Prevention of motorcycle accidents at junctions

[Extracts]

- The last survey of motorcycle accidents in Britain was conducted in 1974.
- It found that 51% of all motorcycle accidents took place between a motorcycle, and another vehicle or vehicles, at a junction, private entrance, or roundabout. In probably 72% of the accidents the motorcycle rider was travelling on the major road.
- The paper accordingly treats the causes and prevention of motorcycle accidents at junctions between another vehicle or vehicles, and a motorcycle rider on the major road.
- It incidentally also treats the causes and prevention of motorcycle accidents with pedestrians, because the perceptual causes of the two types of accident are similar.

Digest paper:

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Prevention of motorcycle accidents at junctions

[Extracts]

A. Introduction

The year 1995 was the European Community's 'Year of the Young Driver'. The British Motorcyclists Federation's contribution was to join in a 'Motorcycle Awareness Campaign' that the Fédération Internationale Motocycliste ran in support of the Community.

At the same time I wrote a paper in which I set out the 'knowledge basis' of the BMF's campaign, namely the basis of the campaign in official statistics, and in academic or non-academic speculation and enquiry.

In the following paper, I rewrite the 1995 paper in order to bring it up-to-date.

I concentrate upon my 'specialist' areas:

- The causes and prevention of daytime motorcycle accidents with other vehicles at junctions
- The official statistics of motorcycle rider casualties in Britain

but digress also into other areas, in particular the causes and prevention of motorcycle accidents with pedestrians.

Since a number of potentially important causes—and measures of prevention—of motorcycle accidents at junctions (and of motorcycle accidents generally) remain either to be investigated, or to be formally 'established', I also finally treated 'research needs'.

My knowledge of the relevant scientific and statistical literature is incomplete. Especially from 1990 onwards, it is only patchily, and part, up-to-date.

Many of the views that I hold, and the conclusions that I draw, are the subject of unresolved controversy within the BMF.

But if I were to wait before writing until matters were otherwise, in the nature of human affairs, and of disagreements of view between motorcyclists, I know I should have to wait for ever.

B. Occasion & Objects

1. Occasion

Protected & Unprotected road users

From the road safety point of view, road users may be divided into protected, and unprotected road users.

Protected road users, such as motorcar drivers, lorry drivers, and bus and coach passengers, have a low casualty rate per mile.

Unprotected road users for whom a comparative casualty rate per mile can be calculated, such as pedal cycle riders and motorcycle riders, may have, *per* the suggestion of the casualty data of Road Accidents Great Britain 1995, a casualty rate of riders killed per mile on A-roads as high as some 25 times the casualty rate of drivers killed per mile of protected road users, such as motorcar drivers.

Probably the most hazardous 'task' on the road is crossing a street or road as a pedestrian. Pedestrians further suffer a significant number of casualties from vehicles that mount the pavement.

So if it were possible to calculate a comparative casualty rate per mile for pedestrian travel, it would almost certainly be of the same order as the casualty rate of pedal cyclists and motorcyclists.

Response of Unprotected road users to high casualty rates

Each of the unprotected road user groups responds to its casualty rate in its own way.

And within each group in turn there are great divergences of response.

But, as regards motorcyclists, there is a particular response to the casualty rate of motorcyclists that differs totally from the response of two influential groups of the middle-class motorcar drivers who between them, whether as politicians, officials, members of the road safety lobby, or road safety research scientists, dominate the formation and implementation of road safety policy in Britain.

Inherent causes of high motorcycle casualty rate

The motorcycle lacks, as said, the protection, and also the four-wheel stability, of the motorcar.

First, the lack of four-wheel stability does not just mean that motorcycles are liable to fall over in an accident, or have accidents because they fall over.

It also, in all bar the most perfect conditions, imposes serious limits on how quickly a motorcycle can be braked in practice.

Second, most of the traffic on the roads consists of motorcars.

And whereas the motorcycle rider may not often suffer injury in a collision with a pedal cyclist or pedestrian, he or she will usually suffer injury in a collision with a motorcar.

First response of Motorcyclist to high motorcycle casualty rate: To look after his own safety

The response of the motorcyclist to the high casualty rate that flows from these causes is, first, to treat his safety as his own personal business, and none of the business of the middle-class, motorcar-driver, 'establishment'.

He sees the establishment as non-motorcyclists, and so as ignorant in the matter. He sees them, as motorcar drivers, as the 'cause', by their 'culpable' driving, of most motorcycle accidents, and so as hypocritical. And last he sees them, behind a facade of concern, as truly 'anti-motorcyclist'.

In other words, the establishment do not sincerely seek, by the measures for the motorcyclist's safety that they propose, to improve motorcycle safety, but rather to put the motorcyclist, as distasteful 'working class' or *'lumpenproletariat',* off the road.

Second response of Motorcyclist to high motorcycle casualty rate: To favour Primary road safety measures

Second, since he so often suffers injury in an accident, the motorcyclist favours 'primary' road safety measures, namely measures that are intended to prevent an accident from occurring in the first place, over 'secondary' road safety measures, namely measures that are intended to mitigate the consequences of an accident once it has happened.

Opposite response of Vehicle & Social engineers of Road safety lobby

In opposition to the sentiment of motorcyclists in favour of primary road safety measures, over the past decade an influential 'Vehicle engineer' led group of the road safety lobby, which has fervently pursued, in the field of motorcar safety, the imposition of secondary road safety measures upon motorcar drivers, has with equal fervour committed itself, in the field of motorcycle safety, to the imposition of secondary road safety measures upon motorcyclists.

And confirming the opinion of motorcyclists that the true motivation of the establishment towards them is anti-motorcyclist, ignoring the equally high casualty rate of all unprotected road users, another influential 'Social engineer' led group of the lobby has indeed, equally fervently, committed itself to the cause, in the 'interest of reducing the road casualty total', to driving the motorcycle, as 'the most dangerous mode of transport', off the road.

2. Objects

Restriction of treatment of paper to Primary road safety measures

I write this paper as a motorcyclist, to the theme of the prevention of motorcycle accidents, and so treat only primary motorcycle safety measures.

Against the background that I have described, the paper has two objects.

First object of paper: To moderate excessive fervour of Vehicle & Social engineers

First, the fervour of the Vehicle and Social engineers has now led them on to join in a 'combined attack' upon primary motorcycle safety measures as 'palliative', and useless.

So if I demonstrate the opposite, I shall have struck back against them an important blow for rational, tolerant, and dispassionate road safety debate.

Second object of paper: To assist arrival of new motorcycle safety measures actually on the road

Second, primary road safety measures, as I have said, are more 'acceptable' to motorcyclists than the secondary road safety measures of the Vehicle engineers.

And, as the campaign against the compulsory fitting of leg protectors to motorcycles has shown, a million British motorcyclists, if they do not 'accept' a motorcycle safety measure, can muster a powerful democratic resistance.

So at the same time, if I demonstrate the effectiveness of primary motorcycle safety measures, I may assist, to the improvement of motorcycle safety, in the arrival of new motorcycle safety measures 'actually on the road'.

D. Statistics

1. Road Accidents Great Britain 1995

Motorcycle accidents involving another vehicle

In 1995 in Britain—*per* Road Accidents Great Britain 1995—a total of 445 moped and motorcycle riders and passengers were killed in road accidents.

Out of them 107 (24%) were killed in accidents in which no other vehicle or road user was involved.

But far more, some 335 (75%), were killed in an accident involving one or more motorcars or other four-wheeled vehicles.

Motorcycle accidents at junctions

Road Accidents Great Britain 1995 did not list the circumstances of accidents between motorcycles and other vehicles.

But 69% of motorcycle accidents took place 'within 20 metres of an intersection or roundabout'. And in 60% of motorcycle accidents the motorcycle was 'going ahead' not on a bend.

By comparison for motorcars the figures were 64% and 49%.

So it could well be that a high proportion of accidents between motorcycles and other vehicles take place at junctions and roundabouts, and in such accidents it is the motorcycle that is travelling on the major road, and has priority over the other vehicle.

2. Transport Research Laboratory studies

Motorcycle rider on major road

In confirmation of the surmise Whitaker 1980 found that, out of 425 motorcycle accidents that took place in 1974 in the Slough and Newbury Divisions of the Thames Valley Police Force area, 'the motorcycle was going ahead, and the other vehicle manoeuvring in 72% of multi-vehicle junction accidents'.

Whilst Faulkner 1975 studied *inter alia* accidents at junctions not controlled by traffic lights involving 1922 drivers and 261 motorcycle riders, and found that 91% of the 261 motorcycle riders were travelling on the major road.

Motorcycle accidents at junctions involving another vehicle

Further Whitaker found that multi-vehicle accidents at junctions, roundabouts, or private entrances made up 51% of all motorcycle accidents in his study.

Motorcycle accidents at junctions between another vehicle, and a motorcycle rider on the major road

The interest of the paper is in motorcycle accidents that take place at a junction, private entrance, or roundabout between another vehicle, and a motorcycle rider on the major road — or more shortly, in motorcycle accidents in which the driver of another vehicle failed to give way to the motorcycle.

It is not possible, on the basis of the findings of Faulkner 1975 and Whitaker 1980, to calculate an exact figure of the number of such accidents.

But it may reasonably be presumed that, in Whitaker 1980's sample of motorcycle accidents, in addition to multi-vehicle accidents at junctions, the motorcycle was also going ahead, and the other vehicle manoeuvring, in 72% of multi-vehicle accidents at private entrances and roundabouts.

If so, a figure of 37% of the motorcycle accidents in Whitaker 1980's sample were accidents that took place at a junction, private entrance, or roundabout between another vehicle, and a motorcycle rider on the major road.

Or granted that, in Faulkner 1975's sample of motorcycle junction accidents, the higher figure of 91% of the motorcycle riders were travelling on the major road, accidents that take place at a junction, private entrance, or roundabout between another vehicle, and a motorcycle rider on the major road may represent, between them, a figure of some 40% of all motorcycle accidents in Britain.

3. Booth 1989

Motorcycle rider not 'at fault' in motorcycle accident: prediction

Accordingly, if in Britain:

- The motorcycle rider is travelling on the major road in a high proportion of junction accidents with other vehicles
- A high proportion of motorcycle accidents are junction accidents with other vehicles,

then one can predict that motorcycle riders will be less often 'at fault' in law in motorcycle accidents than other road users.

Motorcycle rider not 'at fault' in motorcycle accident: findings of Booth 1989

In confirmation of this prediction, Booth (Keith) 1989 assessed fault in 9617 motorcycle accidents that were recorded by the Metropolitan Police in 1985.

Booth found that:

> '62% of accidents involving motorcycles, mopeds and scooters were primarily caused by other road user groups.
>
> 50% of accidents were caused by car drivers, 10% by pedestrians, fewer than 1% each by pedal cyclists, buses and coaches, and heavy goods vehicles.
>
> There were 3% 'other' causes, for example animals running onto the road.
>
> 35% of accidents were caused by motorcyclists (30% on motorcycles, 5% on mopeds and scooters).'

4. Hurt et al 1981

Apart from Britain, Hurt *et al* 1981 (the 'Hurt report') investigated 900 motorcycle accidents 'on-scene' in Los Angeles.

They found, as summarised by Ouellet 1990 [Ouellet was the second co-author of Hurt *et al* 1981]:

> 'Of 716 multiple-vehicle collisions, 195 (27%) involved an oncoming car turning left across the motorcycle path; 123 (17%) involved a car proceeding straight, crossing the motorcycle path perpendicularly. These two scenarios accounted for nearly half the motorcycle collisions.'

In other words, in close correspondence with the British findings, the two categories of 'motorcycle accident at a junction between another vehicle and a motorcycle rider on the major road' that Ouellet 1990 specifies represented 318 (35%) out of all 900 motorcycle accidents in Hurt *et al* 1981's sample.

5. Williams 1976

Last Williams 1976 also analysed data from a sample of 1508 motorcycle accidents (including 76 fatal accidents) that took place in Victoria in 1974.

Williams found that a total of 728 (48%) accidents out of the 1508 accidents of the sample were 'multi-vehicle' accidents.

Accidents between 'motorcycle rider on the major road and another vehicle'

The 728 accidents broke down by:
- Type
- Driver in error (motorcycle rider or other driver)
- Time of day

into:

Type	Error	Day	Night	Total	%*
Right-of-way	mcr	75	27	102	
	o/d	223	69	292	
Total				394	26%
Turning	mcr	11	5	16	
	o/d	102	63	165	
Total				181	12%
Following too close	mcr	84	39	123	
	o/d	16	14	30	
Total				153	10%
All multi-vehicle		511	217	728	48%

* 1508 accidents = 100% .

Thus in particular, suppose the motorcycle rider to have been on the major road in the 292 'Right-of-way: other driver in error', and 165 'Turning: other driver in error', accidents, a total of 457 accidents, or:
- 30% out of all 1508 accidents of the sample
- 63% out of the 728 multi-vehicle accidents of the sample,

were accidents between a 'motorcycle rider on the major road and another vehicle'.

'Pure visibility' daytime multi-vehicle accidents

Williams 1976 also went on to eliminate multi-party (i.e. multi-vehicle, pedal cycle, and pedestrian) accidents that might have other causes besides a lack of visibility of the motorcycle, i.e. accidents that came within the categories:
- Other party stated did not see motorcycle: Vision obstructed
- Other party stated did not see motorcycle: Concentrating on another vehicle
- Other party stated saw motorcycle
- Motorcycle rider's faculties impaired by consumption of alcohol; motorcycle rider in serious breach of road traffic regulations; motorcycle rider exceeding speed limit; motorcycle rider otherwise riding in irresponsible manner.

He found that, by way of residue, a figure of 245 (16%) accidents out of the 1508 accidents of the sample were what he called 'pure visibility' accidents — namely accidents that were solely attributable to the claimed failure of the other party to see an approaching motorcycle.

The 245 'pure visibility' accidents broke down by:
- Time of day
- Location of the motorcycle in the other driver's visual field
- Category of accident,

into:

Part of visual field	Day	Night	Dawn	Dusk	Total
Central	51	27	5	7	90
Multi-vehicle	*51*	*27*	*5*	*7*	*90*
Pedestrian	–	–	–	–	–
Pedal cyclist	–	–	–	–	–
Peripheral	107	40	4	4	155
Multi-vehicle	*94*	*40*	*4*	*2*	*140*
Pedestrian	*12*	–	–	*2*	*14*
Pedal cyclist	*1*	–	–	–	*1*
All 'pure visibility'	158	67	9	11	245

Thus, in particular, a figure of 158 accidents, or:
- 10% out of the 1508 accidents of the sample
- 20% out of the 728 multi-vehicle, 69 pedestrian, and 11 pedal cycle, accidents of the sample
- 28% out of the 511 multi-vehicle, 45 pedestrian, and 10 pedal cycle, daytime accidents of the sample

were 'pure visibility' daytime multi-vehicle accidents.

In 16 (10%) accidents out of the 158 'pure visibility' accidents the motorcycle rider had his lights on.

[As a matter of interpretation, however, Williams 1976 did not report, for comparative purposes, how many motorcycle riders in Victoria in 1974 were in the habit of riding with their lights on in daytime.]

Summary

Or in summary, some 50% of motorcycle accidents in Britain involve the motorcycle and another vehicle or vehicles at a junction, private entrance, or roundabout.

In the large majority of the accidents, it is the motorcycle rider who is travelling on the major road, so that it is the driver, or one of the drivers, of the other vehicles, rather than the motorcycle rider, who is nominally in law 'at fault'.

Such accidents may represent some 40% of motorcycle accidents in Britain.

They may, subject to the different categorisation of accidents by Hurt *et al* 1981 and Williams 1976, represent a similar figure of motorcycle accidents in Los Angeles, USA and Victoria, Australia.

In addition Williams 1976 found that a figure of 10% of motorcycle accidents in Victoria, Australia were solely attributable to the claimed failure of the other party to see an approaching motorcycle.

Unlike motorcycle accidents with another vehicle, it is not possible to analyse motorcycle accidents with pedestrians in the same detail.

But it is likely that, similarly, in the large majority of motorcycle accidents with pedestrians, the motorcycle rider is travelling straight ahead.

And often it will be the pedestrian, rather than the motorcycle rider, who in law is technically 'at fault'.

