MOTORCYCLE SAFETY – AN OXYMORON

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ABSTRACT

Road trauma levels have stabilised in Australia and in Victoria may be increasing. About 15% of fatalities, 10% of serious injuries and 7% of minor injuries relate to motorcycle travel though these vehicles account for only about 0.6% of vehicle occupant travel.

Principle reasons for this high level and motorcycle deaths and hospitalisation are:

- Motorcycle riders and pillions are unprotected road users
- Motorcycles are capable of very high acceleration rates compared to cars and very high speeds, but such acceleration and speed can only be safely undertaken in straight line travel
- Motorcycles are inherently unstable
- Humans can only survive direct impact with cars or fixed objects up to impact speeds of around 80 – 90 km/h
- There are significantly higher levels of "illegal' activity associated with motorcycle travel;
- Motorcycle riders have a belief set that allows them to rationalise away the risks of motorcycle travel, and
- Motorcyclists and others incorrectly believe that drivers should see them, and that if the drivers don't see them the crash is the drivers fault

Gains in light vehicle related road safety have been achieved through occupant protection, pedestrian friendly vehicle front design, and effective enforcement. For heavy vehicles gains have been achieved through speed limiters, fatigue management requirements, extra requirements in regard to drink driving, and effective enforcement. But there have been little gains in motorcycle safety. As a result the relative rate of motorcycle fatalities per unit of travel has increased from around 13 times higher to 30 times higher than for other vehicle "occupants" over the past 20 years. Relative hospitalisation rates are likely to have increased to a similar degree.

Reducing speeds of motorcycles has potential to significantly reduce motorcycle trauma both through reduced impact speeds with heavy objects and moderation of the appeal of motorcycles in respect of high speed travel. Research suggests a rider has a greater than 60% chance of being killed if they hit an object at 60 km/h, and 95% at 80 km/h.

Around one in three motorcycle crashes involve unregistered motorcycles, unlicensed riders or both. Yet motorcycles have no requirement for a front number plate and they are difficult to intercept in traffic because they can travel between lanes.

Motorcyclists have a mistaken belief that they can control their riding environment to the degree they can eliminate risk. Yet the cost of road trauma for motorcycles are around $0.50 per km versus $0.025 for cars. For average annual kilometres the total costs are $3000 - $3500 per year versus $450 -$500.Yet owners pay similar third party insurance costs in the range of $350 to $500.

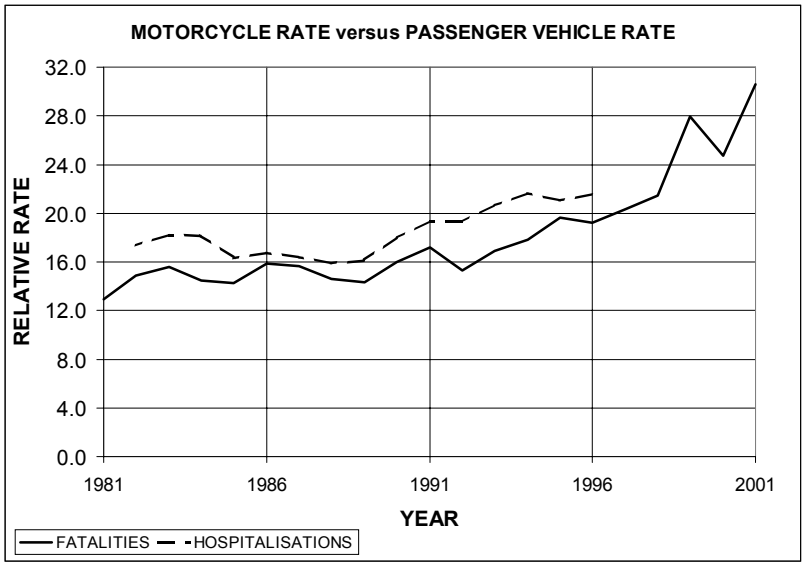
Based on the above, gains in motorcycle safety would be best achieved through speed limiting them to say 110 km/h, requiring full size front and rear number plates as an aid to enforcement, and ensuring the full cost of third party insurance is

BACKGROUND

Safety professionals and government have not addressed less popular options to improve motorcycle safety, perhaps for fear of a political backlash (the compulsory lights-on furore). Only "popular" like training have been tried. Much larger gains are possible from implementing initiatives related to speeding, enforcement and trauma costs.

