MOTORCYCLING SAFETY
POLICY PAPER

JUNE 2006

1 INTRODUCTION

Motorcycling is an important and popular mode of transport, which has some environmental advantages over other forms of motorised transport, as well as other advantages such as flexible journeys and sometimes more efficient use of road and parking space. Unfortunately, it is also associated with a significant accident and casualty risk.

This Policy Paper updates the Paper published in 2001. Its purpose is to:

a) outline the current situation regarding motorcycling and its associated casualty risk

b) identify existing problems and potential safety interventions

c) develop RoSPA's policy positions in relation to motorcycling.

Motorcycles, also described as two-wheeled motor vehicles (TWMVs) and powered two-wheelers (PTWs), encompass a variety of vehicles, the main types being mopeds, scooters and motorcycles. The terms 'motorcycles', 'Two-wheeled Motor Vehicles' and 'Powered Two Wheelers' are interchangeable in this paper, and except where specified, refer to all types of such vehicles.

The role of motorcycling, its benefits and the concerns about its safety have been increasingly recognised in national policy documents and initiatives over the last few years.

The Government's Road Safety Strategy, "Tomorrow's Roads : Safer for Everyone"[1] states that the government's aims for improving the safety of motorcycling are :

- to improve training and testing for all learner riders;
- to publish advice for people returning to motorcycling after a break, and people riding as part of their work;
- to ensure the quality of instruction;
- through training and testing, to help drivers become more aware of how vulnerable motorcyclists are;
- to promote improvements in engineering and technical standards which could protect motorcyclists better; and to work with representatives of interested organisations, in an advisory group, to look at issues of concern.

The White Paper, ''A New Deal for Transport: Better For Everyone''[2], recognised that mopeds and motorcycles can provide an alternative means of transport for many trips and acknowledged the potential environment and congestion benefits offered by motorcycling. However, it also stated that the motorcycling raises some important and complex safety and environmental issues.

Government Guidance to Local Authorities on Local Transport Plans[3] requires Local Authorities to take account of the needs of motorcyclists and find ways to ensure their safety.

In 1999, the Government established the Advisory Group on Motorcycling (AGM) to assist in considering the role of motorcycling in an integrated transport policy and to explore some important and complex issues, including safety and environmental impact. The Advisory Group published its Final Report[4] in 2004.

The Institute of Highway Incorporated Engineers (IHIE) published "Guidelines For Motorcycling: Improving Safety Through Engineering and Integration"[5] in 2005. The purpose of the Guidelines is to demonstrate the role motorcycling can play in an integrated transport system and to assist highway and traffic engineers in developing a safer and more motorcycle friendly road environment.

In 2005, the Government published "The Government's Motorcycling Strategy"[6], the aim of which is *"to facilitate motorcycling as a choice of travel within a safe and sustainable transport framework"*. The Department for Transport (DfT) is now working with the motorcycle industry and user groups, through the National Motorcycle Council, to implement the strategy.

2 MOTORCYCLE USE

There are around 1.52 million motorcycles (excluding mopeds) in Great Britain[7]. In 2004, 2.3% of households owned a motorcycle, the majority of whom also owned one or more cars. In fact, motorcycles are more common in households that own at least one car than in households that do not own a car. The highest ownership rate was in the South West of England and the lowest in Scotland.

Around half of motorcyclists are aged between 30 and 49 years. Less than 10% of motorcyclists are aged 19 years or young, and 15% were aged 20 to 29 years. Just over one quarter are aged 50 years and over.

Transport statistics[8] show that after long term fall in motorcycle use, the trend has reversed, leading to an increase in the level of motorcycling. Over the last decade, motorcycle traffic has risen significantly, with most of the increase occurring between 1998 and 2003.

Table 1: Two-wheel motor vehicle traffic, billion vehicle kilometres[7]

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3.8	3.7	3.8	4.0	4.1	4.5	4.6	4.8	5.1	5.6	5.2	5.4

This trend is echoed by the change in the number of motorcycles licensed over the same period. There were over 1.1 million licensed motorcycles in Britain in 2004, compared with only 721,000 in 1994. These figures exclude unlicensed and tax exempt motorcycles.