E. List of causes

1. Other driver causes

1. Limits of human perceptual capability
2. Misestimation of motorcycle speed
3. Lack of expectation of motorcycles (Position taken up by motorcycle in road)
4. Lack of expectation of motorcycles (Infrequency of motorcycles)
5. Lack of technical awareness of motorcycles
6. Absence of perceived threat from motorcycle (Adverse legal consequences)
7. Absence of perceived threat from motorcycle (Injury to driver)
8. Acceptance of short gap in traffic
9. Execution of rolling right turn
10. Restricted head movement
11. Uncorrected defects of eyesight
12. Lack of conspicuity or visibility of motorcycle

2. Motorcycle rider causes

1. Failure to anticipate driver responses in line with Driver Causes
2. Failure to take up correct position in the road (Facilitating correct estimation by driver of motorcycle speed)
3. Failure to slow down to normal speed of other traffic on road
4. Failure to respond correctly to potential hazard of a Hesitation or After you, Claude collision
5. Failure to take up correct position in the road (Minimising length of 'Collision inevitable' zone)
6. Presence of more than one other vehicle
7. Less than optimal motorcycle brakes
8. Less than optimal official advice on motorcycle braking
9. Failure to use front brake
10. Braking and swerving at same time
11. Failure to achieve optimal braking performance: Other causes
12. Failure to steer correctly in emergency
13. Wrong decision to swerve in emergency
14. Failure to brake or swerve correctly in emergency
15. Gripping reflex in emergency
16. Lack of motorcycle anti-lock brakes
17. Compulsive tendency of motorcycle riders to monitor road surface
18. Susceptibility of motorcycle riders to capacity overload
19. Looking aside
20. Loss of concentration
21. Misting visor
22. Susceptibility of motorcycle riders to lowered body temperature in winter
23. Unergonomic design of motorcycles
24. Possible tendency of motorcycle riders to exceed normal speed of other traffic on road at junctions
25. Possible susceptibility of motorcycle riders to darktime accidents
26. Training and testing of motorcycle riders in performance of tasks of low priority

3. Road causes

1. Road surface
2. Non-constant radius curve

F. Summary of causes

1. Other driver causes

1: Limits of human perceptual capability

1. Hills 1980 in Britain identified four 'impossible' driving situations whose demands will often exceed the perceptual capacity of the average driver:
   1. Overtaking in the face of oncoming traffic
   2. Joining or crossing a high-speed road
   3. Meeting another vehicle also travelling on dipped beam on an unlit—or poorly lit—road at night
   4. Encountering a backlit pedestrian in the middle of the road at night.
2. Hills recited in support of the identification of the four situations:
   1. Overtaking in the face of oncoming traffic:
      At speeds of the overtaken, and oncoming, vehicle of 50 mph, the total overtaking distance required was of the order of 1500 ft.
      It was perceptually impossible to estimate the speed of the oncoming vehicle at such distances.
   2. Joining or crossing a high-speed road:
      The general tenor of the British findings of Moore 1953; Cooper *et al* 1976; Cooper *et al* 1977; Ashworth & Bottom 1977; Bottom & Ashworth 1978; and Hills & Johnson 1980 (Uncompleted) was that:
      a. Drivers may overestimate the 'time of arrival' of slower vehicles, and underestimate the 'time of arrival' of faster vehicles
      b. The changeover from overestimation to underestimation of time of arrival took place at approximately the normal speed of approach of traffic on the road
      c. The degree of overestimation or underestimation of time of arrival increased the slower or faster than normal speed the speed of approach of the vehicle.
   3. Meeting another vehicle also travelling on dipped beam on an unlit—or poorly lit—road at night:
      The Organisation for Economic Cooperation & Development 1975 stated that 'It is generally accepted among researchers' that, in poorly lit or unlit streets, visibility is inadequate for meeting vehicles on dipped beams at speeds greater than about 30 mph.
   4. Encountering a backlit pedestrian in the middle of the road at night:
      'Hartmann & Moser 1968 showed that for values of θ [The visual angle between an obstacle, and a glare source] less than 1.5 deg the effects of glare increased rapidly, possibly owing to lateral inhibition in the retina.
      Such small angles could occur, *inter alia,* where a pedestrian waits in the middle of the road to complete his crossing.'
3. Present paper expresses view that the findings of Moore 1953, etc—and also the findings of the similar motorcycle study that was conducted by Nagayama *et al* 1980 in Japan—are suggestive, not conclusive.
   Paper canvasses explanation of the findings that drivers (and pedestrians) may—to express matters 'loosely' in terms of 'speed of travel' rather than 'time of arrival'—at all speeds:
   - Have difficulty in estimating the speed of travel of an approaching vehicle, be it a motorcycle or a motorcar
   - Respond to greater or lesser degree by the practice of 'arbitrary speed setting by expectation', namely by assuming that the speed of travel of the vehicle is the normal speed of travel of other traffic on the road.

2: Misestimation of motorcycle speed

4. Present paper—developing the arguments of Prower 1990 [non-academic author]—canvasses addition to Hills 1980's list of impossible situations of:
   5. Estimating the speed of approach of a motorcycle (or pedal cycle) in head-on view.
5. Paper notes in support that it is likely that road users estimate the speed of approach of all vehicles in head-on view by their 'width', rather than by their 'height':
   - Motorcars are the predominant vehicles on the road
   - Motorcars are more wide than they are tall
   - It is more difficult to estimate the height, than the width, of a motorcar, because of the 'confused' outline of the bottom of the motorcar
   - The road scene is more 'confusingly' striated, in terms of the contrast of the background against which a moving vehicle is viewed, horizontally, than vertically.
6. Paper notes that, whereas, typically, a motorcar:
   - Will be 6ft wide
   - 'Present' a 'contrasty' outline, with extensive shiny or glazed surfaces,

   a motorcycle:
   - Will be 1½ft wide
   - 'Present' a 'confused' outline, with a pattern of surfaces that is more or less non-extensive, irregular and 'broken up'.

7. Paper notes finding of Hills 1975b that, even under 'favourable' laboratory viewing conditions, for 2sec exposures the figure of threshold longitudinal movement for his experimental subjects was no lower than about 1min arc.

8. Present paper therefore argues that:
   a. All objects, in 'oblique' view, as a matter of ordinary trigonometry, present the same perceptual information of their speed.
   b. By contrast, in 'head-on' view, by comparison with a motorcar, the rate of change of the angle that a motorcycle makes to another driver (or pedestrian) may be, 'perceptually', of the order of some 8 to 10 times less.
   c. The rate of change will, correspondingly, on the implication of Hills 1975b's findings, be, under road viewing conditions, little above the threshold value for detection by the human eye.
   d. In consequence, in head-on view, save in perfect road viewing conditions, it is unlikely that the other driver will be able to estimate the speed of approach of a motorcycle.

3: Lack of expectation of motorcycles (Position taken up by motorcycle in road)

9. Present paper recites anecdote of former police motorcar patrol officer Wilf Goodyear, and serving fireman Steve Bergman, that oncoming drivers would often fail to notice their vehicle when they were travelling in an 'unexpected' position — e.g. on the wrong side of the road.

4: Lack of expectation of motorcycles (Infrequency of motorcycles)

10. Hills 1980, and Thomson 1982, canvassed idea that drivers may not notice a motorcycle on a road where motorcycles are infrequent because they are not 'expecting' to see a motorcycle when they look up the road.

11. In this connection, Thomson 1982 observed that in New Zealand, motorcycles only travelled a figure of 2% of total vehicle mileage.

12. And present paper observes that, in Britain in 1995—*per* Road Accidents Great Britain 1995—motorcycles only travelled a figure of 0.9% of total vehicle mileage.

5: Lack of technical awareness of motorcycles

13. Brooks & Guppy 1990 found that the drivers in their British sample who had ridden a motorcycle were less likely to be involved in a motorcycle accident than the drivers who had not.

6: Absence of perceived threat from motorcycle (Adverse legal consequences)

14. Fulton *et al* 1980 found that an experimental subject who was told that his task was to 'detect motorcycles' detected every motorcycle that was 'presented' to him, even though the motorcycle was not displaying daytime lights, and the rider not wearing fluorescent clothing.

15. Leonard 1974 [non-academic author] found that drivers in the USA on his regular daily motorcycle journey forced him to brake or change position between 18 and 20 times more frequently when he was riding a motorcycle in ordinary or high-conspicuity trim than when he was riding a motorcycle in police trim.

16. Booth (Weldon G) 1978 [non-academic author] found that drivers in the USA braked earlier in response to the presence of a marked police motorcycle parked by the side of the road than they did to the presence of a marked (or unmarked) police motorcar.

17. Present paper recites supporting anecdote of members of the British Motorcyclists Federation who are police motorcycle patrol officers.

18. Present paper argues, nevertheless, in objection to the safety benefits of assimilating the appearance of ordinary motorcycle riders and police motorcycle patrol officers, that:
   a. The initial 'impact' of motorcycle daytime lights upon other road users in Britain is likely to have been to cause them to confuse ordinary motorcycles that used daytime lights with police patrol motorcycles.
   b. If so the impact did not last.
   c. In June 1978, Fulton *et al* 1980 in Britain found that 8.7% more pedestrians noticed a stationary motorcycle in daytime with a 40W low-beam headlight that was lit, than noticed a motorcycle with a headlight that was unlit.
   d. But in March 1982, some four years later, Donne & Fulton 1985 repeated Fulton *et al* 1980's experiment, and found that only 4.8% more pedestrians noticed the motorcycle with such a headlight that was lit.

7: Absence of perceived threat from motorcycle (Injury to driver)

19. Present paper recites suggestion of some motorcyclists that drivers may deliberately disregard the presence of a motorcycle, because it is not associated with the prospect of their being injured should it collide with them.

20. Paper notes, in contradiction of the suggestion, the observation of McDowell *et al* 1983 that drivers in Britain at a junction 'accepted' shorter gaps in traffic in front of goods vehicles than in front of motorcars.

8: Acceptance of short gap in traffic

21. Whitaker 1980 estimated that the speed of impact of the motorcycle in 93% of the 425 accidents of his British sample was under 40mph; and in 75% under 30mph.

22. Hurt *et al* 1981 found that the median pre-crash speed of the motorcycle in the 900 accidents of their Los Angeles survey was 29.8mph, and the median crash speed 21.5mph.

23. Olson *et al* 1981 found that 5% of drivers at intersections on a Michigan thoroughfare with a speed limit of predominantly 70kph (43mph) went to turn or cross in front of a 'test' motorcycle, even though it was less than 3sec (64yd at 43mph) away from them.

24. Nevertheless, Olson *et al* reported that none of their test riders had had an accident.

25. Consistently with the report, Hurt *et al* 1981 found that the typical accident in their survey allowed the rider just less than 2sec to complete all collision avoidance action.

26. Present paper concludes therefore that motorcycle accidents 'seriously start to happen' when another driver infringes the right-of-way of a motorcycle that is less than 2sec (29yd at 30mph; or 39yd at 40mph) away from him.

27. Paper accordingly suggests that a number of drivers may infringe the right of way of a motorcycle for 'forcing', impatient, or other deliberate reasons.

9: Execution of rolling right turn

28. Ouellet 1990 in California calculated that, whatever 'precautionary' position a motorcycle rider may take up in the road, and whether or not he brakes with maximum efficiency, if:
    - The rider is travelling at 30mph on a road with two lanes in either direction
    - At an intersection, a motorcar driver who is travelling in the opposite direction executes a 'rolling left' turn ['rolling right' turn in Britain] at 13mph in front of him
    - The rider is within a given 'zone' (located, variously, according to the position and braking performance of the rider, between bounding points 17yd and 66yd away from the intersection) when the driver commences the turn,

    a collision between the motorcycle rider and the motorcar is inevitable.

29. Ouellet also made a similar calculation for the situation where a motorcar driver at the intersection is on the minor road, and crosses the intersection, from the motorcycle's near-side, from rest.

30. However, whereas, for the 'Rolling left turn' manoeuvre by a motorcar driver, Ouellet calculated that the 'zone' in which the motorcycle rider must be located when the motorcar driver commences his manoeuvre in order for a collision—even with 'best' positioning and braking—to be inevitable was fully 11yd long, for the 'Crossing from nearside from rest' manoeuvre, the zone was the lesser distance of 2yd long.

10: Restricted head movement

31. Present paper suggests, on the basis of personal observation, that many drivers may suffer from chronic or occasional restricted head movement.

32. Paper notes that many drivers in Britain are in the practice of driving in the middle lane of a three-lane carriageway, even though the inner lane is clear.

    Paper notes that, coincidentally, the middle lane is the lane that requires the least number of changes of lane, and so affords the maximum 'economy' of head movements.

33. Paper accordingly canvasses the idea of a pilot survey of 'middle-lane drivers' in order to determine whether or not a substantial number of drivers do indeed suffer from restricted head movement.

11: Uncorrected defects of eyesight

34. Davison & Irving 1980 surveyed the eyesight of 1368 drivers in Britain in 1976. They found that—assuming the official British test of driver eyesight to represent an acuity of between 6/9 and 6/12—only between 1 and 3% of drivers would have failed the test.

    [Under the official British eyesight test, a driver must be able to read a motorcar number plate at 25yd]

35. Present paper recites anecdote of optician members of the BMF, and findings of 'informal' reports and studies, that suggest that, should Davison & Irving's survey be repeated today, it would find a much higher figure of drivers who would fail the official British eyesight test than they found in 1976.

12: Lack of conspicuity or visibility of motorcycle

36. In Prower 1990 (Unpublished)—as summarised in Prower 1990—I reviewed the method, conduct, and findings, of most of the 50 odd studies of the effect of the use of motorcycle, or motorcar, daytime lights that had been conducted internationally to date.

    I concluded that the studies had not, on balance, established that either motorcycle, or motorcar, daytime lights reduce accidents.

2. Motorcycle rider causes

1: Failure to anticipate driver responses in line with Driver Causes

1. Present paper suggests that motorcycle riders may have accidents because they make no allowance for the inherent perceptual difficulties, or likely mental 'set', of drivers, as described under *Driver Causes*.

2: Failure to take up correct position in the road (Facilitating correct estimation by driver of motorcycle speed)

2. Present paper suggests that—to refer back to the distinction between head-on view, and oblique view, as given previously under *Driver Cause 2: Misestimation of motorcycle speed*—motorcycle riders may have accidents because they do not attempt at junctions, by adopting a position in the road that is as far as possible away from any waiting driver, to maximise the driver's perception of their speed.

3. Paper, correspondingly, asserts the first 'paradox' of motorcycle safety at junctions:

   'The closer that the rider rides to a waiting driver at a junction, not only the lesser the opportunity that he will have to avoid a collision should the driver pull out in front of him, but also—paradoxically—the greater the likelihood that the driver will in fact pull out in front of him'.

3: Failure to slow down to normal speed of other traffic on road

4. Present paper suggests that—to refer back again to the distinction between head-on view, and oblique view—motorcycle riders may have accidents because they do not reduce their speed to the normal speed of other traffic on the road. Thus if a driver—or pedestrian—finds it perceptually impossible to estimate the speed of a motorcycle in head-on view, he must resort to arbitrary speed setting. And the most obvious choice of speed to set is the normal speed of traffic on the road.

5. Paper, accordingly, asserts the second 'paradox' of motorcycle safety at junctions:

   'The faster that the rider rides past a junction, not only the lower the chances that he will be able to stop in time should a waiting driver pull out in front of him, but also—paradoxically—the greater the likelihood that the driver will in fact pull out in front of him'.

4: Failure to respond correctly to potential hazard of a Hesitation or After you, Claude collision

6. Present paper suggests that, as a matter of the trigonometry of many junctions, drivers may not perceive the true speed of approach of a motorcycle until, alternatively:
   - The motorcycle commences its final traverse past the driver, and so affords him oblique, in place of head-on, view of it
   - The motorcycle, having 'maintained' head-on view by virtue of the combined motion of the two vehicles, is very near to the driver, and so affords him the peripheral stimulus of a 'looming' large object.

   Motorcycle riders may therefore be at special hazard of drivers' belatedly hesitating in front of them, as followed by a simple 'Hesitation', or more complex 'After you, Claude', collision.

7. Correspondingly paper asserts, first, that riders should 'know', and anticipate, the hazard of a Hesitation, or After you, Claude, collision.

   Second, since it is difficult for the rider to predict either:
   - The initial hesitation of the driver
   - The subsequent decision of the driver whether to continue with his intended manoeuvre, or to stay where he is,

   the rider should usually meet the hazard by the 'prepared' response of braking, rather than swerving.

8. McLean *et al* 1979 conducted an 'in-depth' study of 68 motorcycle accidents in Adelaide in 1976–77.

   Present paper notes that they provided sufficient information to identify one apparent Hesitation, and one apparent After you, Claude, collision.

5: Failure to take up correct position in the road (Minimising length of 'Collision inevitable' zone)

9. Ouellet 1990 compared the retardation that, according to the study findings, a motorcycle rider could achieve by braking in the face of an obstacle, such as a motorcar, in front of him (Mortimer 1986, Donne 1989, Okayama *et al* 1989, Zellner *et al* 1989), and the time that it might take him to swerve around the obstacle (Watanabe & Yoshida 1973, Rice & Kunkel 1976).

   He concluded that the rider had much better chances of avoiding a collision with the obstacle by braking, rather than swerving.

10. As part of the calculations that were referred to under *Driver Cause 9: Execution of rolling right turn,* Ouellet compared, for the 'scenario' of a motorcycle rider approaching an intersection travelling on a road with two lanes in either direction, how far a collision between the rider and an 'intruding' motorcar was inevitable according to whether the rider:
    - Braked effectively
    - Reacted with a fast reaction time
    - Adopted the optimal position in the road.

    He found that optimal positioning achieved the greatest reduction of the risk of a collision.

11. Ouellet 1990 summed up together the implication of conclusion and findings for the rider:
    - In the face of a potentially intruding motorcar at an intersection, the rider should, as a matter of optimal positioning, move laterally away from the threat
    - Optimal, or 'correct', positioning was not a substitute for effective braking. It could reduce, but not eliminate collision risk
    - Effective braking was, equally, not a substitute for correct positioning.
    - However, by comparison with effective braking, correct positioning had the advantage that it could be performed in the relatively low-stress situation before the motorcar actually intruded upon the rider's right-of-way
    - In other words, correct positioning was more likely to be 'done properly' than effective emergency braking in a panic situation.

6: Presence of more than one other vehicle

12. Spicer 1973 found that at least 54% of the 'serious conflicts' between 'vehicles' that he observed at six intersections in Britain 'involved' more than two vehicles.

    Unfortunately Spicer did not go on to clarify whether the other vehicle 'involved' was another vehicle that was present:
    - At the junction
    - On the major road.

    [Spicer defined 'serious conflict' as: 'Rapid deceleration or lane change to avoid a collision by one or more vehicles'. He did not define 'vehicle'.]

13. McLean *et al* 1979 reported—possibly adopting overlapping categories—that, out of the 68 motorcycle accidents that they studied:
    - In 11 accidents the view of the driver was obstructed by another vehicle (or vehicles), or roadside object
    - In 7 accidents the attention of the driver was, or may have been, distracted by other vehicles, or the need to monitor some other area of the road scene
    - In 8 accidents the view of rider was obstructed by another vehicle (or vehicles): in each case the vehicle that was obscured was a motorcar that was turning right, and the obscuring vehicles were stationary vehicles to the rider's right
    - In 1 accident the attention of the rider was distracted by another vehicle.