INTRODUCTION

Motorcycle travel is particularly dangerous. Based on available data for fatalities and serious injuries, and travel data for light vehicles and motorbikes the graph below has been prepared. Note that motorcyclists include pillion passengers



As can be seen the relative hospitalisation rate tends to parallel the fatality rate. And modelling a range of scenarios supports that hospitalisations will tend to follow fatalities. If all the motorcycle travel for the 20 year period had been undertaken in cars about 5500 lives would have been saved and 68000 hospitalisations.

Reasons for the high fatality and hospitalisation rates

Principle reasons for this high level and deaths and hospitalisation are:

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- Motorcycles are inherently unstable
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- There are significantly higher levels of "illegal' activity associated with motorcycle travel;
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Motorcyclists as unprotected road users

Whilst helmets and leathers and chest plates can provide a degree of protection to motorcyclists in respect of grazes, fractures and head injuries, the concept of unprotected roadusers relates to whether they are protected from direct impacts with other vehicles, roads or fixed objects. Motorcyclists are unprotected from these risks.

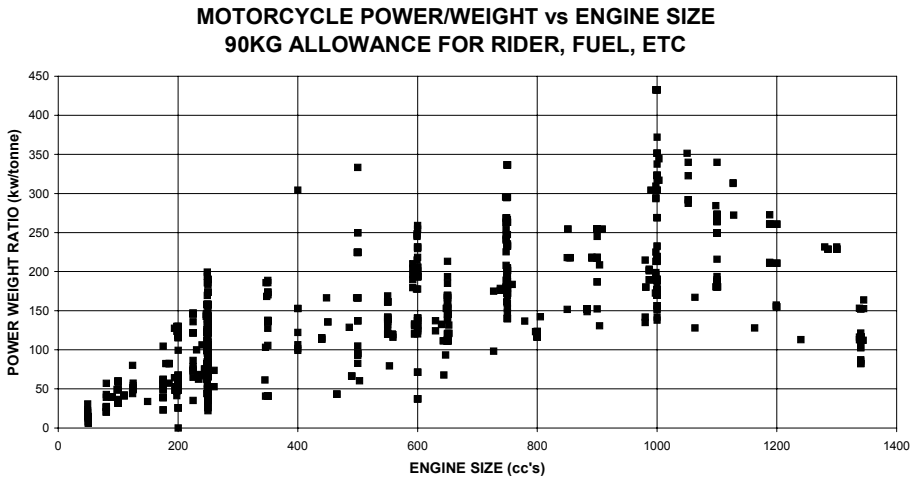
Motorcycle performance

A key issue in relation to motorcycles and speed is the power to weight ratio of these vehicles. The higher this value, the higher the potential acceleration and the higher the maximum speed..

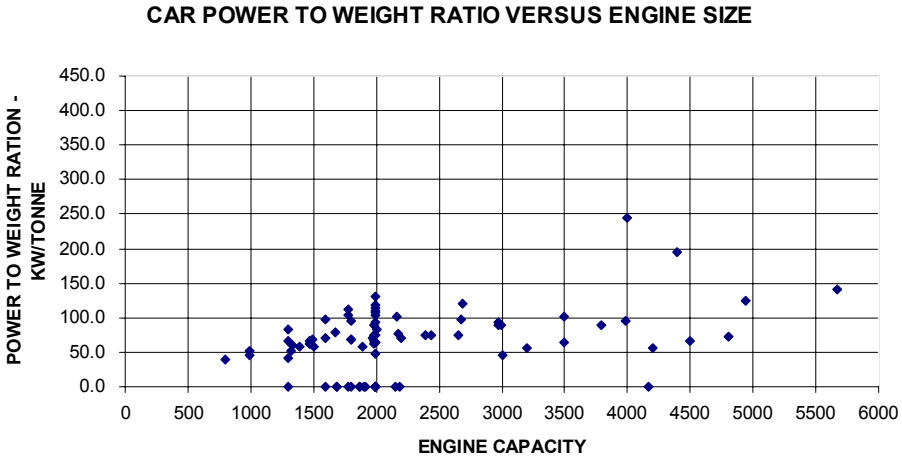
In early 1992 information was collected on 1544 makes and models of motorcycle manufactured between 1980 and 1991. Summary information from this data set is shown in the Table below