The largest increase has been in motorcycles with an engine size of 500 cc and above. An overview of motorcycling safety issues[9] found that stocks of motorcycles over 500 cc had been rising since the late 1980s, and by 1997 accounted for 72% of licensed motorcycles in Britain. However, in more recent years about 45% of new registrations have been machines up to 150 cc and about 45% have been machines over 500 cc.

Table 3: New Motorcycles Licensed (thousands) by Engine Size, 2004[7]

Engine Size	**2003**	**%**
< 50cc	24	18
51 - 150 cc	35	26
151 - 500 cc	13	10
501 - 700 cc	21	15
701 - 1000 cc	23	17
Over 1000 cc	19	14
All	**136**	

In contrast to these trends, the number of people taking the motorcycle test fell to 78,000 in 2004/05, which was the lowest number for seven years. The pass rate for the motorcycle test was 64%.

In 2004[7], around 5.2 billion vehicle kilometres were travelled on motorcycles, which is roughly 1% of the distance travelled by motor vehicles on Britain's roads. This was a fall from the 5.6 billion kilometres motorcycled in 2003, a year which saw higher than average temperatures and lower than average rainfall. Motorcycle travel peaks during the summer months, and in August for example, there is over twice as much motorcycle travel as in February.

Nearly two-thirds of motorcycle trips are for work, business and education purposes (accounting for over half of motorcycle mileage). Although the number of motorcycle trips appears to have fallen by over time (from 11.2 trips per rider per week in 1985/86 to 7.8 trips per rider per week in 2004), the distance travelled has increased (from 62.9 miles per rider per week in 1985/86 to 88.9 miles per rider per week in 2004). [7]

Riders of larger motorcycles (over 500 cc) tend to have higher average mileage than riders of smaller machines.[7]

3 MOTORCYCLE ACCIDENTS AND CASUALTIES[10,11]

Despite forming only 1% of road traffic, motorcyclists account for 18% (almost one in five) of road deaths and serious injuries. In 2005, 569 motorcyclists were killed on the road, 5,939 were seriously injured and just over 18,000 were slightly injured.

Motorcyclist casualties had been rising since the late 1990s, because motorcycling has increased, but 2004 saw a significant drop in the number of motorcycle users killed and injured, although there was also a drop in motorcycle mileage. The fall in deaths and injuries continued in 2005.

Table 4: TWMV Casualties in Great Britain, 1994/98, 2003 - 2005

Casualties	1994/98	2003	2004	2005
Fatal	467	693	585	569
Serious	6,008	6,959	6,063	5,939
Slight	17,547	20,759	18,993	18,316
Total	**24,023**	**28,411**	**25,641**	**24,824**

The vast majority (93%) of motorcyclist casualties are riders, with passengers forming just 7% of casualties.

Table 5: TWMV Rider and Passenger Casualties, GB, 1994/98 and 2004

Casualties	1994/98	2004
Riders		
Killed	434	557
KSI	5,988	6,225
Slight	16,263	17,946
Total	**22,251**	**24,201**
Passengers		
Fatal	33	28
Serious	487	393
Slight	1,285	1,047
Total	**1,772**	**1,440**

Casualty Rates

Much of the increase in motorcyclist casualties in recent years may be due to the fact that the amount of motorcycling has increased (by 33% since 1994-98). This means that the rate of motorcyclist killed or seriously injured casualties per billion kilometres travelled in 2004 had fallen by 23% from its 1994 - 98 level. The slight casualty rate has fallen by 19% and the overall casualty rate by 20%.

Nevertheless, motorcyclist casualty rates are much higher than other road users.

Table 6: Casualty Rates per 100 million vehicle kilometres by Road User Group, 2004

Road user Group	Killed	KSI	All Severities
Pedal Cyclists	3.5	60	431
TWMV Riders	11	121	469
Car Drivers	0.3	2.6	31
All Riders & Drivers	**0.4**	**4.0**	**34**

The casualty rate for motorcyclists is 15 times higher than that of car drivers, but similar to that of pedal cyclists. The fatality rate for motorcyclists is three times higher than for pedal cyclists, but 36 times higher than that for car drivers, reflecting the fact that motorcyclists are not protected by a vehicle body, seat belts or the other occupant protection systems that car drivers enjoy.