    [Vehicles drove on the left of the road.]

7: Less than optimal motorcycle brakes

14. Motorcycle Safety Foundation 1976 in the USA filmed two expert motorcycle riders as they carried out a number of demanding exercises in turning, stopping, avoiding a collision, and surmounting an obstacle.

    The motorcycle that the two riders rode was also instrumented to record:
    - Rider control input
    - Motorcycle response.

    MSF 1976 commented upon the front-wheel skids that the riders experienced during the course of the exercises that the front brake of a motorcycle has a tendency to lock at low speed.

15. Juniper & Good 1983 in Australia reported that a characteristic feature of the brake force response to a rapid step-like input of lever displacement for all of the hydraulic brake systems of the motorcycles in their study was an initial peak, or 'overshoot', followed by a gradual decline in the force level required to maintain a constant lever displacement.

    Thus the brake system presented a time-varying 'stiffness' to the rider.

16. Juniper & Good, accordingly, tested an experimental motorcycle braking mechanism in which the braking force that was applied at the wheel was proportional to the distance that the motorcycle rider displaced the brake lever.

    However, they were not able to take testing of the mechanism beyond the pilot stage.

17. McLean *et al* 1979 'reconstructed' six accidents, out of the 68 accidents in their sample, in which the rider had used only the rear brake.

    They concluded that probably five out of the six accidents would have been avoided had the rider employed the full braking capabilities of the motorcycle.

18. McLean *et al* therefore noted that Moto Guzzi had adopted brakes that were, motorcar style, linked front and rear, and operated by a single foot pedal ('linked brakes'), and recommended their wider adoption by other motorcycle manufacturers.

19. Present paper records the controversy that exists amongst motorcyclists whether linked brakes may indeed improve the braking performance of riders in an emergency.

8: Less than optimal official advice on motorcycle braking

20. Present paper records the substantial differences that exist between the official advice that is given to motorcyclists on optimum braking techniques:
    1. In Britain, by Driving Standards Agency: The Motorcycling Manual 1991:
       To apply the front brake slightly before the back brake
       To apply a greater pressure to the front brake than to the back brake
    2. In Sweden, by Kommunikationsdepartementet *et al*: 'Körteknik MC' 1982:
       To apply the back brake slightly before the front brake
       To apply the front brake hard
       To ease off the back brake as necessary as the front brake bites
    3. In the USA, by Motorcycle Safety Foundation: 'Motorcycle Skill Test: Practice Guide' 1988:
       To pull in the clutch; downshift to first gear; and apply both brakes
       Not to release clutch or brakes until stopped.

    [Candidates for motorcycle driving test required to demonstrate British technique; Swedish and US techniques practised as officially-approved training ground drills.]

9: Failure to use front brake

21. Sheppard *et al* 1985 found that:
    a. Out of a sample of candidates for the British motorcycle driving test during an unspecified period up to March 1982 [i.e. the date of the implementation of the Part I motorcycle driving test in Britain]:
       - 13% demonstrated a serious fault under: 'Emergency stop. Slow reaction or loss of control'
       - 15% demonstrated a serious fault under: 'Emergency stop. Omits use of front brake'.

    b. Out of 58 instances of emergency braking by motorcycle riders that they fully observed out on the road in Britain during an unspecified period:
       - In 12 instances the rider used 'Rear brake alone'
       - In 2 instances the rider used 'Front brake alone'.

22. Hurt *et al* 1981 found that nearly one-third of the motorcycle riders in their sample of 900 accidents had failed to take any evasive action whatsoever, and that only 17% had used both brakes.

23. McLean *et al* 1979 found that 16 motorcycle riders out of the 69 riders (one accident involved two riders) in their sample failed 'to react appropriately in an emergency situation'.

    In each case the braking of the rider was at issue:
    - 1 rider had not attempted to brake
    - 1 rider had swerved to pass by a motorcar, but then seemed to 'freeze', and hit it
    - 1 rider had 'missed' the brake pedal because she expected it to be on the other side of the motorcycle
    - 13 riders had only used the rear brake.

24. McLean *et al* found that the ratio of 'experienced' riders (licensed for more than one year) to 'inexperienced' riders for the 16 motorcycle riders who failed to brake, or failed to use both brakes, in an emergency, namely:
    - 10 out of 16 riders

    was similar to the ratio for riders in the sample as a whole:
    - 41 out of the 63 riders for whom particulars were known.

    In other words, the failure of the 16 motorcycle riders to brake—or to use both brakes—in the emergency did not appear to be related to the inexperience of the rider.

    Rather it appeared to reflect the response to the stress of an emergency of a substantial proportion, in common, of all riders.

25. Nevertheless to qualify the above conclusion, McLean *et al* 1979 also found that out of the 13 motorcycle riders who had used the rear brake only, only 6 riders claimed that they normally used both brakes.

10: Braking and swerving at same time

26. Present paper recites that the manoeuvre of 'braking followed by swerving' (in order to avoid an obstacle, such as an intruding motorcar):
    a. Per 'Körteknik MC' 1982, was taught to motorcycle riders under instruction in Sweden in 1982
    b. Per Motorcycle Safety Foundation riding instructor, Malcolm Palmer, is currently taught by the MSF to riders in the USA
    c. Is also thought to be taught to motorcycle riders under instruction in a number of other countries.

27. Ouellet 1990 criticised the priority that motorcycle rider training schemes gave, in this way, to teaching riders how to swerve.

28. Ouellet was second author of Hurt *et al* 1981.

    Basing himself, it is thought, upon Hurt *et al's* findings, Ouellet stated, *inter alia,* that, in a true

emergency, the rider who swerved in order to avoid a motorcar was likely to combine it with braking.

If so, the result in practice would often be a rear-wheel skid, or high-side, coupled with loss of control.

29. The observations and comments of Motorcycle Safety Foundation 1976 suggested that, even should braking combined with swerving provoke a rear-wheel skid without loss of control, it is likely that the skid will prevent the rider from avoiding the motorcar.

    Thus, as a matter of motorcycle dynamics, the rider must, in order to retain control in a rear-wheel skid, steer 'into the skid'.

    Correspondingly, when, during the exercise of 'braking and swerving to avoid an obstacle', the two expert riders who were observed by MSF experienced a rear-wheel skid, they sought to control the skid by turning back into it — and so turned back in also towards the obstacle.

30. Present paper concludes that a 'braking followed by swerving' exercise that the motorcycle rider practises successfully on the training site may all too easily, to the increased—not reduced—hazard of the rider, become a misperformed 'braking and swerving' exercise when practised instead, in real life, under the stress of an actual emergency on the road.

11: Failure to achieve optimal braking performance: Other causes

I: Failure to brake to limit

31. Present paper recites comments of Woods in Britain, and other, non-academic, motorcyclists that, following a trial of a motorcycle that was fitted with anti-lock brakes, they returned to their own motorcycle, and realised that they had only been using some 50% of its full braking potential.

II: Failure to adopt optimal braking technique

32. Juniper & Good 1983 (No 2) stated, in passing, that their test rider was able, with a little practice, to 'produce a reasonably smooth, constant amplitude sinusoidal input of brake lever displacement, with a frequency of about 2 Hz', or in other words, to practise the technique of 'cadence' braking.

    Juniper & Good commented that they chose such a 'test input' as representative of 'controlled braking situations in which the braking effort is modulated for fine control of deceleration'.

33. Present paper recites practice of former British Motorcyclists Federation Despatch Rider Training Scheme instructor, Dave Field, of teaching riders under instruction 'cadence' braking of the front wheel.

34. Dave Field stated that an advantage of cadence braking, by comparison with conventional braking, was that the rider practised, with far less variance, the same technique when braking on wet roads, as when braking on dry roads.

35. Present paper canvasses that it may also be an advantage of cadence braking that it reduces the 'response time' of the rider between the brake's locking, and the rider's easing of the pressure that he is exerting at the brake lever.

    So in turn the rider will brake with less fear that he may not respond in time should the brakes lock.

    So the rider will achieve closer to optimal braking performance.

III: Failure to cover front brake lever

36. Present paper recites recommendation by Ouellet 1990, Woods, and Dave Field of practice of 'covering' the brake levers in the presence of hazard. It recites the practice of many riders in London, as supported by Dave Field, of riding at all times with:
    - The front brake covered (save for turning)
    - The back brake covered (when turning)
    - Both brakes covered (in close traffic).

12: Failure to steer correctly in emergency

37. Hurt 1973 reported (and it is thought Hurt *et al* 1981 confirmed) that, when faced with an imminent collision with an intruding vehicle, a motorcycle rider will often swerve the wrong way, towards, rather than away from, the vehicle.

38. Hurt speculated that the explanation why the rider steered the wrong way was the natural reaction of the rider to turn the handlebars away from the intruding vehicle.

    As a matter of the ordinary dynamics of a two-wheeled vehicle the effect of doing would in fact be to induce a 'counter-steer', in the opposite direction, towards the vehicle.

39. Present paper observes that an alternative explanation may be that the rider does indeed steer towards the intruding vehicle.

    His intention is, on counter-steering principles, to initiate a turn away from it.

    But either, under stress:
    - He steers too far towards the vehicle
    - He steers for too long towards the vehicle
    - He 'freezes' at the handlebars whilst he is still steering towards the vehicle,

or the vehicle is too close for him in fact to complete more than the initial turn towards the vehicle before he hits it.

40. Present paper recites practice of Motorcycle Safety Foundation in their motorcycle rider training courses to teach riders under instruction to adopt deliberate counter-steering as their preferred method of initiating a turn.

41. Paper canvasses that one of the reasons for the practice may be the speculations of Hurt 1973.

    If so, its purpose is, on 'Pavlovian' principles, to assure that the rider also 'instinctively' adopts counter-steering to initiate a swerve in an emergency.

13: Wrong decision to swerve in emergency

42. Present paper discusses, and contrasts, on the one hand, the rational appraisal that should determine the choice of a motorcycle rider in an emergency between braking and swerving, and on the other hand, the emotional impulses that, in practice, are more likely to do so.

    In particular, paper predicts that the rider will adopt the course of action that offers him the best chance of avoiding a collision altogether, rather than the course of action that best balances:
    - The chance of avoiding a collision
    - The prospect, should, in the event, he fail to do so, that he will suffer more serious injuries.

43. Ouellet 1990 stated, as another of his criticisms of the priority that motorcycle rider training schemes gave to teaching swerving, that, when a rider was faced with an imminent collision, he usually swerved the wrong way: namely towards a portion of the road that was clear when he began to swerve, but that was occupied by the motorcar when he arrived there.

14: Failure to brake or swerve correctly in emergency

44. Hurt *et al* 1981 (as summarised by Ouellet 1990) found that, out of the riders in their sample of 900 motorcycle accidents:
    - Nearly one-third failed to take any evasive action whatsoever
    - Only 17% used both brakes
    - Some sort of braking was reported for 515 accidents, but there were 205 cases of slide-out or high-side loss of control.

    Ouellet commented that, since the vast majority of slide-out and high-side losses of control were the result of braking errors, it might have been that as many as 40% of the riders who braked in order to avoid a collision did so incorrectly, and so lost control and fell to the roadway.

45. Hurt *et al* recommended that the effectiveness of motorcycle brakes be improved.

46. Ouellet 1990 went on also to criticise the conclusion that motorcycle rider training schemes had drawn, from the findings of simulation studies employing test riders, that riders under instruction should, as a matter of priority over the teaching—as part of 'defensive riding'—of correct positioning, be 'prepared' for an emergency by training in braking and swerving skills:

    a. He canvassed what, in practice, as opposed to under the conditions of a simulation study, was the mental and physical response of riders to an imminent collision.

       He instanced (it is thought upon the basis of the findings of Hurt *et al* 1981):
       - Panicking, and stamping on the rear brake only
       - Shouting obscenities
       - Freezing at the controls, instead of braking or swerving.

    b. He commented that the conclusion conflicted with the basic principle of experimental psychology that, whereas low or moderate stress may improve the performance of 'well-learned' behaviours, high levels of stress lead to a marked deterioration in their performance.

    c. He stated that, by focusing upon braking and swerving—i.e. upon manoeuvres that were practised only after the rider was 'threatened'—, training schemes were focusing upon a time period when:
       - The actions of the rider had little chance of affecting collision outcome
       - The rider was simultaneously likely to 'botch' what little chance he had of doing so.

    d. He supported the first statement by calculating—as already described under *Rider Cause 5: Failure to take up correct position in the road (Minimising length of 'Collision inevitable' zone)—,* on the basis of the findings of the relevant studies:
       - How far skilled braking—by comparison with no braking at all—could delay the arrival of the motorcycle at the other vehicle
       - How long it would take a skilled rider to swerve around an intruding motorcar.

    e. He supported the second statement as already recited under a. above.

    f. He concluded, to repeat from *Rider Cause 5*: *Failure to take up correct position in the road:*
       - Correct positioning was not a substitute for effective braking: it could reduce, but not eliminate collision risk. But effective braking was, equally, not a substitute for correct positioning.

- Correct positioning, by contrast with effective braking, could be practised before the rider was stressed.

47. Present paper notes, in support of Ouellet 1990's argument, the finding of McLean *et al* 1979 that experienced riders were just as likely as inexperienced riders to misperform braking.

    Thus the import of the finding is that: 'All riders are equally liable to "lose" their skills in an emergency'.

48. But paper notes also, to opposite effect, McLean *et al's* other finding that half of riders failed to use both brakes.

    The import of the finding is that: 'Nevertheless one half of all riders may retain their skills'.

49. Similarly paper notes anecdote of:
    - Six motorcycle riders as collected in the USA by Summerfield & Winiecki 1990
    - Two riders as collected by Malcolm Palmer
    - One rider as collected by self

    that they have successfully performed in an emergency the mentally 'pre-prepared' response of 'crash jumping', i.e. vaulting, off the footrests, over the top of a motorcar.

50. Nevertheless present paper agrees with general implication of Ouellet 1990's arguments and findings.

    Insofar as motorcycle rider training schemes presently give first emphasis to training in braking and swerving skills, and only second emphasis to the teaching of correct positioning (and the other practices of defensive riding), the emphases should be reversed.

15: Gripping reflex in emergency

51. Woods speculated that:
    - There may be a reflex contraction of the fingers in frightening or emergency circumstances
    - If so, the contraction will prevent extension of the motorcycle rider's fingers to operate the clutch or front brake
    - Alternatively, if the rider is already operating the front brake, the contraction may result in a jerk response, and inevitable front wheel skid
    - Motorcar drivers who make a 'panic leg motion', by contrast with motorcycle riders, 'safely' de-clutch and brake.

    In support, Woods recited that he had professionally examined the gloves of a number of motorcyclists who had been involved in an accident.

    He was impressed by the high frequency with which the gloves were worn through, not at the palm of the hand, but at the knuckle.

52. As to how the reflex might be triggered, Woods suggested that panic or fear sets in when the foreseeable task (i.e. staying upright, or avoiding an accident) becomes impossible.

    Available mental and physical capacity at the start of the incident will determine the exact moment when panic or fear sets in, i.e:
    - If 'capacity overload' is imminent, panic will set in immediately
    - If capacity overload is not imminent, panic will set in when, coupled with new input, overload point is reached.

53. Commenting more broadly, Woods added that, 'ergonomically', the motorcycle rider's hands have too many tasks to perform: they have, at the same time, to hold the rider secure, and to operate the throttle, clutch, brake and switchgear.

    Motorcycles, by contrast with motorcars, are thus badly designed for emergencies.

54. Chris Dell [non-academic motorcyclist] in Britain had personally experienced the speed and suddenness with which a rider and motorcycle may fall to the ground in a front wheel skid.

    He put this forward as an alternative explanation why the gloves of a motorcyclist might be worn through at the knuckle after an accident.

16: Lack of motorcycle anti-lock brakes

55. Present paper asserts, as potential 'benefits' of motorcycle anti-lock brakes:
    - The large number of *Rider Causes,* as already—or as follows—to be summarised, that motorcycle anti-lock brakes may be predicted to mitigate or eliminate.

    But paper also notes the following potential, or known, 'disbenefits' of anti-lock brakes:
    - 'Risk compensation', whereby the riders of motorcycles that are fitted with anti-lock brakes may 'consume' the 'positive' safety benefits of anti-lock brakes as 'performance' benefits, e.g. ride faster, or brake later
    - The lesser performance of anti-lock brakes than conventional brakes in the hands of an expert rider
    - The adverse effects that arise when anti-lock brakes are applied whilst cornering.

56. Motor Cycle News 4 December 1996 recited statement of a spokesman for the motorcycle manufacturer, BMW:

    > 'Interestingly, since BMW introduced ABS brakes [i.e. anti-lock brakes], the number of spare fairings ordered has gone down by 40 per cent.'

57. Present paper notes, by way of qualification of the statement, that:

a. Some motorcycle insurance companies in Britain have recently begun, when they deem it appropriate, to specify the repair, rather than replacement, of a damaged fairing.

b. The introduction of anti-lock brakes may have attracted to BMW a new higher proportion of safety-conscious customers.

58. Paper concludes, nevertheless, that the statement of the BMW spokesman is highly suggestive that the 'positive' benefits of motorcycle anti-lock brakes may, in practice, preponderate overwhelmingly over the 'negative' disbenefits.

17: Compulsive tendency of motorcycle riders to monitor road surface

18: Susceptibility of motorcycle riders to capacity overload

59. Watson & Lander 1973 conducted a survey of 120 motorcycle accidents in Britain. They found that in 17% of daytime accidents, and 26% of darktime accidents, the rider did not see the relevant hazard in time to avoid an accident.

