres to reach 60 km/h and 275 metres to reach 70 km/h. This reflects the use of about 15% of maximum available power. Of course under maximum power the distances will be much shorter, being around 50 metres and 75 metres respectively for a small car and 30 metres and 45 metres respectively for a typical family sedan of around 4 litre engine capacity. However in the writers observation most of the speeding behaviour that results in infringement notices results from situations where heavy acceleration is not a factor.



Speeding in a 50 km/h urban road segment with stop signs or a T intersection at each end, or in a court
Modelling was undertaken assuming no through traffic, that most people (60%) leaving or returning from their house used the shortest route to the network and that most drivers (70%-80%) would stop at the street end. The results of the modelling are shown in the left hand graph below. For a segment length of 350 metres there would be virtually no speeding. At 740 metres only half the residents would have enough road length from their house to the intersection to reach the enforced speed of 60 km/h in a 50 km/h zone.

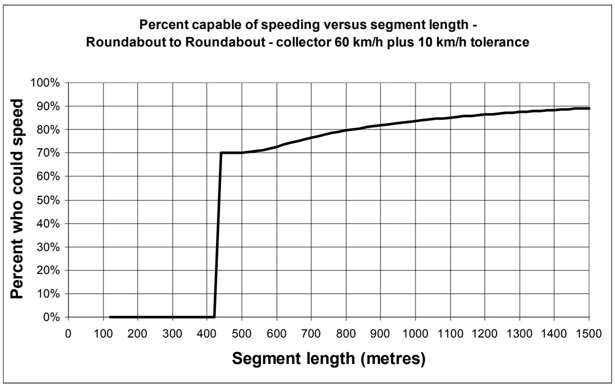


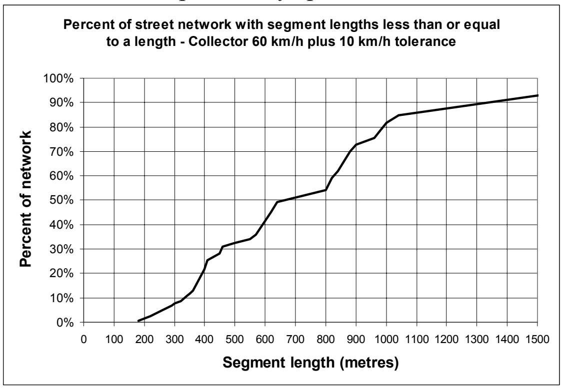


The writer also surveyed the segment lengths for a number of older and newer urban 50 km/h areas **in Melbourne**. The writer acknowledges that this data may be somewhat different to the situation in Adelaide. Speed humps were ignored in this desktop survey. The results of that survey are shown in the right hand graph above. As can be seen 50% of the road network have segment lengths of 350 metres or less where there would be virtually no speeding, and another 40% of segments were 350 metres to 740 metres in length potential with speeding levels of 0% -- 50%. Overall analysis shows that in a free travel situation about 10% - 15% of travel would be in situations where drivers accelerating at typical rates could travel at speeds exceeding the 60 km/h enforcement limit if they so chose.

Speeding on an collector road segment bounded by roundabouts

Modelling was undertaken assuming that 70% of traffic was through traffic, that most people (60%) leaving or returning from their house used the shortest route to get to the network and that all drivers on average would slow to 40 km/h at a roundabout. The results of the modelling are shown in the left hand graph below. The graph is much steeper because 70% of traffic is assumed to start at 40 km/h, increase speed and then slow down. Hence for segment lengths of around 450 metres or longer around 70% of vehicles could potentially speed.

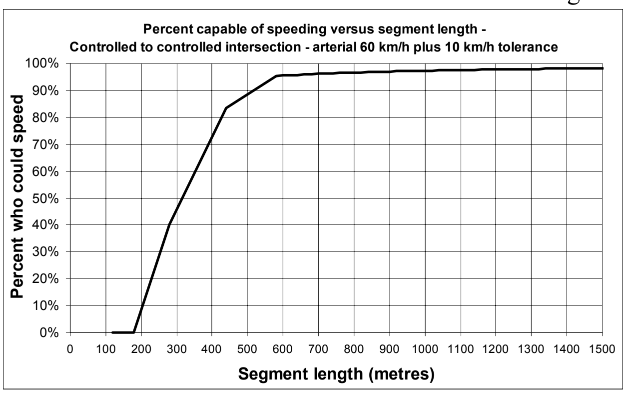


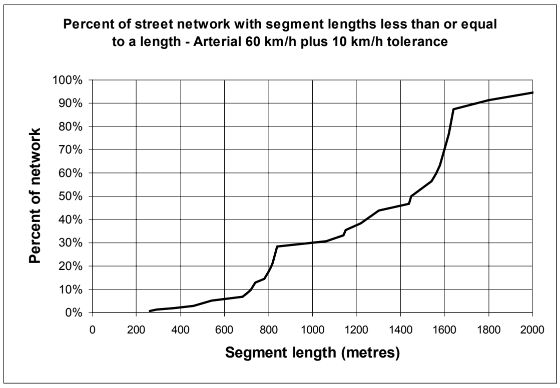


Data on collector road segment lengths is shown in the right hand graph. It shows that 70% of segments are long enough for most drivers to reach the enforcement limit speeds. Overall analysis shows that in a free travel situation about 60% of travel would be in situations where drivers accelerating at typical rates could travel at speeds exceeding the 70 km/h enforcement limit if they so chose.