Vehicle Involvement Rates
Vehicle accident involvement rates show that motorcyclists are seven times more likely to be involved in an accident than a car, and 15 times more likely to be involved in a fatal or serious accident.

Table 7: Vehicle Involvement Rates (per 100 million vehicle kilometres) by Type of Vehicle, 2004

Road user Group	Fatal	Fatal & Serious	All Severities
Pedal Cycles	3.7	63	442
TWMVs	13	137	521
Cars	0.9	9	73
All Vehicles	**1.1**	**10**	**76**

Motorcyclist Casualties by Age
There is a clear relationship between motorcyclist casualties and age. There are few casualties below the age of 16 years because children do not generally use motorcycles. Moped users show a casualty peak between the ages of 16 and 19 years. Motorcycle and motorcycle scooter user casualties peak between 20 - 49 years. These patterns probably reflect usage patterns of different types of motorcycles.

Table 8: Motorcyclist Casualties by Age, 2004

	Moped	Users		Motorcycle	Users	
	Killed	**KSI**	**All**	**Killed**	**KSI**	**All**
0 - 15	1	35	134	4	86	300
16 - 19	14	511	3,250	37	762	3,306
20 - 29	2	92	590	125	1,426	5,243
30 - 39	2	66	382	219	1,712	5,686
40 - 49	2	29	185	117	1,144	3,807
50 - 59	1	28	117	38	476	1,544
60 +	2	19	80	14	172	542
All Ages*	**25**	**792**	**4,819**	**560**	**5,856**	**20,822**

* Includes age not reported

An In-depth study of motorcycle accidents[12] found that there are two peak ages for motorcyclist casualties: 16 – 20 years and 35 – 39 years.

Motorcyclist Casualties by Gender
Motorcyclist casualties are predominately male. Men account for 91% of motorcyclist deaths and serious injuries, and 89% of total motorcyclist casualties.

Table 9: Motorcyclist Casualties by Gender, 2004

	Male	**Female**	**All**
Killed	559	26	585
KSI	6,068	578	6,648
Total*	22,813	2,819	25,641

* Includes gender not reported

The In-depth study[12] estimated that there are more than twelve times as many male motorcyclist casualties than female ones.

Casualties by Location
Overall, almost three quarters (72%) of motorcyclist casualties occur on built-up roads (roads with a speed limit of up to 40 mph), even though such roads carry less than half of motorcycle traffic. Around 89% of moped casualties occur on built up roads, compared.

One quarter (26%) of motorcyclist casualties and 10% of moped casualties occur on non built-up roads (roads with a speed limit of over 40 mph). And less than 2% of motorcyclist casualties (and virtually no moped casualties) occur on motorways, which carry 7% of motorcyclist traffic.

However, the pattern for motorcyclist fatalities differs: 59% of motorcyclist deaths occur on non built-up roads, 38% on built-up roads and 2.5% on motorways. The reverse is true for moped users: 64% of moped deaths occur on built-up roads and 36% on non-built-up roads.

Urban A roads, followed by urban minor roads, have the highest casualty rates for motorcyclists. However, the fatality rate for motorcyclists is much higher on rural roads than on urban roads.

A detailed examination of 1,790 motorcycle accidents[13] identified that almost three-quarters of motorcycle accidents occur in urban or suburban areas. But it also found that there are over five times as many accidents on bends in rural areas than in urban areas. Motorcycle accidents in rural areas also tend to be more severe – they are three times more likely to be fatal and 1.5 times more likely to be serious, than motorcycle accidents in urban areas.

An earlier analysis of motorcycle accidents in Cheshire[14] indicated a shift in the balance of casualties from urban to rural roads, along with an increase in the proportion of casualties who are killed or seriously injured.

Motorcyclist Casualties by Month
Motorcyclist casualties are highly seasonal. Fatalities and overall casualties peak during the Spring and Summer months, which reflecting increased riding during this period.

Table 10: Motorcyclist Casualties by Month: 2004

Month	Killed	KSI	All
January	9	317	1,487
February	19	391	1,511
March	34	415	1,796
April	57	615	2,131
May	81	788	2,634
June	70	683	2,522
July	69	709	2,434
August	74	702	2,468
September	67	690	2,616
October	29	492	2,218
November	34	475	2,151
December	32	371	1,673

Casualties by Time and Day
Fridays have the highest number of motorcyclist casualties, followed by the other days of the week which each have a similar level. During the week, casualties peak between 4:00 pm and 6:00 pm and between 7:00 am and 9:00 am. The number of weekend casualties is slightly lower, and more evenly spread through the day, with a slight peak between midday and 6:00 pm.