60. Nagayama *et al* 1979 recited the findings of a survey by other authors of motorcycle accidents in Osaka Prefecture. [It is thought that the survey in question was conducted, during the first half of 1975, by Nagayama 1978.] The survey found that:

a. In the case of 'collisions on turning right', collisions between a motorcycle proceeding straight ahead, and a motorcar turning right, were most 'typical'. The motorcar driver expected that the motorcycle rider would give way. But almost without braking, the motorcycle would crash into the motorcar.

b. Riders were more frequently killed in accidents of the type than any other. In the fatal accidents, the motorcycle would crash into the front or side of the motorcar without braking.

[Traffic travels on the left of the road in Japan. But Nagayama *et al* state that 'priorities are not as clear as in Western countries'.]

61. Hurt *et al* 1981, to repeat, conducted a survey of 900 motorcycle accidents in the Los Angeles area. They found that nearly one-third of riders failed to take any evasive action whatsoever.

62. Nagayama 1984 conducted a survey of 118 motorcycle accidents at intersections in Osaka prefecture. He found that 7 out of the 12 riders who collided with a motorcar that, in uncongested traffic, had turned right in front of them had not seen the motorcar.

63. Further Nagayama *et al* 1979 also went on to conduct an experimental investigation, using an 'Eye-marker camera', of the comparative 'visual scanning patterns' of motorcyclists and motorcar drivers.

64. In Nagayama *et al 's* first experiment, three subjects drove a 650cc motorcycle, and a motorcar, at a speed of approximately 50kph along a 2 km stretch of 'typical' four-lane suburban arterial road with no median barriers. The findings of the experiment, as transcribed from Nagayama *et al 's* diagrams, were:

1. Fixations on road surface:
   When riding the motorcycle, subjects directed 29.3% of their eye 'fixations', time-weighted, at the road surface.
   By contrast, when driving the motorcar, they directed 0.0% of their fixations at the road surface
2. Fixations below road horizon (i.e. line where sky meets road):
   When riding the motorcycle, the subjects directed 81.7% of their eye fixations below the road horizon.
   By contrast, when driving the motorcar, they directed 10.6% of their fixations below the road horizon.

65. It would seem, further, that, when riding the motorcycle, subjects made a total of 500 fixations (representing 447 fixations after Nagayama *et al* 's time-weighting adjustment).

    By contrast, when driving the motorcar, they made 830 fixations (584).

    If so, the finding would imply that, when riding the motorcycle, by virtue of scanning a more extensive area (and so spending more time in traversing between fixations), subjects:
    - Spent less time upon fixations
    - Made fewer fixations.

66. In Nagayama *et al 's* second experiment, three subjects again drove a 50cc motorcycle, 400cc motorcycle, and motorcar, at speeds of 30, 45, and 60kph along a nearly straight 1 km stretch of quiet four-lane suburban road with footpaths, and trees planted as median barrier.

    Taken separately, the findings of the second experiment did not differ in essence from the findings of the first experiment.

    In addition, Nagayama *et al* made a number of tentative findings of the effect of increasing vehicle speed, and to a lesser extent, increasing motorcycle size.

    The most 'assured' of the findings was that, when riding either of the two motorcycles, the average duration of fixations of subjects decreased with increasing vehicle speed.

67. Last Nagayama *et al* 1979 speculated, as follows, on the basis of their findings:

1. Motorcar drivers

   'Automobile drivers are looking further ahead, and the proportion of the road surface in their visual field is smaller. Therefore, it seems that they can cover a more extended visual world efficiently by peripheral vision. From the compactness of the dispersion of their fixation points and the finding that they are looking ahead, it can be suggested that for them it is relatively unnecessary to acquire information with frequent and divergent eye movements in order to cover the foreground. They seem to be acquiring forward information with more spare capacity. This might be related to the finding of relatively longer fixation durations of automobile drivers.'

2. Motorcycle riders

   'On the other hand, motorcyclist are looking at the closer foreground and the proportion of the road surface in their visual field is larger. Therefore, they should scan and search far and near in order both to acquire information from the distant foreground and to acquire information from the closer road surface for securing their riding stability. They seem to have a conflict regarding looking far and near. This is reflected in the findings of larger vertical variance of horizontal lines and divergent eye movements. Also, from the finding of the shorter duration of fixations, it could be suggested that they are scanning and searching superficially and extensively. It seems reasonable to infer that they are apt to fail in acquiring necessary information.'

3. Effect of speed

   'From the findings of the decreased redundancy of fixation points (more divergent distribution) and the shorter fixation durations with speed, it could be suggested that under a lower speed drivers and riders have more spare capacity and that under a higher speed they are under tension or mentally loaded so they have less spare capacity. But the results are not conclusive.'

68. Present paper suggests, in addition, on the basis of Nagayama *et al* 1979's findings, that:

    1. Motorcycle riders, by comparison with motorcar drivers, may have a compulsive tendency to monitor the road surface

       So, when travelling on the major road, a motorcycle rider may collide with a vehicle that intrudes upon his road because at the time he is looking at the road surface, and so does not see the vehicle.

    2. Motorcycle riders, further in consequence of the compulsive tendency to monitor the road surface, may have less 'spare capacity' to perform other driving tasks than motorcar drivers

       So, even if the motorcycle rider does see the vehicle intrude upon his road, he is more likely, then, to be subject to 'capacity overload', and so still collide with the vehicle.

19: Looking aside

69. Present paper reluctantly bases a 'suggestion upon a suggestion'.

    It suggests that, suppose motorcycle riders indeed to have a compulsive tendency to monitor the road surface, then:

    - If a motorcycle rider looks aside from the direction in which he is travelling
    - If a motorcycle rider loses concentration, so that his attention departs from his riding,

    when the rider looks back in the direction in which he is travelling, or regains concentration, his eyes will not return directly to the direction in which he is travelling.

    Rather his eyes will return, indirectly, via a compulsive monitoring glance at the road surface.

    Similarly, such a glance will precede any diversion of the eyes of the rider from the direction in which he is travelling, or the commencement by the rider any such 'road-surface sensitive' action as braking.

70. Paper notes in support, first, that it is well known amongst motorcyclists that even the 'ordinary' action of looking down at the speedometer may involve a dangerously long diversion of the attention of the rider from the road.

    Should the full sequence of the rider's actions also comprehend sub-conscious glances, before and after looking down at the speedometer, at the road surface, the length of time that it takes to complete the action acquires a rational and plausible—if not an exclusive—explanation.

71. Paper recites, second, a suggestive personal anecdote of my own of the longer diversion of attention that is involved in 'looking aside' when riding a motorcycle, than when driving a motorcar.

[Criticisms of findings of Nagayama et al 1979]

I: Discrepant findings of Mortimer & Jorgeson 1975

72. Mortimer & Jorgeson 1975 conducted a similar experimental investigation using an 'Eye-marker camera' to Nagayama *et al* 1979 in the USA.

    Two subjects drove a motorcycle, and an automobile, along two-lane rural roads, at about 45 mph, in daytime. Mortimer & Jorgeson reported their findings as follows:

    'The results indicated that most of the drivers' attention was directed within 5° of the forward line of sight, but on curves, the drivers' eye fixations shifted

in the direction of the curve. When an oncoming vehicle appeared, the drivers spent a substantial proportion of the viewing time looking at it periodically. The mean duration of glances were longer for these drivers when operating a motorcycle than an automobile. When operating the motorcycle there were relatively more glance made closer to the vehicle than when driving the car, suggesting that motorcyclists are more concerned with irregularities, composition and frictional characteristics of the pavement surface. The motorcycle riders also tended to view along the right side of the lane more than when driving the car.'

II: Failure of Nagayama *et al* 1979 to discuss discrepant findings of Mortimer & Jorgeson 1975

73. Present paper notes that Nagayama *et al* 1979 cite Mortimer & Jorgeson 1975 as a previous eye-marker camera study of motorcycle riders. But they fail to discuss the discrepancies between the findings of the two studies.

    Paper is accordingly unable to resolve the discrepancies.

III: Criticisms of Robertson

74. Robertson in Britain entered the caveat against the findings of Nagayama *et al* 1979 that they should be 'repeated', with the object of establishing what influence the comparative driving position of the subjects when riding the motorcycle, and driving the motorcar, may have had upon the pattern of the distribution of their fixations.

75. Thus Robertson noted, for instance, the finding of Nagayama *et al 's* first experiment that, when driving the motorcar, the 'field of view' of subjects was 'elevated'. Dividing the 'road scene' at the road horizon:
    - 71% of the field of view comprised 'Sky'
    - 29% comprised 'Road'.

    By contrast, when riding the motorcycle, the figures were almost exactly reversed:
    - 31% of the field of view comprised 'Sky'
    - 69% comprised 'Road'.

    In other words, Nagayama *et al* found that, not only the fixations, but also the head, or eyes, of subjects, were directed 'upwards' when driving the motorcar, but 'downwards' when riding the motorcycle.

76. Accordingly Robertson concluded that, in the present state of Nagayama *et al* 1979's findings, it could not be eliminated that the findings might have:
    - An 'ergonomic' explanation, in terms of a comparatively 'bad' riding position of motorcycle riders, and 'good' driving position of motorcar drivers,

    rather than:
    - A 'behavioural' explanation, in terms of a compulsive tendency of motorcycle riders to monitor the road surface.

IV: Reply of Minter and paper to criticisms of Robertson

77. In reply, Minter in Britain—who for more than ten years now has ridden a succession of motorcycles with a pronounced, 'café racer' style, crouched forward, riding position—dismissed the ergonomic explanation, on the basis of his personal experience.

78. Present paper has recited previously, under *Rider Cause 19: Looking aside*, certain contrary motorcyclist's and personal anecdote.

79. And together Minter and paper note the inherent implausibility of the ergonomic explanation, by comparison with the behavioural explanation.

V: Conclusion

80. However Minter and present paper agree with Robertson that 'speculation' affords no substitute for a full repetition, with appropriate additional 'conditions', of Nagayama *et al* 1979's experiment.

81. Present paper also observes the need for such a repetition in order to resolve the discrepant findings of Nagayama *et al* 1979, and Mortimer & Jorgeson 1975.

20: Loss of concentration

82. McLean *et al* 1979 reported four accidents, out of the 68 accidents in their sample, in which the motorcycle rider may have been distracted:
    - One rider was still excited from chasing a man who had knocked over his motorcycle in a hotel car park
    - One rider was still fumbling for the horn button, in order to warn a pedestrian, when he hit the pedestrian (Although the motor scooter that he was riding was, in other respects, the same as the scooter that he used at work, the horn button was located on the opposite side of the handlebars)
    - Two riders were watching for changes in traffic lights ahead of them.

21: Misting visor

83. Present paper recites frequent complaint of motorcyclists that the visor of their helmet has a tendency to mist up.

84. Paper recites anecdote of BMF director Fred Tolley that another motorcycle rider of a group with which he was travelling hit a parked car because his visor was misted up.

22: Susceptibility of motorcycle riders to lowered body temperature in winter

85. Woods 1983 found that, whereas relatively inactive subjects, if their clothing is fully windproof, and thick enough, cool very slowly, if at all, when exposed to winds up to 100kph at temperatures around 5°C, some of the sample of seven motorcyclists whom he tested whilst they rode wearing their normal riding clothing cooled very fast under the same conditions.

86. Woods 1986 found that much thicker and more windproof riding clothing than was generally available on the market was needed in order to maintain normal body temperature when riding an unfaired motorcycle in winter.

87. Present paper suggests, on the basis of Woods' findings, that a diminished mental and physical performance of motorcycle riders, in consequence of inadequate clothing, and so of pronounced cooling, may be an important contributory cause of motorcycle accidents in winter in Britain.

    Or indeed, given the temperature of 5°C that Woods 1983 specified in his findings, it could also be a significant contributory cause of motorcycle accidents at other times of the year.

23: Unergonomic design of motorcycles

88. Robertson commented adversely upon the present design of motorcycles that, ergonomically:

    1. Riding position:
       A number of custom and sports style motorcycles force 'extreme' laid back, or forward crouch, riding positions upon the rider.
    2. Range of adjustments:
       By comparison with the marked variability of human physical dimensions, few models of motorcycle afford more than a very limited range of adjustments to accommodate riders of different dimensions.

    Present paper comments that:

    3. Switchgear:
       The switchgear of many motorcycles is awkward to operate 'reflexly'—i.e. without a conscious diversion of attention—under the conditions of ordinary riding, let alone in an emergency.

    And Woods commented, to repeat from *Rider Cause 15: Gripping reflex in emergency:*

    4. Handlebar controls:
       Motorcycle riders' hands have too many tasks to perform: they have, at the same time, to hold the rider secure, and to operate the throttle, clutch, brake and switchgear.

89. Present paper doubts that, for journeys of the length that are typically undertaken by motorcycle riders, the rider's powers of concentration will be affected—*pace* Robertson's comments—by a 'bad' riding position.

90. Paper recites, in support, the estimate of National Travel Survey 1991/1993 that most motorcycle journeys in Britain were under 25 miles in distance.

24: Possible tendency of motorcycle riders to exceed normal speed of other traffic on road at junctions

91. Transport Statistics Great Britain 1995 reports the findings of an official survey of, *inter alia,* the comparative speeds of travel of motorcycles and mopeds, and of motorcars, on different classes of road in Britain in 1994.

    To refer back to *Rider Cause 3: Failure to slow down to normal speed of other traffic on road*, the findings show that:

    a. 60mph and 70mph non-motorway roads: There was a clear tendency of a substantial proportion of the total motorcycle and moped rider population in Britain in 1994 to travel at a speed in excess of the 'normal' speed of other, motorcar, traffic on the road.
    b. 30mph and 40mph roads: There was a clear tendency of a lesser, but still significant, proportion of the motorcycle and moped rider population to travel at a speed in excess of the 'normal' speed of other, motorcar, traffic on the road.
    c. If it had been possible, on the data, to disaggregate and exclude the riders of mopeds and small commuter motorcycles from the total rider population under consideration—i.e. to treat only the population of the riders of 'learner' 125cc motorcycles, and motorcycles over 125cc—, the two proportions would have been even greater.

       Indeed, on 60mph and 70mph non-motorway roads, between a quarter and a half of all riders of motorcycles over 500cc might have travelled at a speed in excess of the 'normal' speed of other, motorcar, traffic on the road.

92. Present paper comments that, nevertheless, for present purposes the information of the 1994 speed survey is insufficient, since Transport Statistics Great Britain does not supply descriptive details of the survey sites.

    Correspondingly it is not known whether the tendency of motorcycle riders to exceed the normal speed of other, motorcar, traffic on the road at the survey sites applied equally also to hazard sites, in particular to junctions.

25: Possible susceptibility of motorcycle riders to darktime accidents

93. Present paper suggests that, since traffic density falls in darktime, one may expect also in darktime that the proportion of multi-vehicle accidents (including junction accidents) to single vehicle accidents will fall.

94. Consistently with the suggestion, in Williams 1976's survey of 1508 motorcycle accidents in Victoria, out of the 457 accidents that took place between a 'motorcycle rider on the major road and another vehicle', only 132 (29%) took place at night.

95. Present paper notes that the Department of Transport in Britain does not:
- Collect separate data of the mileage that vehicles travel in daytime, and darktime.

Further, although the police report to the Department, *inter alia,* whether an accident took place in daylight or darkness, the Department does not:
- Publish a breakdown of road accident casualties by type of vehicle; severity of injuries; and whether the relevant accident took place in daylight or darkness.

96. By way of exception, however, Whitaker 1980 did publish a breakdown of motorcycle rider casualties in 1974 by severity of injuries, and whether the accident took place in daylight or darkness.

The breakdown showed that, in Britain in 1974, first:
- 52% of motorcycle riders killed
- 40% of motorcycle riders seriously injured
- 32% of motorcycle riders slightly injured

suffered their injuries in an accident that took place in darkness.

Second, motorcycle riders suffered more severe injuries in accidents that took place in darkness, than in accidents that took place in daytime.

[Incidentally, it should be noted, as a matter of interpretation of the figures, that it is likely that a lower proportion of accidents in which a party is slightly or seriously injured are reported to the police after dark.]

97. Whitaker 1980 did not publish a similar breakdown of motorcar driver casualties.

98. However, Organisation for Economic Cooperation & Development 1978 published an international comparison table that listed, *inter alia* for mopeds, motorcycles, and motorcars, the proportion of fatal accidents that occurred during darkness in a number of countries in the early 1970s.

The table did not suggest that the proportion of fatal accidents that occurred during darkness was systematically greater for mopeds or motorcycles than for motorcars.

99. Present paper knows of no study that has, other than perfunctorily:
- Performed a separate analysis of the circumstances of darktime motorcycle accidents
- Considered separately the possibly distinct causes of them.

100. Present paper therefore concludes that:
- It is likely that fewer motorcycle accidents in darktime, than in daytime, are multi-vehicle accidents
- It is correspondingly also likely that fewer motorcycle accidents in darktime, than in daytime, occur at junctions
- It is unlikely that the proportion of fatal motorcycle accidents that occur in darktime is greater than the proportion for motorcars.

Accordingly darktime motorcycle accidents do not fall to be accorded a special treatment in the paper.

Nevertheless a figure of 52% of motorcycle riders killed, who are killed in an accident that takes place during darktime, is a very high one.

If the figure remains as high today, the paper therefore recommends:

1. The conduct of an enquiry into the distinctive causes of motorcycle darktime accidents
2. The institution of the training of motorcycle riders in darktime, as well as daytime.

26: Training and testing of motorcycle riders in performance of tasks of low priority

101. Present paper sums up the effect of the various *Driver* and *Rider Causes* that have been described in the paper: there are essential differences between riding a motorcycle, and driving a motorcar.

102. Paper asserts the paradox that:

'Because the motorcycle lacks the protection, stability, and reliable braking performance in an emergency, of the motorcar:
- A greater hazard is presented to the motorcycle rider than the motorcar driver by what lies in the road scene directly ahead of him.