Speeding in an arterial road segment with traffic lights at each end

The graphs below represent the same processes as described above but for an arterial segment and assuming there is effectively no local travel. For segment lengths of at least 400 metres 70% of drivers could potentially exceed the 70 km/h enforcement limit while at 600 m and above the figure is 95%.





Only about 5% of segments are under 600 m in length. Overall analysis shows that in a free travel situation about 95% of travel would be in situations where drivers accelerating at typical rates could travel at speeds exceeding the 70 km/h enforcement limit if they so chose.

Finding: The average driver accelerates at a speed that in conjunction with the road environment means that:

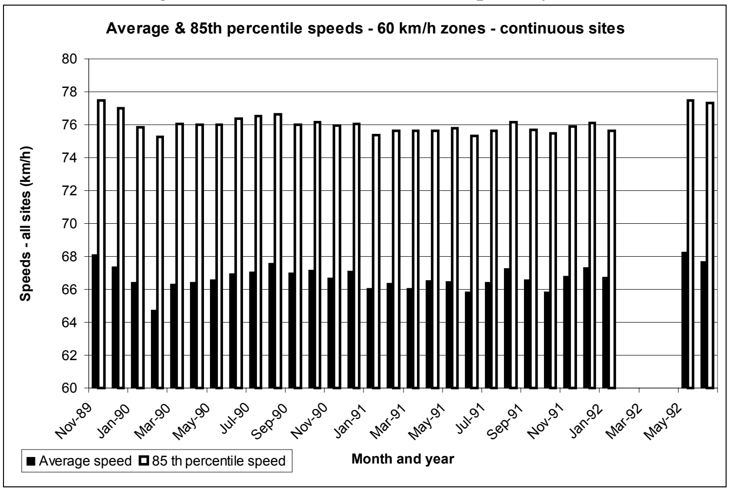
- **On urban 50 km/h zone roads with a 10 km/h speed tolerance there are few opportunities for drivers to exceed the enforcement limit. Overall about 10% - 15% of travel could result in "speeding"**
- **On collector 60 km/h zone roads with a 10 km/h speed tolerance opportunities for drivers to exceed the enforcement limit exist on long straight segments. Overall about 60% of travel could result "speeding";**

- **On arterial 60 km/h zone roads with a 10 km/h speed tolerance opportunities for drivers to exceed the enforcement limit exist on long straight sections. Overall about 95% of travel could result in "speeding".**

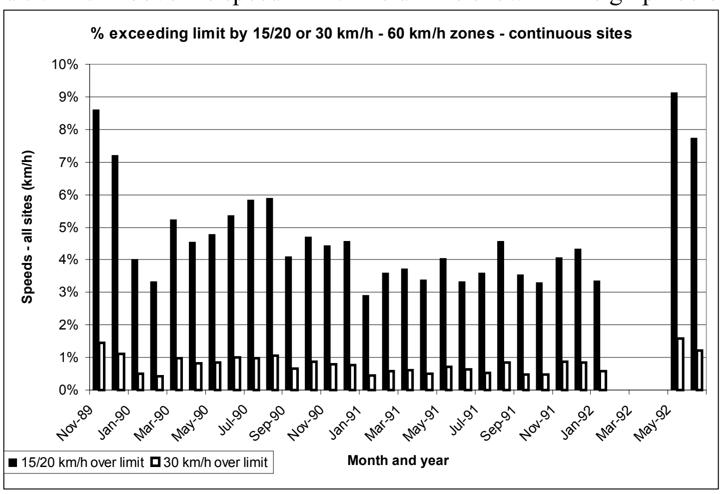
Speed camera and other urban enforcement
The writer is aware of numbers of urban sites where speed cameras or patrol cars are used for speed enforcement in the Melbourne and Geelong areas. Analysis of these sites shows all are on arterial roads, the minimum arterial segment length is 600 metres, with most in the range of 700 – 1400 metres, and all roads are wide and straight at the point of enforcement. Note that the writer is not suggesting that enforcement is not done on collector roads, only that he has not observed that occurring.