An analysis of fatal accidents involving motorcyclists[15] found that 63% of such accidents occurred in daylight, and a further 26% occurred on lit roads in the dark. However, there were a higher proportion of motorcycle only crashes in the dark.

Road Surface Condition
Motorcyclists are more susceptible to the condition of the road surface. They are more likely to skid on both dry and wet road surfaces, and in particular are put at greater risk by mud or oil on the road. Snow and ice seems to affect car drivers just as much as motorcyclists, although motorcycle use probably drops significantly when ice and snow make riding very difficult and unpleasant.

Table 11: Percentage of Vehicles Skidding by Road Surface Condition: 2004

Road user Group	**Dry**	**Wet or Flood**	**Snow or Ice**	**Mud or Oil**	**All Cond's**
TWMV	19.2	29.6	51.6	72.8	22.6
Cars	10.2	19.5	45.0	51.4	14.2
All Vehicles	10.4	19.3	43.9	52.5	14.0

The study of fatal accidents involving motorcyclists[15] found that 88% of these accidents occurred in fine weather and 80% on dry roads.

Motorcyclist Casualties by Manoeuvre
As with all road user groups (except pedestrians) most motorcycle accidents are listed as "Going ahead other". However, 12% of motorcycle accidents are listed as "Going ahead on a bend", compared to only 9% of cars. Similarly, 15% occur when the rider is overtaking another vehicle, compared to only 3% of car accidents during this manoeuvre. This reflects motorcyclists' greater vulnerability during these manoeuvres.

Table 12: Motorcycle Accidents by Manoeuvre: 2004

Manoeuvre	**No.**
Going ahead other	15,721
Overtaking a moving or stationary vehicle	3,976
Going ahead on a bend	3,170
Turning or waiting to turn right	1,271
Turning or waiting to turn left	738
Stopping	702
Waiting to go ahead	666
Changing lane	286
Starting	155
Parked	77
U-Turning	66
Reversing	10
All known manoeuvres	**26,838**

Types of Motorcyclist Crashes

There are a number of common types of crashes involving motorcyclists[16]:

- Failure to negotiate bends on rural A roads
- Collision at junctions (Right of Way Violations)
- Collision while overtaking
- Rider losing control without another vehicle being involved.

Bends
Losing control on a bend accounted for about 15% of motorcycle accidents in the In-depth study. This type of crash tends to be the fault of the rider, often because s/he approaches the bend too fast and/or mis-judges the curve of the bend. They occur more often on leisure rides. Riders involved in this type of accident are more likely to be inexperienced, either because they have not held a motorcycle licence for very long or because they have returned to motorcycling after a long gap.

Junctions
Right of way violations accounted for about 38% of motorcycle accidents in the In-depth study. They were usually the fault of the other road user, who was usually a driver. Most occurred at T-junctions, although they also happened at crossroads and roundabouts. About two-thirds of these types of crashes, where the rider was not to blame, the driver failed to see a rider who was in clear view (and was often seen by other road users). In about 12% of these cases, the driver failed to see the motorcyclist even though s/he was wearing high visibility garments or using daytime running lights.

This concurs with earlier research. The Booth report[17], published in 1989, assessed nearly 10,000 motorcycle accidents in the Metropolitan Police area. It concluded that nearly two-thirds (62%) were primarily caused by the other road user. Half of the accidents were caused by car drivers, and 10% by pedestrians. The report found that two-thirds of motorcycle accidents where the driver was at fault were due to the driver failing to anticipate the action of the motorcyclist.

Another common type of motorcycle accidents at junctions identified in the In-depth study was ‘shunts’, which accounted for over 11% of all motorcycle accidents in the study. The rider is more often at fault in shunt accidents than the other driver, and the rider tends to be younger, less experienced and riding a smaller machine.

Rider Losing Control
Almost one in five (18%) motorcycle accidents involve the motorcyclist losing control, without any other road user being involved. They are due to rider error, poor road surfaces and avoiding other road users.