Yet because of the preoccupation of the rider with the road surface that, in particular, the lack of stability, and reliable braking performance, at the same time, implies:
- The motorcycle rider has less attention, or spare mental capacity, than the motorcar driver to devote to the road scene directly ahead of him'.

103. Paper observes that the official practices and requirements of motorcycle rider testing in Britain are laid down by the Highway Code, and by the Motorcycling Manual.

The practices and requirements mould the practices that are taught in motorcycle rider training.

104. But in spite of the differences between riding a motorcycle, and driving a motorcar, paper comments, largely, the practices and requirements of motorcycle rider testing in Britain continue to be modelled upon the practices and requirements of motorcar driver testing.

Thus, motorcycle rider testing is predicated upon:

1. The motorcycle rider's being able to 'spare' fixations from 'where he is going' to the same degree as the motorcar driver

   So rider testing wrongly fails to place a greater emphasis upon forward, than upon rearward or sideward, observation

2. The motorcycle rider's having the same spare mental and physical capacity as the motorcar driver to perform driving tasks of low, as well as high, priority

   So rider testing wrongly requires riders to 'squander' capacity upon inessential 'motorcar' taught practices

3. The motorcycle rider's being at the same statistical hazard of an accident at a junction, private entrance, or roundabout when travelling upon the major road, and minor road, as the motorcar driver

   So, although, in fact, to refer back to *Statistics:*

   - Whitaker 1980 found that 'the motorcycle was going ahead, and the other vehicle manoeuvring in 72% of multi-vehicle junction accidents'
   - Faulkner 1975 in Britain found that the motorcycle was travelling on the major road in 91% of junction accidents,

   rider testing wrongly places the same, or greater, emphasis upon the practices that the rider should follow when approaching a junction on the minor road, than upon the practices that he should follow when approaching a junction on the major road.

105. And, as a reflection of similar 'motorcar-centred' thinking, the other contents of the Highway Code, and the Motorcycling Manual, reveal a number of examples of ignorance of:

- Safe motorcycle riding practice
- The official British casualty statistics
- The findings of official British studies of motorcycle accidents.

In particular:

a. The Highway Code 1993 does not—unlike the Pedal cyclist—include a separate section of advice addressed to the Motorcyclist.

   Instead it assimilates its advice to the Motorcyclist, and to the Motorcar driver, together.

b. The Highway Code 1993, and the Motorcycling Manual 1991, do not—*pace,* to repeat, the findings of Whitaker 1980 and Faulkner 1975—systematically bring together, and concentrate in one place, their treatment and illustrations of the situations:
   - 'Motorcycle rider approaching intersection, junction, or private entrance on major road'
   - 'Motorcycle rider negotiating roundabout on major road'.

c. The chapter of the Motorcycling Manual 1991 that treats 'Defensive riding' fails either to stress and give prominence to, or to illustrate:
   - Safe 'See and Be seen' riding lines
   - Correct positioning in the road in the presence of a waiting vehicle at a junction.

   Instead the overall impression that the illustrations of the chapter give is that the 'normal' line of a motorcycle in the road should be the 'Gutter' line.

   Whereas the Gutter line will often be the most hazardous line of all.

d. The chapter of the Motorcycling Manual 1991 that treats 'Riding at night' is only 4 pages long.

   In essence, it merely repeats the advice of the Highway Code 1993 on the need for good eyesight, good vehicle conspicuity, and good vehicle lighting.

e. The Motorcycling Manual 1991 makes only incidental mention of pedestrians.

   It totally fails to stress at all—let alone lay down precautionary practices against—the special hazard of a motorcycle accident with a pedestrian.

f. The Highway Code 1993 advises motorcycle riders to pursue an even more extensive—not less extensive—routine of backward glances, mirror sights, and hand signals than motorcar drivers.

106. Present paper accordingly concludes that motorcycle riders who have been prepared for the road by rider training that is 'tailored' to the official requirements of the British motorcycle driving test may dissipate their fixations, capacity, and attention upon the correct performance of tasks that are of low degree of priority in the scale of their contribution to the rider's survival.

3. Road causes

1: Road surface

1. Present paper notes, as one of the implications of Nagayama *et al* 1979's findings of the distribution of the fixations of motorcycle riders (as given under *Rider Cause 19: Compulsive tendency of motorcycle riders to monitor road surface*), that any irregularity, inconsistency, or shortfall in adhesion of the road surface will yet further aggravate the already marked compulsive tendency of the motorcycle rider (or pedal cyclist) to monitor the road surface.

2. Paper recapitulates that the roads travelled by Nagayama *et al's* experimental subjects were, on the face of Nagayama *et al's* description of them, from a motorcycle rider's point of view, 'undemanding'.

   So, on a road with a 'demanding' road surface, a rider might only direct the occasional glance at or above the road horizon, and devote fully one half or more of his attention to the road surface.

3. Paper recites that it is already well-known that a motorcycle may lose adhesion on a defective or inconsistent road surface under emergency braking.

4. But present paper emphasises that a defective or inconsistent road surface can act too as a contributory cause of motorcycle accidents for the above reason also.

2: Non-constant radius curve

5. In 1994, Stewart recited, in a letter to *The Times,* the conclusion of 'recent research' in California that curves in the road to the 'spiral' design that is conventional practice in Britain 'had almost twice as many accidents' as curves in the road to the 'constant radius' design that, by contrast, is conventional practice in the USA.

6. Stewart reported that the British Department of Transport did not intend to act upon the conclusion, or to repeat the research.

7. Present paper comments that anything, such as a bend of varying radius of curvature, that causes a motorcycle rider to concentrate his attention upon the road, rather than upon the road scene ahead of him, must also aggravate the compulsive tendency of riders to monitor the road surface that was identified by Nagayama *et al* 1979.

   So, where, e.g, the bend also features a junction, it must have implications also for accidents of the type that are treated in the paper.

H. Prevention

1. Choice of target: Other driver or Motorcycle rider

1. Choice of target

It is a popular response of motorcyclists to the high incidence of accidents between motorcycles and motorcars at junctions to call for the introduction of measures 'to improve the driving of motorcar drivers'.

The response is fuelled by the fact that, as noted under *Statistics,* in such accidents the motorcycle rider will usually be travelling on the major road, so that in law it is the motorcar driver who is 'at fault'.

Between them, the Transport Act 1981, and the introduction of Compulsory Basic Training in 1990, implemented a more 'onerous' training regime for motorcycle riders than for motorcar drivers.

Since then many motorcyclists have called vociferously for a similar training regime for motorcar drivers.

Together, in support, they assert the:

- Road safety ground that such a regime will 'enable' motorcar drivers 'to be trained to drive safely towards motorcycle riders'.
- Political ground that there should be 'equal treatment' of drivers and riders.

It is clearly 'fair' that motorcar drivers should share with motorcycle riders the 'burden' of reducing motorcycle accidents.

And training motorcar drivers to drive safely towards motorcycle riders must be, to a small, but significant, degree, an effective measure towards that end.

But in my view training motorcycle riders to ride safely and 'defensively' towards motorcar drivers, as a measure, is effective to a much greater degree.

Or more broadly, the main target of measures to reduce the number of motorcycle accidents must be, not the motorcar driver, but the motorcyclist.

In this preliminary Section, I justify the view.

The *ratio* of the justification is that, in order to be effective, rider or driver training must not just be effective 'in itself': it must also be 'reinforced', out on the road, by 'reminders', or 'feedback', of the potential hazard of a motorcycle accident.

I therefore estimate, from British studies and statistics, the respective amount of feedback of the potential hazard of a motorcycle accident that, typically, per week or per year, a motorcar driver, and a motorcycle rider, will receive.

2. Feedback: Other driver

Figures of Spicer 1973 and RAGB 1995

Spicer 1973, as already mentioned, observed 'serious conflicts'—defined by Spicer as: 'situations involving a vehicle in at least a sudden rapid deceleration or lane change to avoid collision'—between 'vehicles' at six junctions in Britain.

In passing, he stated (without citing authority for the first assertion) that:

> 'On average a driver is involved in an injury accident once in about 47 years. If the ratio of conflicts to accidents [observed in the study] is approximately constant over the whole of the road system then on average a driver is involved in one serious conflict during about 200 miles of driving i.e. one serious conflict per week.'

[So, to reconstruct Spicer's actual finding, he must have observed a ratio of serious conflicts to accidents of about 2444:1.]

In 1995 in Britain, *per* Road Accidents Great Britain 1995, motorcars were involved in:

14,384 injury accidents with a motorcycle
20,238 accidents with a pedal cycle
104,791 injury accidents with another powered vehicle.

In addition motorcars were involved in 22,259 injury accidents with two or more other powered vehicles (or pedal cycles).

Unfortunately, in the 'confusing' way of many road safety research scientists, Spicer 1973 did not—apart from the term 'serious conflict'—formally 'define his terms'.

In particular, he did not define the terms 'vehicle', and 'injury accident'.

But it is most likely that, in his study, when treating 'vehicles', and 'injury accidents', he excluded, certainly, pedal cycles, and pedal cycle injury accidents, from consideration.

Calculation of rate per year of 'serious conflicts' between a motorcar driver and a motorcycle

So without attempting a proper calculation, take a:

14,384:104,791 figure of the 'ratio of motorcar accidents with motorcycles to motorcar accidents with all powered vehicles',

and apply it to:

Spicer's figure of 'one serious conflict per week'.

Then a motorcar driver might experience, by way of 'feedback', some 7 serious conflicts with a motorcycle per year.

And a driver might be involved in a motorcycle injury accident once every 342 years, or once in some seven driving lifetimes.

Most of the serious conflicts—to refer back again to the findings of Faulkner 1973 and Whitaker 1980 under *Statistics*—will be serious conflicts in which it was the motorcycle rider, not the driver, who braked or swerved to avoid the collision.

And each one will be interspersed with some 6–7 serious conflicts not involving a motorcycle.

3. Feedback: Motorcycle rider

Figures of VED Evasion 1994/95, RAGB 1995 and Tunbridge et al *1988*

In June 1994 in Britain, *per* Department of Transport 'Vehicle Excise Duty evasion in Great Britain: 1994/95', an estimated total of:

1,061,000 motorcycles

were used on the road.

In 1994, *per* Road Accidents Great Britain 1995, a total of:

22,498 motorcycle riders

1,811 motorcycle passengers

suffered slight, serious, or fatal injuries in an accident that was reported to the police.

And Tunbridge *et al* 1988 surveyed 6040 persons who attended hospital in Oxfordshire for treatment for road traffic injuries in 1983 and 1984. They found that:

51% of slight injuries

32% of moderate to severe injuries

to motorcycle riders and passengers had not been reported to the police.

[The figures of 51% and 32% were probably even higher in 1994.

Thus, between 1984 and 1994, the figure of motorcycles that were ridden unlicensed, and so illegally, on the road without payment of Vehicle Excise Duty rose from 20% to 35%.]

Calculation of frequency with which a motorcycle rider will suffer injury in an accident

So, again without attempting a proper calculation, suppose that:

50% of motorcycle riders who suffered slight or serious injuries failed to report them to the police.

Then, in 1994 in Britain, some 45,000 motorcycle riders suffered injuries in a motorcycle accident.

Or a motorcycle rider might expect to suffer an injury in an accident approximately once every 23–24 years.

Calculation of frequency with which a young novice motorcycle rider will suffer injury in an accident

In Road Accidents Great Britain 1980—using 1979 national data, and the data of the National Travel Survey 1978/79—, it was calculated that, whereas, for motorcycle riders of all ages, taken together, the rate of slight, serious, or fatal injuries in an accident was:

860 injuries per hundred million vehicle kilometres,

for motorcycle riders aged 18–19 the rate was:

2000 injuries per hundred million vehicle kilometres.

Lynn 1990 surveyed, *inter alia*, the annual mileage that was travelled in 1987 in Britain by a sample of 6245 owners of licensed motorcycles. He found that, whereas motorcycle riders of all ages, taken together, travelled an estimated average annual mileage of:

3700 miles per annum,

motorcycle riders aged 18 and 19 travelled an average annual mileage of, respectively:

5300 or 5600 miles per annum.

Make adjustments to the estimate that 'a motorcycle rider might expect to suffer an injury in an accident approximately once every 23–24 years' in order to allow for the:

- Higher annual casualty rate per mile
- Higher average annual mileage

of the 18–19 year old rider that are revealed by the above figures.

Then the young novice 18–19 year old motorcycle rider might expect to suffer an injury in an accident approximately once every 7 years.

Calculation of rate per year of 'serious conflicts' between a young novice motorcycle rider and a motorcar

If so, take:

Spicer 1973's ratio of serious conflicts to injury accidents of 2444:1,

and apply it to a:

Frequency of injury accidents of once every 7 years.

Then the young novice 18–19 year old motorcycle rider might expect to experience, by way of 'feedback', some 7 serious conflicts with another vehicle—predominantly serious conflicts with a motorcar—per week.

4. Feedback: Summary

To sum up, therefore, the typical young novice motorcyclist will receive, by way of the 'feedback' of 'serious conflicts', or disturbing encounters, with other vehicles, a reminder of the need to be vigilant in the presence of motorcars some 7 times a week.

But the typical motorcar driver will receive a reminder to be vigilant in the presence of motorcycles only 7 times a year.

Further the 'impact' of the motorcar driver's 'disturbing encounters' with a motorcycle will be 'diluted'.

First, the encounters with a motorcycle will be interspersed with 6–7 disturbing encounters with a motorcar, or other four-wheeled vehicle.

Second, in the encounters with a motorcycle, it is far more likely that it will be the motorcycle rider who has to brake or swerve to avoid the driver, than the driver who has to brake or swerve to avoid the motorcycle.

5. Principal target: Motorcycle rider

So, as between attempting to reduce the number of accidents between motorcycles and other vehicles by improving motorcar driver, or motorcycle rider, behaviour, the main prospect of achieving an enduring improvement must lie with attempts to improve motorcycle rider behaviour.

Such attempts will be 'reinforced' 7 times a week by the rider's actual experience out riding on the road.

Whereas attempts to improve motorcar driver behaviour will be reinforced only 7 times a year, and possibly reinforced, also, in a psychologically weaker fashion.

6. Subsidiary target: Other driver

Subject to the qualification, a reinforcement of 7 times a year must still permit a worthwhile improvement of motorcar driver behaviour to be achieved.

Motorcycle accidents are popularly accepted to be numerous, and regrettable in their consequences.

The only danger lies in adopting 'forceful' methods, and thereby arousing also other responses.

I note, for instance, the mental twist whereby, after an accident, to the disgust of police officers and bystanders, a motorcar driver may blame the pedestrian, pedal cyclist, or motorcyclist victim for the accident, as though he, rather, had caused it, simply by 'being there' in the first place.

7. Subsidiary target: Pedestrian

It is not possible to express, or assess, the number of pedestrian accidents, or serious conflicts, with motorcycles on a comparable basis to motorcar driver, or motorcycle rider, accidents.

But pedestrians could well experience serious conflicts with motorcycles at the same, or at a greater, frequency per year than motorcar drivers.

And whereas the motorcar driver may not have in mind that he might, prospectively, be injured by the motorcycle, the pedestrian will, most definitely, have this in mind.

So the 'impact' of the conflicts upon pedestrians will be comparatively far greater. because,

Accordingly, like motorcar drivers, pedestrians are likely to receive sufficient reinforcement for a worthwhile improvement of pedestrian behaviour to be achieved.

8. Commentary

Since I have, in the Section, raised a considerable 'castle' of findings and conclusions upon the 'sand' of a purely statistical 'calculation', I conclude with a brief commentary.

To a motorcyclist, the calculation is indeed fraught with arguable assumptions, e.g. that:

- The ratio of serious conflicts to injury accidents is the same for motorcycles and motorcars,

and makes 'non-intuitive', and possibly contentious, findings, e.g. that:

- An 18–19 year old motorcycle rider might expect to suffer an injury in an accident only once every 7 years.

And a scientist must further doubt that there exists a necessary, or close, relation between 'serious conflicts' of the type defined and observed by Spicer 1973, and the real hazard of an accident.

I therefore deliberately discussed the intermediate, and final, findings of the calculation with an experienced motorcycle rider training instructor.

He told me that: 'Cut through the macho talk of your average bullshitting motorcyclist, and the false general image that the public holds of the invariable teararse or tearaway young rider, and the findings were in full accord with his personal observations of the riding behaviour, or professional knowledge of the accident experience, of both young and old riders over the years.'

2. List of measures: Other driver

1. Publicity campaigns
2. Highway Code revision
3. Certainty of prosecution and conviction
4. Road improvements
5. Law enforcement

1. Publicity campaigns

The British Motorcyclists Federation's 'Motorcycle Awareness Campaign' 1995 was an attempt, in line with what has just been said under *Feedback: Other driver,* to influence driver behaviour — namely to 'deliver' the 'message' to motorcar drivers: 'Be aware of, and look out for, the presence of motorcyclists'

Driver Cause 3: Lack of expectation of motorcycles (Position taken up by motorcycle in road)
Driver Cause 4: Lack of expectation of motorcycles (Infrequency of motorcycles).

Its aim was, part presently:

- To 'refresh', as assisted by the 'reinforcement' of driver feedback on the road, the impact of past campaigns of the sort,

and part prospectively:

- To attract European Community funding in support of further 'refreshing' campaigns.

2. Highway Code revision

The Highway Code merits total revision: as stated under *Rider Cause 26: Training and testing of motorcycle riders in performance of tasks of low priority,* it has grown by accretion for many years, and now suffers from great defects of structure and balance.

One submission that the BMF made when the Code was last revised in 1992—as edited for greater clarity, and brought up-to-date—was that:

'1. The Highway Code should, in the current state of evidence on the subject, remove—or, if not, highly qualify—its advice to motorcycle riders to use daytime lights or other conspicuity aids

Driver Cause 12: Lack of conspicuity or visibility of motorcycle
Driver Cause 6: Absence of perceived threat from motorcycles (Adverse legal consequences).