Finding: Based on the above analysis enforcement authorities in Victoria generally chose sites were speeding is highly likely for speed enforcement. That is sites that would allow 95% of the driving population to reach enforcement limits if they so chose.

Speed behaviour at free travel 60 km/h sites - VicRoads speed monitor - continuously monitored sites
VicRoads undertook a major speed survey from November 1989 to 1992 with the aim of monitoring the effect of speed cameras on driver behaviour generally. Sites were selected where drivers could reach their desired speed, and where speed camera enforcement was not undertaken. Some sites were monitored continuously and results aggregated for each month. None of the sites were associated with black spots are black links. The sum of the AADT's for these sites were in the range of 58000 to 68000 vehicles per day. The results are shown below



Average speeds initially dropped but returned to 66-67 km/h –the last two sets of data should be ignored because of missing data problems. The overall average speed was 66.7 km/h and the 85th percentile average was 76.0 km/h. Some traffic monitoring units could only aggregate data into 10 km/h bins – that is 60, 70, 80, 90 km/h. Data was requested at the enforcement points of 15 km/h and 30 km/h above the speed limit. Actual data was for 15/20 km/h above the speed limit and 30 km/h above the speed limit. The data is shown in the graph below



Note the significant initial drop in speeding behaviour, the return to higher levels once drivers determined the difference between the "hype" and reality, and then a slow downward trend in percentages exceeding the speed limits. The Table below shows expected values for a normal speed distribution, and the actual values.

	Observed	% speeding	Normal distribution
Average speed	66.7		
One standard deviation ~ 85th percentile	76.0	15%	
15/20 km over the limit	75-80	3.95%	Expect 18.5 % at 75 km/h, 7.6% at 80 km/h
30 km/h over the limit	90.0	0.57%	Expect 0.62%

Findings: Enforcement efforts are concentrated on long straight and generally wide arterial road segments because that is where they are likely to detect speeding behaviourThis is the result of two factors:

1. **the segment lengths are long enough for the majority of drivers accelerating at typically low levels to reach the enforcement limit; and**
2. **Drivers in general see these wide straight arterial road segments as safe for travelling at higher speeds.**

On such roads, even with speed cameras, average speeds are likely to be in the 65-68 km/h range and yet there is no evidence of a crash problem mid straight where enforcement is undertaken.

The impact of black spots and black links

One unintended outcome of the approach taken to this research paper is that the data is biased by black spots and black links in the road network. This is simply because crashes are more likely at those locations. Of all the crashes 86% were on main roads. Analysis of the data gives the following table for arterial roads

	Mid arterial intersection	Arterial node intersection	**Total**
Cross Intersection	10%	29%	**39%**
Y intersection		2%	**2%**
T intersection	31%	4%	**34%**
Total intersections	**41%**	**34%**	**75%**
Mid-block	na	na	**25%**

Modelling by the author assuming that the intersection effect 65 metres in all directions from other intersections (distance required to stop under heavy braking) gives the following data:

	Mid – block related travel	Intersection related travel
Urban 60 km/h enforcement limit road	75% (65 – 85%)	25% (15 – 35%)
Collector 70 km/h enforcement limit road	80%	20%
Arterial 70 km/h enforcement limit road	85% (80 – 90%)	15% (10 – 20%)
Arterial road crashes from study	25%	75%
Hence relative risk	**0.29**	**5.00**

This table shows that intersection crash risk for the type of crash investigated in this study is about 17 times greater than mid-block crash risk on a per km of travel basis.

Finding: Of the crashes used in this research, 86% were on main roads. And of these 75% were within 65 metres of an intersection. Yet only about 15% of travel is in the area around intersections. Hence the crash rate at intersections is about 17 times that for mid-block on a per kilometre of travel basis. Hence the data is dominated by intersection "black spot" crashes.

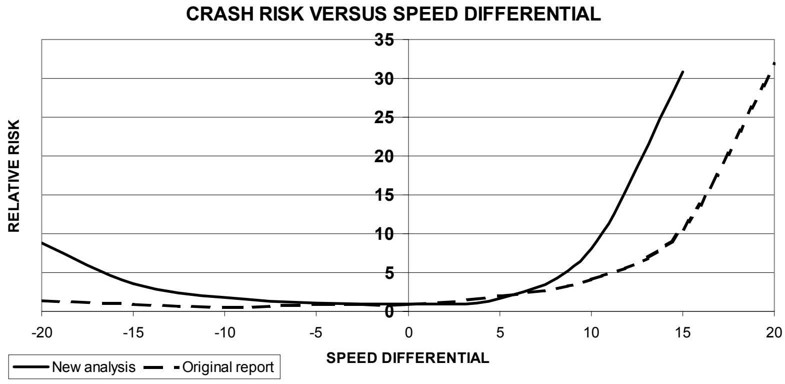
Re-analysis of the Adelaide data

In Lambert (2000) the Kloeden et al (1997) date was reanalysed and a Table and risk curve produced