Characteristic	No of data points	Minimum value	Average	Maximum value
Engine capacity (cc)	1544	49	633	1520
Engine power (kW)	1107	0.9	42	135
Weight (kg)	1391	35	187	366
Power to weight – 90 kg of rider and fuel (kW/tonne)	1107	6.1	146	433

The power to weight data for the 1107 motorcycles is presented graphically below. Current large sedans like Falcons, Magnas, and Commodores weigh around 1.5 – 1.7 tonnes and have engines producing 145 – 160 kW. This gives then power to weight ratios of 90 – 100 kW per tonne.



In comparison the graph below shows their much lower power to weight ratios of 64 different makes and models of cars for which power to weight ratios could be determined.



The much lower power to weight ratios are evident with only 10% of cars having ratios exceeding 120 kW/tonne. In comparison more than 60% of motorcycle makes and models have power to weight ratios of at least 120 kW/tonne. Below are specifications of the most recent four motorcycles previewed in the Geelong Advertiser.

HONDA HORNET CB900F - 900 cc: Cost: $13990 + ORC; Power – 80 kW; weight – 194 kg; Power to weight ratio – **282** with 90 kg of rider, fuel etc; Acceleration – 0-100 km/h – 2.9 sec; top speed – 228 km/h

KAWASAKI ZX – 9R - 900 cc: Cost: $17990 + ORC; Power – 105 kW; weight – 186 kg; Power to weight ratio – **380** with 90 kg of rider, fuel etc; Acceleration – 0-100 km/h – 2.9 sec; top speed – 276 km/h

MOTO GUZZI V11 SPORT - 1064 cc: Cost: $22990 + ORC; Power – 67 kW; weight – 221 kg; Power to weight ratio – **215** with 90 kg of rider, fuel etc; Acceleration – 0-100 km/h – 3.9 sec; top speed – 220 km/h

SUZUKI V-STROM DL - 1000 cc: Cost: $15490 + ORC; Power – 72 kW; weight – 207 kg; Power to weight ratio – **242** with 90 kg of rider, fuel etc; Acceleration – 0-100 km/h – 3.4 sec; top speed – 200 km/h

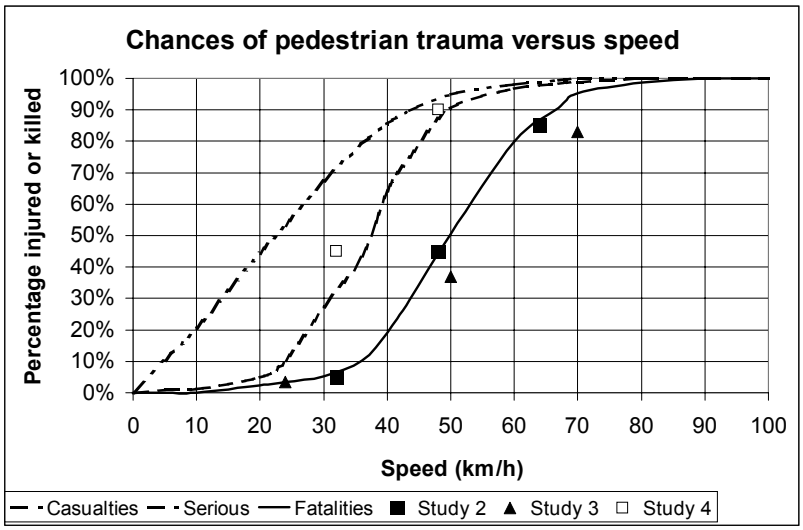
Based on the information on these four motorcycles about one third of motorcycle models would have top speeds of around 200 km/h or greater, and acceleration rates that meant they reached 100 km/h in under about 4 seconds. These are motorcycles with power to weight ratios of around 200 or greater.