2. The Highway Code should remove all reference to motorcycles being difficult to see

Ditto

Such advice runs counter to the best view, even amongst road safety research scientists who support measures such as daytime lights for motorcycles, that what is at issue is the 'conspicuity', not 'visibility', of motorcycles. The advice has unfortunately persuaded many motorcar drivers—and magistrates—that failure to see the motorcycle is an acceptable explanation, if not an excuse, for a motorcycle accident

3. The Highway Code should advise motorcar drivers (as also motorcycle riders and other road users) specifically, in terms, of Hills 1980's four 'impossible situations', as he described them as inherent in the limits of human perception

Driver Cause 1: Limits of human perceptual capability

4. A study should be undertaken to measure the errors of estimation of speed to which motorcycles are liable in head-on view. Subject to the findings of the study, 'Estimating the speed of a motorcycle in head-on view' should be added as a fifth item to Hills 1980's list of 'impossible situations'

Driver Cause 2: Misestimation of motorcycle speed

5. The BMF is currently debating whether, given its persuasive influence upon the Courts, the Highway Code should advise road users in even more strong terms 'to give way to more vulnerable road users'

Driver Cause 6: Absence of perceived threat from motorcycle (Adverse legal consequences)

In countries, such as Sweden, where road safety, or 'no fault' insurance, legislation formally 'favours' one group of road users (Pedal cyclists and Pedestrians) legally, or financially, over another group of road users (Drivers of powered vehicles), 'hostile' remarks have been made orally and in print, to the BMF's knowledge, by members of the 'disfavoured' group against the 'favoured' road user group.

Accordingly the BMF, mindful of the present, already disturbingly high, frequency with which motorcyclists report incidents of aggressive driving by motorcar drivers towards them, is settling its position with care.'

3. Certainty of prosecution and conviction

The suggestion of the findings of the non-academic studies, Leonard 1974, and Booth (Weldon G) 1978, and of the anecdotal experience of motorcyclists who are also police motorcycle patrol officers, is that drivers do 'notice' and respond to the presence of a motorcycle in circumstances where they may face adverse legal consequences should they fail to do so

Driver Cause 6: Absence of perceived threat from motorcycle (Adverse legal consequences).

I therefore find it frustrating that no road safety research scientist, to date, has seen fit to investigate 'formally' how

far the probability—or certainty—of prosecution and conviction may 'influence' driver behaviour.

It is popular amongst motorcyclists in Britain to complain, either that:

- Prosecutors, and Magistrates, are reluctant to prosecute or convict,

or that:

- Magistrates only hand down derisory sentences to,

a driver at a junction who 'causes' an accident by failing to give way to a motorcyclist on the major road.

It is however more likely that this is a manifestation of a general trend that applies to all motoring offenders, not just motoring offenders who cause motorcycle accidents.

Thus, between 1984 and 1994, according to Transport Statistics Great Britain 1996, :

- 'Findings of guilt, etc' for 'Dangerous, careless or drunken driving, etc' fell from 251,000 to 190,000,

even though, according to Road Accidents Great Britain 1994:

- Total injury accidents, at 429,520 and 422,362, remained effectively constant, and did not, by contrast, fall at all.

Nevertheless I must record the relentless assertion that, over the past 30 years, has been made, by advocates of the use of daytime lights and fluorescent clothing by motorcyclists, that motorcar drivers have accidents with motorcycles because motorcycles are 'difficult to see'.

The assertion—which is also embodied in the Highway Code— must have had a pronounced weakening effect upon the resolve of prosecutors and magistrates to prosecute or convict motorcar drivers after a motorcycle accident.

Yet, the assertion is purely 'intuitive' — and almost certainly, in most cases before them, wrong.

Thus, as stated earlier in the paper:

- *Per* Whitaker 1980 and Hurt *et al* 1981, in most motorcycle accidents, it is likely that the motorcycle is travelling at less than 40mph
- *Per* the suggestion of Hurt *et al* 1981, and Olson *et al* 1981's, findings, it is likely that motorcycle accidents at junctions only 'seriously start to happen' when the other driver fails to give way to a motorcycle that is less than 3sec—or 60yd at 40mph—distant from him.

And any driver can 'see' a motorcycle that is 60yd or less distant from him.

4. Road improvements

Currently, the police only give limited priority to the enforcement of road traffic law by the deployment of policemen actually 'on the street', or 'on the road'. So it is unlikely that, for instance, the return of widespread Halt and Stop signs would inhibit many motorcar drivers from executing a rolling right or rolling left turn
Driver Cause 9: Execution of rolling right turn.

Nevertheless certain Highway Authorities have responded to the practice of drivers of making dangerous U-turns on dual carriageways by closing gaps in the central reservation.

Similarly they have inhibited the practice of drivers of entering roundabouts from the minor road at speed by 'fishtailing' [unfortunately, *vide Road Cause 2: Non-constant radius curve,* sometimes using 'spiral' curves] the approach roads to roundabouts.

I therefore observe that such 'Civil engineering' responses may also be practicable to 'improve' the substantial number of junctions, and private entrances, in Britain where the bevels of the road presently facilitate and 'encourage', rather than inhibit, the practice of drivers of executing a rolling right or left turn.

5. Law enforcement

Uncorrected defects of eyesight

To repeat, it is regularly reported in the national newspapers, or in the magazines of the road safety 'press', that either a 'non-academic' survey, a survey by opticians, or a police 'Stop and Check' exercise, has identified a substantial number of motorcar (and other) drivers who drive with uncorrected defective eyesight
Driver Cause 11: Uncorrected defects of eyesight.

And according to Local Transport Today 13 February 1997, more formally, a 'recent study' by Aston University and Vauxhall Motors 'showed that 16% of drivers failed the legal eyesight standard in 1996'.

I have not, by contrast, noted any 'academic' findings to like effect.

But I could easily have missed a study.

Restricted head movement

As a matter of ordinary observation, the number of drivers who, even though the inner lane of a multi-lane carriageway is clear, nevertheless drive in the middle or outer lane, is very high indeed
Driver Cause 10: Restricted head movement.

So far as is known, the reasons for the behaviour have never been formally studied.

But certainly the behaviour greatly reduces the number of occasions on which the driver must turn his head, in order to look in the mirrors, or look over his shoulder, in order to observe other traffic.

So it is plausible that a substantial number of drivers who drive in the middle or outer lane do so because they suffer either from passing, or chronic, restricted head movement.

Official policy of tolerating the unfit driver

Official policy in Britain is to 'tolerate' the extensive presence of 'unfit' drivers on the roads—or more bluntly,

not to enforce the law against them—because, as it is put: 'The unfit older driver who drives within his limits is, notwithstanding the fact, a much safer driver than the impetuous and inexperienced younger driver'.

This is so: Moore *et al* 1982 reported relative car driver casualty rates, by age-group, in Britain in 1975 of:

17–20	21–24	25–29	30–39	40–49	50–59	60–64	65+	All
4.45	2.19	0.97	0.76	0.61	0.63	0.74	1.08	1.00

.

And although, as reported by more recent studies, the 'advantage' of the older driver is thought to have diminished, it still remains substantial.

Alternatively, on the issue of driver eyesight, the Government states that, contrary to the findings of the 'informal' surveys, Davison & Irving 1980 found, in *paraphrasis,* that: 'There was no serious problem of drivers driving with defective eyesight in Britain'.

Out-of-date basis of findings of Davison & Irving 1980

Nevertheless, *pace* the findings of Davison & Irving 1980, and the informality of the later surveys, the strong suggestion remains that, since Davison & Irving conducted their survey—now 22 years ago—in 1976, the incidence of persons who drive with defective eyesight in Britain has risen substantially.

And as stated, the incidence of restricted head movement has never been studied, and so is unknown.

Implications for prevention

In summary, therefore, it must be viewed as an 'unsatisfactory' situation that so large a possible number of accidents—in particular, so large a possible number of motorcycle accidents—may, in consequence of the unmonitored 'realism' and tolerance of British official policy, presently go unprevented.

6. List of measures: Motorcycle rider (apart from Motorcycle rider training)

1. Anti-lock brakes
2. Conventional brakes
3. Motorcycling Manual
4. Darktime motorcycle rider training and testing
5. Darktime motorcycle lights
6. Misting visor
7. Self-cancelling indicators
8. Location of horn button
9. Law enforcement

1. Anti-lock brakes

Prospective mitigation of many important causes of motorcycle accidents

Presently the motorcycle manufacturers only offer anti-lock brakes as an option on a very small number of expensive 'top of range' models of motorcycle
Rider Cause 16: Lack of motorcycle anti-lock brakes.

Yet potentially, given the mass adoption of anti-lock brakes by the motorcycle manufacturers, it may be predicted that anti-lock brakes will, under the headings of:

1. Brakes & Braking
   Substantially mitigate, or eliminate,
   the causes of motorcycle accidents:
   Rider Cause 7. Less than optimal motorcycle brakes
   Rider Cause 9. Failure to use front brake
   Rider Cause 11. Failure to achieve optimal braking performance
   Rider Cause 14. Failure to brake correctly in emergency
   Rider Cause 15: Gripping reflex in emergency
2. Road surface
   Substantially mitigate the causes
   of motorcycle accidents:
   Road Cause 1: Road surface
   Rider Cause 17: Compulsive tendency of motorcycle riders to monitor road surface
   Rider Cause 19. Looking aside
3. Capacity overload
   Significantly mitigate the cause
   of motorcycle accidents:
   Rider Cause 18: Susceptibility of motorcycle riders to capacity overload
4. General
   Substantially mitigate the causes
   of motorcycle accidents:
   Rider Cause 4: Failure to respond correctly to potential hazard of a Hesitation or After you, Claude collision
   Rider Cause 8: Less than optimal official advice on motorcycle braking
   Rider Cause 13: Wrong decision to swerve in emergency.

Findings

However, to repeat from the treatment of Anti-lock brakes under 'Rider causes' and 'Risk compensation', it has been necessary to leave open that the potential of anti-lock brakes, as so predicted in theory, might not in practice be realised, because of the operation of risk compensation.

But in 1996, whilst addressing another topic, a BMW spokesman incidentally 'let slip' in passing that, since BMW had introduced anti-lock brakes, the demand for replacement fairings had dropped by 40%.

The figure of 40% is, in fact, subject to important qualifications.

Nevertheless, so very large a figure remains highly suggestive that anti-lock brakes do indeed, in practice, achieve much of the potential reduction of motorcycle accidents that can, in theory, be predicted in their favour.

Or in other words, anti-lock brakes seem to demonstrate a substantial 'net safety benefit' after 'discounting' risk compensation.

Current state of development

The motorcycle manufacturers have only fitted anti-lock brakes to a small number of expensive top-of-range models.

They first appeared on a 'production' motorcycle as an optional fitting on one of BMW's models in the late 1980s.

In the early 1980s, as reported by Watson 1985, the Transport Research Laboratory in Britain did do some preliminary work on the development of a simplified design of anti-lock brakes for mopeds and light motorcycles.

I have a memory that, some 10 years ago, in a motorcycle magazine, I saw a photograph of a light motorcycle that had been experimentally fitted with anti-lock brakes, certainly on the front wheel. By its appearance, the motorcycle was made by one of the major Japanese manufacturers.

But otherwise I have no knowledge of the conduct of any work on the development of motorcycle anti-lock brakes, more extensively, for the 'mass market'.

Problems of development

Chris Dell has ridden professionally several production models of motorcycle fitted with anti-lock brakes.

As to the performance of the anti-lock brakes themselves, in Chris Dell's practical experience:

a. There are numerous problems of design that remain to be overcome before anti-lock brakes can be said to perform 'properly' on any current individual model of motorcycle — let alone, more widely, on other models of motorcycle.

Thus Chris Dell was only fully satisfied with their performance in the case of the front brake of one particular model of motorcycle. However the back brake of the same model hardly exerted any retardation at all. And the design of the front suspension, which was exceptionally stiff, was unique to the model in question.

As to the necessary features of the design of the model of motorcycle on which the anti-lock brakes are to be installed, in Chris Dell's experienced opinion:

b. Anti-lock brakes demand a much stiffer, and better performing, design of front suspension than is fitted to most production models of motorcycle today.

Most current models are fitted with telescopic forks: their performance 'characteristics', in particular, do not 'marry very happily' with anti-lock brakes.

Last Chris Dell commented that:

c. The weight, complexity, demand for electrical power, and price of present designs of anti-lock brakes render them unsuitable for fitting to small to medium-sized models of motorcycle.

Chris Dell's report of his experience and opinions may, to a greater or lesser extent, be controversial.

But there is little doubt that motorcycle anti-lock brakes are at an early stage of their practical development 'in production'.

Product liability suits

It is not known why the motorcycle manufacturers have failed to place models of motorcycle fitted with anti-lock brakes on the mass market.

But all the signs are that it was in response, not to the problems of practical development, but, rather, to the growing volume of product liability litigation in the USA in the late 1980s.

In particular the determining series of events was the launch, by lawyers acting on behalf of injured motorcycle riders, of a growing number of product liability suits against the motorcycle (and motorcycle helmet) manufacturers.

Most notoriously, the lawyers claimed in the suits that the motorcycle manufacturers 'should have developed and fitted "leg protectors" to their motorcycles'.

So, it may be surmised, rather than provide 'evidence' that the lawyers might speciously claim in court 'showed' that it was 'possible', and 'effective', to fit anti-lock brakes generally to all models of motorcycle—and so provoke a multi-million dollar suit after almost every serious motorcycle injury accident—, the manufacturers ceased, certainly in public view, to develop anti-lock brakes for other than their most expensive top-of-range touring models.

[And in further self-protection, until the statement of the BMW spokesman, they conducted no public evaluation of the practical, as opposed to theoretical, effect of anti-lock brakes to reduce accidents.]

Obstacles to mass adoption

It is impractical to pursue the mass adoption of anti-lock brakes gradually:

a. The introduction of anti-lock brakes by the motorcycle manufacturers on any significant number of models of motorcycle (whether in the USA or elsewhere) will almost certainly, as outlined above, be met in the USA by product liability suits in respect of the remainder of models that are still fitted with 'conventional' brakes.

The suits will be so numerous and expensive as to end the manufacture, or import, of motorcycles into the USA.

The consequent adverse repercussions upon the viability of the manufacture, or import, of motorcycles will extend right around the World.

b. Anti-lock brakes will be too expensive for the mass market unless they benefit from the economies of scale of mass production.

Action

It is therefore clearly a matter of urgency that persons in Government, as a first step:

- Solicit from the motorcycle manufacturers who have introduced models of motorcycle that are fitted with anti-lock brakes all information that they hold on the net safety benefit of anti-lock brakes in the hands of their customers

and then, according to what the information reveals:

- On the one hand, offer the motorcycle manufacturers legal protection against product liability suits should they develop anti-lock brakes for the mass market
- On the other hand, encourage the motorcycle manufacturers, by incentives, or sanctions, to develop anti-lock brakes for the mass market.

Thus, first, given the number and power of lawyers in the institutions of government of the United States, it is not to be hoped that US product liability legislation will be reformed for at least several years.

For instance, in the recent presidential election campaign, both candidate, former senior Republican Senator, Bob Dole, and incumbent President, Bill Clinton, listed their actions in the cause of reform. But US product liability legislation, in spite of the ostensible political power of the two men, still then nevertheless remained, so far as I know, not one jot altered or reformed.

And, second, given the restraints of national Anti-trust, or Anti-cartel, legislation, it is difficult for the motorcycle manufacturers, on their own initiative, to conclude any voluntary agreement amongst themselves on the mass development and mass marketing of anti-lock brakes.

Or more shortly, in the words of Oliver Hardy to Stan Laurel: 'It is Governments who, by their expedient concessions to Ralph Nader and his "howling mob", got us into this mess. So it is Governments who, by the necessary repeals or reforms, should now also get us out of it!'

2. Conventional brakes

Recommendation of linked brakes by McLean et al *1979 and Mortimer 1984*

Over the years, study authors such as McLean *et al* 1979 and Mortimer 1984 have persistently recommended the mass adoption of linked brakes on motorcycles, and, with rare exceptions, the motorcycle manufacturers have just as persistently ignored them.

Rider Cause 7: Less than optimal brakes.

Resistance of motorcycle manufacturers

The reasons of the motorcycle manufacturers are, no doubt, in part:

- The conservatism of many of their customers
- The insistence of many of their customers upon motorcycles that are designed and specified to the model of a sporting or racing motorcycle.

So, since, in particular, a rider on the race track can achieve a better braking performance from conventional brakes than from linked brakes motorcycles are invariably fitted with conventional brakes.

But in public, the main 'objection' that the motorcycle manufacturers are thought to raise to the recommendations is the fact—as found and freely admitted by e.g. Mortimer 1984—that, not just a sporting rider, but also a skilled road rider can, under experimental conditions on the test strip, achieve a better braking performance from conventional brakes than from linked brakes.

Indeed the motorcycle manufacturers have the same reasons for resisting, and so may raise the same objection to, the mass adoption by them of motorcycle anti-lock brakes.

Non-treatment

However, the potential improvement in the braking performance of 'ordinary' motorcycle riders from linked brakes is much less than the improvement from anti-lock brakes.

Apart from the motorcycle manufacturers, Chris Dell has—as noted under *Rider Cause 7,*—made his own substantial criticisms, both in principle and practice, of the design, and performance on the road, of linked brakes, as they have, to date, been implemented upon motorcycles.

So, given the prospect of practical confirmation of the net safety benefit of motorcycle anti-lock brakes, I shall not treat the subject of linked brakes—or other improved designs of conventional brakes—further here.