Speed differential	Speed Range	No. of Cases	No. of Controls	Relative Risk
-20	-22 to -18	1	1	8.81
-15	-17 to -13	2	5	3.52
-10	-12 to -8	6	30	1.76
-5	-7 to -3	19	149	1.12
0	-2 to 2	26	229	1.00
5	3 to 7	31	159	1.71
10	8 to 12	21	23	8.04

15	13 to 17	14	4	30.83
20	18 to 22	11		infinite
25	23 to 27	10		infinite
	28 +	9		infinite
Total		**150**	**600**	

The results are graphed below and compared to the form of the original reports data by setting 0 = 60 km/h.



Speeding versus BAC
Based on the elevated risks in the analysis above, it has been suggested that the penalties for speeding should reflect those used in respect of high BAC readings. Whilst this has some logic and appeal it has a major flaw. That is that someone with a high BAC reading is a quantifiable risk for the whole of the time they are driving. However someone who is aware and has correctly assessed there is no risk in travelling at a speed of say 15 km/h above the limit on a safe section is no risk at all, provided that elsewhere in their trip speeds are appropriately reduced. And there is another significant flaw in that the Kloeden et al (1997) research identifies risks associated with travel speeds primarily at intersections whereas enforcement is undertaken at safe mid-block locations. There is no proof that a person exceeding a speed limit in a wide straight arterial road section will speed through an adjacent intersection.

Finding: The concept that BAC type penalties be applied to speeding is flawed on a number of grounds including the fact that speed enforcement is not generally undertaken at crash sites (mainly intersections) and there is no evidence that speeding on a safe section of road correlates with speeding at crash sites .

CONCLUSIONS AND RECOMMENDATIONS
Re-analysis of the original data plus addition work on characteristics of speeding and the road network shows that:

- The most likely outcome of reduced enforcement tolerances and a local road limit of 50 km/h would be a reduction in crashes and injuries of about 4%.
- The average driver accelerates at a speed that in conjunction with the road environment means that:
    - On urban 50 km/h zone roads, **about 10% - 15% of travel could result in "speeding**
    - On collector 60 km/h zone roads, **about 60% of travel on these roads could result "speeding"; and**
    - On arterial 60 km/h zone roads **about 95% of travel on these roads could result in "speeding"**
- Enforcement efforts are concentrated on long straight and generally wide arterial road segments because as noted above 95% of travel on these roads could result in "speeding"**. Yet drivers in general correctly see these wide straight arterial road segments are safe for travel at higher speeds. T**here is no evidence of a crash problem at these mid straight locations.
- Of the crashes used in this research, 86% were on main roads. And 75% of these were within 65 metres of an intersection. Only about 15% of travel is in the area around intersections. Hence the crash rate at intersections is about 17 times that which occurs mid-block on a per kilometre of travel basis. **Hence the data is dominated by intersection "black spot" crashes.**
- There is no proof that *"the risk of involvement in a casualty crash doubled with each 5 km/h increase in free travelling speed above **60 km/h**." **There is no magical property of 60 km/h in respect of urban crashes.***
- There is evidence that the risk of crash involvement increases for speeds significantly less than or greater than average speeds, with the increase in risk being much greater at high speeds. **Hence consideration should be given to relating speed offences to the average speed at a location.**

Given this fact and the risk curve above, **it is recommended that the use of a 10 km/h enforcement tolerance, and the setting of 15 km/h as the next level of enforcement be retained as a fair approach to speed enforcement.** However the author agrees with the finding of the original report, and **recommends that the penalties at 15 km/h or higher above the speed limit should be increased based on the very rapid rise in crash risk.**

Further given that it is speeding at intersections that is the major problem speed enforcement authorities change their enforcement policies to enforce speed limits in and around intersections

ACKNOWLEDGMENTS
The work undertaken by CN Kloeden, AJ (Jack) McLean, VM Moore and G Ponte in producing the research report on which this work is based is acknowledged

REFERENCES

"Travelling Speed and Risk of Crash Involvement" research report, November 1997, by -NHMRC Road Accident Research Unit of the University of Adelaide on behalf of the Federal Office of Road Safety, CN Kloeden, AJ (Jack) McLean, VM Moore and G Ponte.
"Speed behaviour and drivers' attitudes to speeding". Fildes BN, Rumbold G, Leening A. 1991. Melbourne: VicRoads. Report No.: 16.
"Speed camera - speed monitoring project - summary report" Lambert J M, 1991, VicRoads Unpublished report
Does the crash rate really double for each 5 km/h above 60 km? Lambert J M, 2000, (available at http://www.transport.qld.gov.au/qt/driver.nsf/index/conference_speeding)