The typical large Australian family car will take 160 – 200 metres to reach 100 km/h under full acceleration, whereas motorbikes will take 80 metres or less.

Motorcycle stability
Motorcycles are inherently instable because they are a two wheel vehicle.

Speed of impact versus injury of death
The greatest cause of injury to motorcyclists is impact with there motorcycle in a crash situation or impacts with other vehicles or fixed objects either while still on the bikes of after they have separated from their bike. There are no studies into speed of impact versus risk of injury for motorcyclists. However there are a number of studies into pedestrian trauma outcomes versus speed of impact by cars. Whilst these are not representative of impacts with other fixed objects they do provide guidance into what outcomes impact speeds may have on motorcyclists.

The outcomes of available studies on pedestrian impact speeds are shown in the graph below. Note that studies 2 and 3 relate to fatalities while study 4 relates to injury.



Based on the graph above the following table can be drawn up

Impact speed	Chances of being killed	Chances of serious injury	Chances of having an injury
30 km/h	5%	25%-30%	45% - 70%
40 km/h	15% - 20%	60% - 705	70% - 85%
50 km/h	35% - 50%	90%	90% - 100%
60 km/h	60% - 80%	95% - 100 %	95% - 100 %
70 km/h	80% - 95%	~ 100%	~ 100%
80 km/h	95% - 100%	~ 100%	~ 100%
90 km/h	~ 100%	~ 100%	~ 100%
100 km/h	~ 100%	~ 100%	~ 100%

Illegal activity and motorcycles

There is a lot of evidence showing a high level of illegal behaviour associated with motorcycle crashes. For example:

- in 1992 research at VicRoads showed that for motorcycle crashes in Victoria, excluding >.05% BAC and exceeding speed limits:
    - about 15% may be unlicensed (compared to around 6% for light vehicle drivers)
    - about 8% may be on an unregistered motorcycle
    - 5%-6% are novices on "illegal" >259 cc motorbikes (around 30% are learners or probationary licence holders)
    - about 2% are novices illegally carrying pillions
    - of learners and first year licenced riders about 35% are riding "illegally" at the time of their crash.

  Overall, motorcyclists are as likely as other drivers to be >0.05 BAC, more likely to be speeding, and much more likely to be not complying with other laws.
- In Victoria in the 1994 Demerit Points Scheme Inquiry:
    - Of the learners who had 12 or more demerit points 14 out of 23 (61%) were motorcycle learners. Only around 25% of all learner permits are motorcycle learner permits;
    - Of a sample of 87 drivers sent suspension letters for reaching 12 or more demerit points, 18% were motorcycle riders. Yet only 5% of licences are motorcycle licences. Of these riders 75% had court convictions almost all of which were not demerit point related – 2 court demerit point offences out of 77 offences.
- In Australia there are similar levels of "driving under the influence" for car drivers and motorcycle riders even though heavy drinking effects the balance required to ride a motorcycle
- in the USA:
    - 42% of riders in fatal crashes are either unlicensed or improperly licensed;
    - 41% of riders killed are intoxicated;
    - 38% of riders were speeding, about twice that for light vehicles;
- in Canada, drink riding is involved in one third of crashes

Failure to have a front number plate aids and abets this illegality in that it makes identification of individual motor cycles from the front impossible. And it is not until the motorcycle is past that you can see if it has any rear number plate – a plate which is allowed to be small so it rapidly becomes unreadable as the motorcycle accelerates away. Interestingly the argument about number plates causing injury apply to a huge degree to motorcycle handle bars – talk to those who deal with motorcycle trauma about the affect of these in tearing into the groin of motorcyclists. The number plate argument would have them banned to – of course effectively banning motorcycles.