3. Motorcycling Manual

Predominant influence upon practices of motorcycle rider training and testing in Britain

The advice and recommendations of the Motorcycling Manual, not only directly influence the requirements of the British motorcycle driving test, but also indirectly influence the practice of every motorcycle rider training scheme in Britain that is engaged in the training of new riders

Rider Cause 26: Training and testing of motorcycle riders in performance of tasks of low priority.

Gross deficiencies of Manual

Yet, to summarise the criticisms of the Motorcycling Manual that I made earlier:

- Its treatment is confused and disordered
- It is incomplete
- The weight and prominence that it accords to individual motorcycle accident situations, or to particular riding conditions, bear little or no relation to the known frequency and importance of the situations or conditions, as recorded in national data, or reported by official studies
- The practices that it recommends are, for the most part, exclusively 'experience' or 'intuition', not 'knowledge', based.

Action

The situation calls for immediate, drastic, and radical reform.

As a first step, the Motorcycling Manual should be completely rewritten.

The new Motorcycling Manual should:

- 'Know', and reflect in the weight and prominence of its treatment, existing statistical data of motorcycle accidents
- 'Know', and reflect in its advice and recommended practices, the findings of existing research into the causes and prevention of motorcycle accidents.

As a second step, the Government should:

- Commission the collection and analysis of new data to supply the gaps in existing knowledge of the frequency and circumstances of motorcycle accidents.
- Commission new research to supply the gaps in existing knowledge of the causes and prevention of motorcycle accidents.

And as a third step, the new Motorcycling Manual should be again revised to reflect the analysis of the new data, and the findings of the new research, the Government has commissioned.

4. Darktime motorcycle rider training and testing

Obstacles to implementation

As soon as the suggestion is made that motorcycle riders should be trained on the road after dark, simultaneously both:

- The specific hazards of training motorcycle riders after dark — in particular, the hazard to riders, and instructor, as identified by Hills 1980, of meeting an oncoming vehicle, that is also travelling on dipped beam headlights, on an unlit road
- The practical obstacles that stand in the way of training motorcycle riders after dark — for instance, the difficulty that the instructor will have in properly observing and supervising riders

must spring straightaway into the reader's mind

Rider Cause 25: Possible susceptibility of motorcycle riders to darktime accidents.

Action

But, to repeat, Whitaker 1980 reported that 52% of motorcycle accidents, in which the rider was killed, in Britain in 1974 took place after dark.

The necessary data to recalculate an up-to-date figure are already contained in the 'Stats 19' forms that the police forward to the Department of Transport each year.

So if, on recalculation, the figure remains just as high today, the issue must imperatively be, not:

1. Whether, in view of the obstacles, motorcycle riders should be trained—and tested—in safe riding after dark,

but:

2. How motorcycle riders should be trained—and tested—in safe riding after dark.

Research needs

In spite of Whitaker 1980's report, few, if any, scientific studies in the perceptual field have, to date, investigated the specific causes and circumstances of motorcycle accidents after dark.

Motorcycle rider training that is supported by scientifically established knowledge is more likely to be effective than rider training that is not supported by knowledge.

So if, again, the figure of riders killed in accidents after dark remains high today, it becomes imperative that the seeming failure of road safety research scientists to investigate the causes of such accidents belatedly be remedied.

5. Darktime motorcycle lights

Low performance of some motorcycle headlights

It was a long standing recommendation of Peter Watson, when he was in charge of motorcycle research at the Transport Research Laboratory, that the performance of motorcycle lights after dark should be enhanced

Rider Cause 25: Possible susceptibility of motorcycle riders to darktime accidents.

As I believe, there are now fewer models of motorcycle on the market that, like the old Suzuki GN 400 model of the 1970s, were fitted only with direct lighting.

But, less tractably, the performance of the lights of a number of models of light motorcycle, such as the Yamaha RXS 100, continues to be, to greater or lesser degree, for inherent reasons—the low power output of the generators or alternators of light motorcycles—, mismatched to ordinary speeds of darktime travel.

Research needs

Should therefore a survey of motorcycle accidents in darktime, as recommended under *Darktime motorcycle rider training and testing*, be conducted, it might be useful to include as one of its incidental objects to determine how far the low performance of the lights of light motorcycles may currently, in practice, operate as an important contributory cause of darktime accidents.

6. Misting visor

Abjuration of responsibility by Standards bodies

Minter has for a number of years past made the criticism of the practice of the British and International Standards bodies that, whereas they lay down separate Standards for the safe performance of motorcycle Crash helmets, and Visors, they do not lay down a combined Standard for the safe performance of Crash helmets and Visors, as they are in fact used, as one combined item

Rider Cause 21: Misting visor.

The result of this bureaucratic, and practically disinterested, manner of proceeding is that, in particular, the Standards bodies abjure responsibility for mitigating the well-known tendency of the visors of motorcycle crash helmets to mist up, and so partly or wholly obscure the vision of the motorcycle rider.

Misting as direct & indirect cause of motorcycle accidents

The tendency may cause motorcycle accidents directly:

Rider Cause 21: Misting visor;

or it may, by making it more difficult for the motorcycle rider to discern the road surface, importantly aggravate:

Rider Cause 17: Compulsive tendency of motorcycle riders to look at road surface,

and so, in turn:

Rider Cause 18: Susceptibility of motorcycle riders to Capacity overload.

Action

I understand that the Standards bodies regulate themselves.

If so, Governments should threaten the Standards bodies that, if, in this matter, they do not reform themselves, Governments will reform them in their place.

In the meantime, Governments should, in default of action by the Standards bodies, urgently commission preparatory research in contemplation of the eventual evolution and enactment of a new 'misting' Standard.

7. Self-cancelling indicators

Obstacles to general fitting of efficient self-cancelling indicators

The general fitting of efficient self-cancelling indicators to motorcycles must make a small, but important, contribution to reducing the 'capacity load' of motorcycle riders

Rider Cause 18: Susceptibility of motorcycle riders to Capacity overload.

A precondition of the implementation of this state of affairs is, however, the expiry of the patents that certain motorcycle manufacturers, such as Yamaha, are thought to have taken out on the best designs.

Action

It is, I am sure, within the formal power of Governments to buy out the patents compulsorily.

But the exercise, less expensively, by Governments of their powers of 'friendly persuasion' should be sufficient, in such a good cause, to persuade the manufacturers who hold the patents 'voluntarily' to license their designs to other manufacturers upon 'generous' terms.

8. Location of horn button

Difficulty of locating and operating horn button

On a number of models of motorcycle, it is difficult, even in ordinary riding—let alone in an emergency—, to locate and operate the horn button with a gloved hand

Rider Cause 23: Unergonomic design of motorcycles.

Action

The Separate Directive on Motorcycle type approval: Audible warning devices was adopted by the European Council about 1993.

The Directive does prescribe the minimum and maximum noise levels of motorcycle horns. But it fails to go on, also, to address the issue of convenience of operation.

Member Governments are empowered to remedy the omission under the procedure of the European Union for the 'Adaptation of the Framework Directive—and Separate Directives—on Motorcycle type approval to Technical Progress'.

They should do so.

9. Law enforcement

Misdeployment of police resources

It is clearly a more effective method to 'influence' the safe riding behaviour of motorcyclists to deploy a policeman to stop the motorcycle rider on the road, and tell him, for instance, 'You went too fast through that junction', than to deploy a surveillance *apparat* of GATSO cameras and officials, in order to prosecute him for 'doing 100mph on a clear motorway'

Rider Cause 3: Failure to slow down to normal speed of other traffic on road.

Nevertheless, to repeat, according to Transport Statistics Great Britain 1996, between 1984 and 1994, whilst:

- 'Findings of guilt at all courts, fixed penalty notices and written warnings' for 'Speed limit offences' rose from 256,000 to 602,000,

by contrast:

- 'Findings of guilt, etc' for 'Dangerous, careless or drunken driving, etc' fell from 251,000 to 190,000.

Action

The Home Office, Police Authorities, and Chief Constables should alter their road safety priorities; dismantle their *apparat* of surveillance; and deploy policemen, in place of officials, once more on the road.

8. Motorcycle rider training: Improvements in Skills

Motorcycle rider 'skills' training under heads of:

1. Braking a motorcycle in an emergency
2. Swerving a motorcycle in an emergency

1. Braking a motorcycle in an emergency

As observed, the officially recommended methods of braking a motorcycle in an emergency in Britain, Sweden, and the USA, differ in substantial particulars
Rider Cause 8: Less than optimal official advice on motorcycle braking.

It is clearly urgent that the differences be resolved by a scientific comparative study.

I anticipate that it is the method that is recommended in the USA that—by virtue of its provisions, not only against a rear-wheel skid, but also against high-siding—will turn out to be the most correct, or 'best', method.

If so, I predict that its implementation in Britain will be followed by an important improvement in the braking performance of motorcycle riders.

2. Swerving a motorcycle in an emergency

As observed, a number of countries place official emphasis upon the teaching of swerving, as well as braking, skills.

Yet Ouellet 1990 gives important reasons:

- Why it is rare, in an emergency, that a rider should, in practice, choose to swerve, rather than brake
- Why a rider who swerves, as well as brakes, in an emergency may, in practice, often lose control

Rider Cause 5: Failure to take up correct position in the road (Minimising length of 'Collision inevitable' zone)
Rider Cause 10: Braking and swerving at same time.

Nevertheless, in particular circumstances, the correct response of the rider will be to swerve, rather than brake.

In particular—as canvassed *post* under *Motorcycle accidents with pedestrians—,* the rider must swerve, in the presence of a pedestrian in the road, if braking will be insufficient to reduce his speed to a speed at impact that the pedestrian may prospectively survive.

So it remains important to teach riders swerving skills, but it should be done:

- With a lesser emphasis than is placed upon the teaching of braking skills
- As a separate exercise from, not a combined exercise with, the teaching of braking skills.

9. Motorcycle rider training: Improvements in Behaviour [Headings only]

Motorcycle rider 'behaviour' training under heads of:

A. General: Behaviour
B. General: Positioning
C. General: Resources
D. Arbitrary estimation by other driver of motorcycle speed
E. Rider looking at road surface
F. Hesitation or After you, Claude collision
G. Same time & Same place collision
H. Presence of more than one other vehicle at junction
I Riding in presence of other traffic

10. Motorcycle rider training: Discussion

Proposal of new classification of motorcycle accidents

It is difficult to achieve novelty in the field of motorcycle rider training.

Nevertheless, on the basis of the established, or suggested, *Driver* and *Rider Causes* of motorcycle accidents at junctions that I have described in the paper, I do venture to propose that motorcycle rider training re-order its priorities, and alter its practices, in accordance with a new 'classification' of accidents.

The classification adopts the American collision-focused and knowledge-based approach, but combines with it also the British emphasis upon defensive riding.

I cannot be sure that the classification is novel. I am only familiar with a small part of motorcycle rider training schemes around the world. But certainly, I have not, to date, read, or heard of, the proposal or adoption of a similar classification elsewhere.

New classification

The classification adopts the rider's perspective, and divides up motorcycle accidents at junctions, as they occur or develop, into four main successive 'stages':

1. Collision may be avoided by defensive riding
2. Collision may be avoided by making correct choice between braking and swerving
3. Collision may only be avoided by correctly predicting the actions of the other driver (or pedestrian)
4. Collision inevitable.

It provides, in addition, a fifth stage, which overlaps with stages 2. and 3:

5. Collision may be avoided by successfully influencing the actions of the other driver.

[Dave Hammond has suggested adding also the further stage:

> Collision may be avoided by correctly anticipating the possible actions of the other driver (or pedestrian).

But on consideration I feel that the stage does not represent an additional stage, since it is fully overlapped by, and so subsumed under, stage 1.]

Subordination of enhanced rider skills to improved rider behaviour

Thus—to refer back to the discussion under *Choice of improving Skills or Behaviour of Motorcycle riders*—the classification does 'recognise' that enhanced rider braking and swerving skills (or a reduced rider reaction time) may:

- Offer the rider more choice at stage 2.
  (i.e. at the 'correct choice between braking and swerving' stage)
- Postpone stages 3. or 4.
  (i.e. the 'correct prediction of other driver's actions', or 'collision inevitable', stages).

But it treats the acquisition of enhanced braking and swerving skills as 'subordinate', as a matter of training priority and emphasis, to:

- Realising the full potential of defensive riding at stage 1.
- Making the correct choice between braking and swerving at stage 2.
- Correctly predicting the actions of the other driver at stage 3.
- Successfully influencing the actions of the other driver at overlapping stage 5. — i.e. at stage 2. or 3.

Or more shortly, the classification subordinates the enhancement of rider 'skills' to the improvement of rider 'behaviour'.

Subordination of enhanced swerving skills to enhanced braking skills

Last, the classification does not, as formulated, take up a 'position' what respective emphasis should be placed upon the enhancement of braking, and swerving, skills.

But, to complete matters, the classification would largely subordinate the enhancement of swerving skills to the enhancement of braking skills.

11. Motorcycle rider training: Summary

To conclude, therefore, by summarising the main *Rider measures of prevention* of motorcycle junction (and pedestrian) accidents that may be taught as part of motorcycle rider training, I adopt for the purpose the heads of the 'new' classification.

Correspondingly re-ordered, the measures comprise the following advice to be learned, and—as appropriate—then practised on the road, by riders under instruction:

A. Main stages of motorcycle accident at junction (Stages 1–4)

1. Collision may be avoided by defensive riding
   - Ride the 'See and Be Seen' line
   - Deliberately keep the head up in anticipation of hazard
     Suggestion of findings of Nagayama et al *1979*
   - Shed all extraneous capacity load in anticipation of hazard
     Suggestion of findings of Nagayama et al *1979*
   - Get in early all your glances aside to comprehend the whole road scene, mirror sights, etc (So you will minimise the diversion of your attention away from the road scene as it develops in front of you)
     Extrapolation from findings of Nagayama et al *1979*
   - As necessary, adopt a 'blocking' position, or ostentatiously 'sit up', and cover the brakes (So you will minimise the possibility of 'distraction' by following traffic)
   - Adopt a position in the road as far as possible away from the other driver (So you will reduce the length of the zone in which a collision is inevitable should the other driver pull out in front of you)
     Suggestion of calculations of Ouellet 1990
   - Adopt a position in the road as far as possible away from the other driver (So, also, you will maximise the other driver's perception of your speed)
     Suggestion of arguments of Prower 1990, and Paper
   - Slow down to the normal speed of other traffic on the road (So the other driver will be most likely to 'estimate' your speed correctly)
     Suggestion of arguments of Prower 1990, and Paper

2. Collision may be avoided by making correct choice between braking and swerving
   - Decide to brake, rather than swerve, unless circumstances compel you, for overwhelming reasons, to swerve ('Overwhelming reasons' for swerving include, in particular, the prospect that, even though you should brake, you will still hit a pedestrian at speed)
     Suggestion of findings—and arguments—recited by Ouellet 1990

3. Collision may only be avoided by correctly predicting the actions of the other driver (or pedestrian)
   - Anticipate the threat of a possible 'Hesitation', or 'After you, Claude' collision
     Suggestion of arguments of Prower 1990, and Paper
   - React as necessary to the threat by early braking, or change of position in the road
   - Once the other driver starts to pull out, make an immediate decision whether it is the 'better' course of events for you that he alters his intentions, and stops where he is, or that he proceeds
   - According to your decision, 'manage' as far as possible how far, by facilitating the other driver's perception of your speed, you draw—or do not draw—his attention to you
     Suggestion of arguments of Prower 1990, and Paper
   - According to your decision, manage as far as possible how far, by the ostentation of your actions, you draw—or do not draw—the attention of the other driver to you
   - Should the other driver, having started to pull out, then hesitate still in your path, make a further immediate decision whether it is the 'better' course of events for you that he remains where he is, or that he proceeds
   - As far as possible 'communicate' your decision to the other driver by the ostentatious execution of the appropriate change of direction, or application of the brakes

4. Collision inevitable
   - Know the existence of the zones in which a 'Same time and same place' collision is inevitable if the other driver executes a rolling right turn, or pulls out from the nearside, in front of you
     Suggestion of calculations of Ouellet 1990
   - Attempt to 'freeze' the other driver, whilst you travel through the zones, by utilising the peripheral stimulus of speed
     Suggestion of arguments of Prower 1990, and Paper

B. Overlapping stage of motorcycle accident at junction (Stage 5)

5. Collision may be avoided by successfully influencing the actions of the other driver
   - Utilise the ostentatious execution of any change of line or position in the road to 'communicate' your intentions to the other driver (E.g. your intention not to give way to him; or to pass in front of, or pass behind, him)
   - Utilise the ostentatious execution of the actions of 'sitting up' to brake; covering the brakes or clutch lever; applying the brakes; or changing gear to 'communicate' your apprehension to the other driver that he may pull out in front of you (But—see Stage 3 of A. above—do not necessarily do so, also, to communicate your apprehension that he may hesitate in front of you)
   - Utilise the peripheral stimulus of speed, as you come near to the junction, as it suits you, to attempt to draw the attention of the other driver to you
     Suggestion of arguments of Prower 1990, and Paper
   - Utilise the peripheral stimulus of speed, as you come very near to the junction, as it suits you, to attempt to 'freeze' the other driver
     Suggestion of arguments of Prower 1990, and Paper
   - Utilise the other means of influencing the actions of the other driver that have already described under the Stages 1 to 4 of A. above.

12. List of measures: Road

1. Road surface
2. Curve design

1. Road surface

Common benefit of improvements to Motorcycle riders & Pedal cyclists

Motorcycle accidents may rarely—to repeat from *Road Causes: Introduction*—concentrate in the same specific location, and so be 'economic' to treat by civil engineering measures.

However, not just motorcycles, but also pedal cycles, are two-wheeled vehicles, and so particularly sensitive to defects and deficiencies of the road surface.
Road Cause 1: Road surface.