Motorcyclists' beleifs about risk and hazard.

Natalier K. J Sociology 2001; 37(1): 65-80, investigated the understanding of risk among motorcyclists. Data were collected through focused interviews from motorcyclists from Tasmania, Australia (n=30, age 17 - 65 years, 25 of whom were male).

The results were that "objective indicators of risk such as cause-of-death statistics have little resonance for those who ride motorcycles. Central to motorcyclists' understandings of their pursuit is the celebration of technique and a belief in the ability to control their riding experiences. The importance of the lived experience of riding encourages motorcyclists to marginalize expert systems of knowledge in favor of their own practical experience. Through these processes, the potential of injury and death are downplayed."

"Motorcyclists' activities occur within the context of an ambivalent relationship to risk. They attempt to marginalize the risks of motorcycling when even a cursory knowledge of the statistics, in association with their own crashes and

close calls renders their interpretation insupportable. Motorcyclists emphasize their embodied experience as a key constitutive element of control. Citing their expertise motorcyclists create the grounds for their opinion that motorcycling may be hazardous for others but isn't particularly hazardous for them."

Given this scenario it is important that:

- some aspects of motorcycle riding risk be removed from the control of motorcyclists (fitting speed limiters),
- the risk of being infringed for illegal activity be increased (fitting front plates), and
- an unambiguous indicator of the risk of motorcycle travel be present (charging of the full cost of motorcycle trauma through increasing third party charges. Given that motorcycle trauma averages about $0.50 per km the third party person charges should increase to $3000 or more versus the $400 or less current charge)

Motorcyclists being "seen or seen in time" by others

There is an unfortunate belief by many motorcyclists and others that other road users should see motorcyclists and that if they do not and a crash results it is the other road users fault (" 74% of crashes are caused by the driver of the other vehicle").

However there are two aspects to being seen or seen in time by other road users:

1. that the eye and optical nerve system and subconscious brain correctly identify a motorcycle as a threat so that the conscious brain is alerted and the driver takes appropriate action, and
2. that the behaviour of the motorcycle is within the expected range of vehicle behaviours.

Driving is a visually demanding activity. Wendy MacDonald showed in her research that much of the visual processing in undertaken subconsciously - experienced drivers had about half the ability to recall signs and other aspects of the road environment when an opaque visor was dropped down in front of their eyes compared to novices. Yet experienced drivers are much safer drivers.

The subconscious processing aims to sort "threats" (mostly other light vehicles, important signs like stop lights and stop signs et cetera) from all the other visual inputs (houses and other buildings, trees, poles, et cetera). Given that motorcycles don't look like light vehicles, and that motorcycles are "rare" in the traffic stream there is a significant risk that they won't be "seen" - that is the subconscious will not alert the conscious to the crash risk in time.

The other aspect relates to the typical scanning undertaken by drivers. Scanning to the front sides and rear of the car, and of instruments is undertaken in a manner that is likely to "discover" any "threats" in time to prevent a crash. And the driver adjusts the emphasis of the scanning to suit the occasion, and adjusts the vehicle's speed if necessary to ensure risks are "discovered" in time. In this context motorcyclists who travel between lanes, and particularly at speed between lanes are less likely to be seen in time, especially as the major threats in heavy traffic come from the front.

Similarly motorcyclists travelling much faster (vehicles travelling 18 km/h faster or more than the traffic generally represent 2% or less of the traffic stream) or accelerating much faster than others in the traffic stream may not be seen in time.

It is hence the responsibility of motorcyclists to adjust for these realities. No amount of "Look left, look right, look bike" advertisements will reprogram the subconscious of other drivers to see motorcycles in time. Motorcyclists should assume they have not be seen, and should ride in predictable ways that reflect how other light vehicles are driven.

CONCLUSIONS AND RECOMMENDATIONS

Refer to the abstract above.