And in Britain in 1995, *per* Road Accidents Great Britain 1995, between them, motorcycle users and pedal cycle users represented 18% of all road users killed.

Special benefit of improvements to Motorcycle riders

In particular, of special importance to motorcycles, it can be predicted that defects and deficiencies of the road surface will greatly aggravate:
Rider Cause 17: Compulsive tendency of motorcycle riders to monitor road surface,
and so, in turn, also:
Rider Cause 19: Looking aside
Rider Cause 18: Susceptibility of motorcycle riders to Capacity overload.

Low priority historically accorded to improvements by Highway Authorities

As a body, Highway Authorities in Britain have, in the past, paid little attention, as regards the maintenance or improvement of the road surface, to the 'safe operation' of motorcycles or pedal cycles.

Certainly they have not paid it the attention commensurate with a figure of 18% of all road users killed.

Rather their predominant concerns have been, seemingly:
- The 'speedy and convenient transport' of persons and goods by four-wheeled vehicles
- The 'safe operation' of, likewise, four-wheeled vehicles.

Action

The concerns and priorities of Highway Authorities have begun to alter.

This is a trend that the Government should take steps to maintain and accelerate.

In particular, officers of Highway Authorities should ride 'their' roads on pedal cycles and motorcycles, as well as motorcars.

If so, assuredly, they will discover many repairs and improvements of the road surface that 'urgently need to be put in hand'.

2. Curve design

Common benefit of improvements to Motorcycle riders & Motorcar drivers

As was pointed out, improvements of the road surface become more 'economic' when they are costed on the basis that they benefit, not just motorcycles, but also pedal cycles.

So too, to even greater degree, improvements in curve design become more economic when they are costed on the basis that they may potentially benefit, not just motorcycles, but also motorcars and all other four-wheeled vehicles
Road Cause 2: Non-constant radius curve.

Rejection of Stewart's submission by Department of Transport

Yet according to Stewart's letter to the Times, the Department of Transport rejected out of hand his conclusions in favour of 'constant-radius' curves, even though, on the face of the letter, the conclusions were supported, both by persuasive arguments, and by the findings of 'recent research' in California.

Instead the Department stands by 'design standards' in Britain, which prescribe 'spiral' curves.

Action

The Department of Transport should, in the ordinary way of responding to reasoned criticism, on road safety grounds, of officially-prescribed civil engineering practice in Britain, alternatively:
- Justify the design of 'spiral' curves
- Accept the finding of the Californian research in favour, rather, of the design of 'constant-radius' curves
- Repeat the Californian research in Britain.

Any other course smacks of a Department that is moved by considerations, not of road safety, but of bureaucratic convenience and inertia.

J. Motorcycle accidents with pedestrians

1. Causes

Absence of study findings

I do not know of any study that has specifically considered the causes or prevention of motorcycle accidents with pedestrians.

In particular I do not know of any study that has—as the essential first step towards the systematic accumulation of a body of research literature—specifically investigated and analysed the distinctive causes and circumstances of motorcycle accidents with pedestrians.

Close perceptual relation to causes of motorcycle accidents with other drivers at junctions

Nevertheless, to refer back to *Preliminary matters,* it may be predicted, on first principles, that many of the causes and circumstances of motorcycle accidents with pedestrians will be similar to the causes and circumstances of accidents between a motorcycle on the major road at a junction, and another vehicle that intrudes upon the motorcycle rider's road.

Thus, for instance:

a. The situation of a pedestrian who crosses the road in front of a motorcycle is, perceptually, almost identical to the situation of the driver of another vehicle who crosses, emerges, or turns in front of a motorcycle at a junction.
b. The occurrence of a large number of motorcycle accidents with pedestrians, in spite of the much narrower width of a pedestrian than of a motorcar, implies that even more motorcycle accidents with pedestrians, than accidents with a motorcar at a junction, fall into the category of a Hesitation, or After you, Claude, collision.

Hills 1980's perceptually 'impossible situations'

And, just as, to refer back to Hills 1980's list of perceptually 'impossible situations', the situation:

1. Joining or crossing a high-speed road

is implicated in motorcycle accidents with motorcars at junctions, so too the situations:

3. Meeting another vehicle also travelling on dipped beam on an unlit—or poorly lit—road at night [in the presence of a pedestrian walking along one's own side of the road]
4. Encountering a backlit pedestrian in the middle of the road at night

are likely to be implicated in motorcycle (and not just motorcar) accidents with pedestrians.

The first situation, because of the narrow width of a motorcycle, may present only a low hazard of an accident. But the second situation holds the full possibility of either a Same time & Same place; Hesitation; or After you, Claude collision, between the motorcycle and the pedestrian.

2. Prevention: Motorcycle rider

Defensive riding

Since I have no new study findings to recite, I shall not systematically list the measures of prevention of pedestrian accidents that may be taught by motorcycle rider training schemes to riders under instruction by way of advice on 'defensive riding' practices.

But along the above lines, most of the measures that I have canvassed in relation to the prevention of motorcycle accidents with a motorcar at junctions, will apply also, with slight alteration, to the prevention of motorcycle accidents with pedestrians.

For example, the items of advice:

Slow down to the normal speed of other traffic on the road at junctions
Deliberately keep your head up in the presence of another vehicle at a junction (or at a blind junction)

become:

Slow down to the normal speed of other traffic on the road in the presence of pedestrians
Deliberately keep your head up in the presence of pedestrians.

Braking or swerving

Road Accidents Great Britain 1995 listed the total number of motorcycle user, and pedestrian, casualties in Britain in 1995 for, *inter alia,* accidents involving only a motorcycle, and one or more pedestrians. The respective number of motorcycle user and pedestrian casualties in such accidents was:

	Moped-Pedestrian accident		Motorcycle-Pedestrian accident	
	Moped users	Pedestrians	Motorcycle users	Pedestrians
Killed	0	2	3	36
Serious	7	12	55	331
All severities	29	101	347	1339

Thus, whereas, in a motorcycle accident with a motorcar, only the motorcycle rider is usually at hazard of injury, in a motorcycle accident with a pedestrian:

- Both pedestrian and motorcycle rider are at hazard of injury
- The pedestrian is at hazard of much more severe injury than the motorcycle rider.

Correspondingly, once a collision is imminent, the considerations that will govern the motorcycle rider's decision whether to brake, or swerve, are complex.

Further, the greater hazard of injury to the pedestrian than to the rider brings into issue once again how far, in an emergency, the motorcycle rider should practise the dangerous manoeuvre of 'braking followed by swerving'.

I cannot, in the absence of studies, come to conclusions.

But I shall, as follows, outline in turn, the often contradictory considerations that, taken together, may 'indicate' whether the motorcycle rider should brake, or swerve, in order to avoid a collision with a pedestrian.

Braking

The considerations that will indicate braking are that:

a. Even the impact of a motorcycle and rider travelling at slow speed may kill, or seriously injure, a pedestrian.
b. A pedestrian is just as likely to hesitate in the path of a motorcycle—as prospectively followed by a Hesitation, or After you, Claude collision—as a motorcar driver.

   Further, by contrast with a motorcar, a pedestrian can move just as quickly backwards as forwards.
c. The motorcycle rider who decides to swerve may, in practice, 'swerve the wrong way', i.e. swerve towards, rather than away from, the pedestrian.

   Just as in the case of an intruding motorcar, he may:

   Per the 'reconstruction' of Hurt 1973:
   - In panic, steer away from the pedestrian, and so produce a counter-steering turn in his direction

   Per the comments of the paper upon the reconstruction of Hurt 1973:
   - Not be able to complete his counter-steering turn towards the pedestrian before he hits him
   - Counter-steer too far towards the vehicle
   - Counter-steer for too long towards the vehicle
   - 'Freeze' at the handlebars whilst he is still counter-steering towards the vehicle

   Per the observations of Motorcycle Safety Foundation 1976:
   - Complete his counter-steering turn, but then be forced to turn back again towards the pedestrian, in order to control a rear-wheel skid.

Swerving

The considerations that will indicate swerving are that:

a. A pedestrian is far less wide than a motorcar. So by comparison with swerving past a motorcar, swerving past a pedestrian will take less time.

   Possibly even, in the case of a pedestrian—by contrast with Ouellet 1990's conclusions from the findings of the studies in the case of a motorcar—, swerving may take no more time than braking.

   Or it may take less time.
b. The motorcycle rider may be unable to reduce his speed by braking, prospectively, to a speed at impact that the pedestrian may survive.

Braking and swerving

The considerations that may indicate braking, followed by swerving, are essentially the same as for swerving alone.

Advice on braking or swerving

To repeat, in the absence of studies, I cannot resolve the contradictions in the considerations. So I do not come to any conclusions.

Correspondingly, the only measure that I can suggest is that the motorcycle rider training instructor advise the rider under instruction, 'uncommittedly':

> Whether you decide to brake or to swerve, given the hazard of a Hesitation, or After you, Claude collision, you should make, and act upon, the decision as early, and as 'ostentatiously' before the pedestrian, as possible.

3. Prevention: Pedestrian

For the same reasons that were canvassed, under *Choice of target: Other driver or Motorcycle rider,* in regard to motorcar drivers, the principal target of measures of prevention of motorcycle accidents with pedestrians must be the motorcycle rider.

The pedestrian may be at an equal, or greater, risk of injury, in an accident between a motorcycle and a pedestrian, than the motorcycle rider.

But pedestrians will experience, per year, fewer 'disturbing' encounters with motorcycles, than motorcycle riders experience with pedestrians.

Thus suppose, in 1995, there were a notional 20 million 'regular pedestrians', and 1 million motorcyclists, in Britain.

Then:

- The rate of pedestrians injured in motorcycle accidents per pedestrian per year

will have been 20 times lower than:

- The rate of pedestrians injured in motorcycle accidents per motorcyclist per year.

4. Research needs

The list of specific research needs, as to motorcycle accidents with pedestrians, to conclude, follows from my initial remarks:

1. Extraction from Police Stats 19 reports in Britain, and publication, of statistics of the number of motorcycle accidents with pedestrians that take place, respectively, in the daytime, and after dark

2. Investigation and analysis of the distinctive causes and circumstances of motorcycle accidents with pedestrians with special reference, *inter alia*, to the following categorisation:
   a. Type:
      Same time & Same place collision
      Hesitation collision
      After you, Claude collision
   b. Pedestrian actions:
      Stopped at roadside
      Turned directly off pavement into roadway
      Crossed road directly without stopping at roadside
   c. Rider actions:
      Looking at road surface
      Looking below road horizon
      Looking at or above road horizon
   d. Rider position in the road
   e. Rider response to intrusion of pedestrian:
      Braking
      Swerving
      Braking & Swerving
      None
   f. Number of influencing other pedestrians or vehicles
3. Conduct, in conjunction with the above investigation of motorcycle accidents with pedestrians, of a survey of motorcycle riders that comprehends the investigation and analysis of the causes and circumstances, not only of the accidents with pedestrians that subjects have experienced, but also of the accidents that they have successfully avoided
4. Conduct of a comparative survey of the result of encounters with pedestrians of motorcycle riders who have been trained in:
   - Swerving
   - Braking followed by swerving,

   and of riders who have not.
5. Investigation and analysis of the distinctive causes and circumstances of motorcycle accidents with pedestrians that take place after dark.

K. Conclusions

Summary

It is unfortunate that, in the paper, I have had to treat many more potential, than established, causes and measures of prevention of motorcycle accidents at junctions (or motorcycle accidents with pedestrians).

But two potential measures of prevention of motorcycle accidents stand out:

- The mass adoption of motorcycle anti-lock brakes
- The implementation of 'knowledge-based' motorcycle rider behaviour training.

Mass adoption of motorcycle anti-lock brakes

The mass adoption of motorcycle anti-lock brakes stands out because of:

- The very large number of established or potential causes of motorcycle accidents that it treats
- The suggestion of the first, qualified, information of the effect of anti-lock brakes, in practice, that they may, indeed, have achieved a very marked reduction of motorcycle accidents.

Implementation of 'knowledge-based' motorcycle rider behaviour training

The implementation of 'knowledge-based' motorcycle rider behaviour training stands out, likewise, because of the number of established or potential causes of motorcycle accidents that it treats.

It is frustrating that one must wait upon full investigation of the potential causes in order to speak conclusively, with full scientific 'authority'.

But sufficient information has been established—or persuasively suggested—by the existing body of motorcycle safety research studies to say that 'knowledge-based' motorcycle rider behaviour training has important new practices to add to the existing practices of British 'experienced-based', or 'intuition-based', rider training.

In addition the teaching of the existing practices of rider training also, as appropriate, upon a new 'knowledge basis' may be expected to enhance the 'authority' of the motorcycle rider training instructor before new riders under instruction.

So it may assist in the resolution of the particular problem of rider training in Britain of influencing and improving the behaviour of the 'unreceptive' young rider.

Counter-assertions of faction of road safety lobby

Motorcycle anti-lock brakes, and motorcycle rider training, are 'primary' road safety measures, i.e. they have as object, not to mitigate the consequences of an accident, but to prevent the accident from happening in the first place.

And a faction of the road safety lobby in Britain takes up the position, in summary, that:

> 'Every primary road safety measure to improve motorcycle rider safety has been tried, but none, save motorcycle daytime lights, has proved—or ever will prove—effective to reduce motorcycle accidents'.

In particular the faction assert that:

- The benefits of motorcycle anti-lock brakes will, in practice, be 'wiped out by motorcycle riders riding more fast, and more dangerously', i.e. negated by 'risk compensation'
- Motorcycle rider training has already, part by virtue of giving new riders the confidence to ride further and more often, and part by virtue of risk compensation, 'proven ineffective, on the basis of evaluation studies to date, to reduce motorcycle rider casualties'.

Or in short, motorcycle daytime lights are effective to reduce motorcycle rider casualties, but anti-lock brakes and motorcycle rider training are not.

Daytime lights

To answer the three points, therefore, altogether, up to 1990, eight studies monitored the effect of motorcycle and motorcar daytime lights laws.

As summarised in the paper, the studies failed, on balance, between them, to demonstrate that the daytime lights laws had, in practice, reduced motorcycle or motorcar accidents.

Since 1990 further studies have been published. But, as considered separately in Prower 1996, they have not, on balance, altered the position.

It would therefore appear that, compared to the effect of the other factors that go to influence the number of motorcycle or motorcar accidents, the effect of daytime lights is small.

Further, since daytime lights:

- If they are not effective, will give 'false confidence' to motorcycle riders and motorcar drivers who use them
- Are a 'net safety benefit' device, i.e. also have the side-effects of causing glare and distraction,

the effect could just as plausibly be adverse as beneficial.

Motorcycle rider training

Motorcycle rider training in Britain may admittedly, to date, have achieved no demonstrable reduction of motorcycle rider casualties.

However the practices of British motorcycle rider training derive from the practices of the British motorcycle driving test, which in turn derive, essentially, from the intuition and experience of the instructors of the Hendon Driving School of the British Metropolitan Police.

Thus the British Government, and the Transport Research Laboratory, have only unsystematically, and

to limited extent, supported motorcycle rider training with scientific research.

Instead, in the spirit of engineers, rather than of scientists, they have preferred to conduct 'remedy-led' research into such mechanical, as opposed to behavioural, means of improving motorcycle rider safety as daytime lights, anti-lock brakes, leg protectors, and air bags.

Accordingly the true point that I have to answer is the prediction that, even if motorcycle rider training in Britain were to be put on a 'knowledge', as well as 'intuition', basis, the benefits of rider training would, in practice, be eliminated by risk compensation.

So to match prediction with prediction, I do not think that it will.

Motorcycle rider training provides the new rider—or equally, more lastingly, the new rider who becomes an 'old' rider—with a means of 'risk management' that, as he or she chooses:

- He can use 'neutrally' to ride further, faster, or more furiously, without increasing the risk to him
- He can use 'positively' to reduce the risk to him.

The risk that a new rider faces is high — As I have suggested by the calculations of the paper, it is almost certainly also 'felt' by him as high — So that, sooner or later, the new rider will 'respond' to it.

Yet the faction of the road safety lobby proposes, on the basis that they may 'cut both ways', to deny the new rider—in the form of the appropriate defensive riding skills, knowledge and practices—the 'sharp tools' then, in fact, to set about cutting the risk down.

I answer, rather, give him tools that 'cut yet more sharply downwards'.

Anti-lock brakes

Last anti-lock brakes have been adopted enthusiastically, certainly by the motorcar manufacturers.

By contrast, as to motorcycle anti-lock brakes, publicity of the work of the Transport Research Laboratory upon motorcycle leg protectors has spawned an inhibitory background to their implementation of leg protector product liability suits against the motorcycle manufacturers in the USA.

Nevertheless, by way of 'transfer of technology', anti-lock brakes have also arrived on a few top-of-range production models of motorcycle, and so started upon their practical implementation.

In consequence, I am not forced to answer the prediction of risk compensation from motorcycle anti-lock brakes by the faction of the road safety lobby with counter-prediction, but can answer it, more satisfactorily, with suggestive fact.

The first information to emerge from the motorcycle manufacturers of the accident experience of motorcycles fitted with anti-lock brakes is that BMW has experienced a 40% fall in orders for spare fairings.

The figure is highly qualified; but it does suggest that, in practice, the positive safety benefits of anti-lock brakes may greatly outweigh the asserted negative safety disbenefits of risk compensation.

Conclusions

The conclusions of the paper are, accordingly, that, between them, the mass adoption of motorcycle anti-lock brakes, and the implementation of 'knowledge-based' motorcycle rider behaviour training, do offer the promise of a substantial reduction in motorcycle rider casualties.

Motorcycles will never become as safe as motorcars. They lack, on the one hand, the stability of four wheels, and on the other hand, the outer protection of a strong steel shell.

But motorcycles can, in real prospect, as I trust I have shown, become safer than they presently are.

Stephen Prower
5 March 1998