Over one quarter (29%) of the fatal accidents in TRL’s analysis of Police reports of fatal accidents involving motorcyclists[18] were motorcycle-only accidents. These were more common on rural roads and often linked to excessive speed, alcohol, other impairment or careless/reckless behaviour.

An analysis of motorcycle accidents in rural Cheshire[19] found that 67% of such accidents were due to rider error, with losing control on a bend and overtaking featuring strongly.

Overtaking
The In-depth[16] study found that overtaking by a motorcyclist was involved in 16.5% of crashes in which the rider was wholly or partly to blame. A further 5% involve riders 'filtering' through stationary or slow moving traffic. In filtering accidents, a driver is more than twice as likely to be at fault for the collision than the filtering rider.

The study of police reports of fatal accidents involving motorcyclists[16] suggested that poor overtaking was a more common factor in accidents involving riders of 201 – 650 cc machines, possibly because the riders were seeking to emulate the behaviour of riders of more powerful motorcycles.

Motorcyclists and Drink Driving
Motorcyclists have a lower breath test failure rate than car drivers.

Table 13: Breath Tests: 2004

Road User	No. Involved in RTA	No. Tested (%)	No. Failed	Fails as % of Involved	Fails as % of Tested
Car Drivers	291,842	149,430 (51%)	6,655	2.3%	4.5%
TWMV Riders	26,857	12,422 (46%)	423	1.6%	3.4%

A lower proportion of motorcyclist fatalities (14%) were over the drink drive limit than car driver fatalities (21%).

Table 14: Percentage of TWMV Riders and Motor Vehicle Driver Fatalities Over the Legal Blood Alcohol Limit: GB 1993-2004

Year	TWMV Riders	Drivers
1993	15	19
1994	18	21
1995	15	19
1996	13	21
1997	13	17
1998	11	15
1999	9	17
2000	10	18
2001	10	18
2002	11	19
2003	13	19
2004 *P*	14	21

P Provisional figures

Motorcyclist Injury Patterns
Various studies[20],[21] have assessed the types and frequencies of injuries to motorcyclists. Legs are the most commonly injured, followed by the head and arms.

Table 15: Proportion of Injuries to Motorcyclists

Site of Injury	% of all Injuries
Legs	39%
Head	23%
Arms	19%
Shoulder/Thorax	10%
Abdomen/Pelvis	7%
Neck	1%

Around 80% of motorcyclist casualties suffer leg injuries, 56% suffer injuries to the arms and 48% to the head. However, head injuries are usually more severe than those to the legs or arms, and account for over 70% of motorcyclist fatalities[9]. Injuries to the thorax and pelvis are infrequent, but usually severe.

Table 16: Proportion of Motorcyclists by Injury

Site of Injury	% of Casualties
Legs	80%
Head	48%
Arms	56%

Head Injuries
Around 80% of seriously injured motorcyclists, and 73% of motorcyclist fatalities suffer head injuries (they usually suffer other injuries as well), including cuts, abrasions, concussion, severe facial injuries, skull fractures and brain injuries.[9] They appear to be more likely in crashes in which the motorcyclist collides with another vehicle at right angles and the head impacts against the vehicle, or where the rider slides along the ground and strikes their head on a kerb or piece of roadside furniture. Skull fractures may occur at speeds of 30 km/h or more, but brain injuries may happen at much lower speeds, from 11 km/h upwards.

Leg Injuries
Leg injuries, including cuts and abrasions, fractures, broken bones and dislocated joints, account for 60% of serious injuries. The knee and lower leg appear to be the most vulnerable. Leg injuries are most frequently caused in accidents that involve the motorcyclist striking the side of a vehicle at an oblique angle, or a vehicle striking the motorcyclist side-on. The injuries are caused by a direct impact or by the leg being trapped and crushed between the vehicles.

THE MAIN SAFETY ISSUES
The following sections of this report explore a number of key issues:

- Riders
- Other Road Users
- Motorcycles
- Roads

5 RIDERS

5.1 UK Licensing Laws

Anyone who obtained their full car driving licence on or after 1 February 2001 must complete Compulsory Basic Training (CBT) before they can legally ride any type of motorcycle or moped on the road. People who obtained their full car driving licence before 1 February 2001 do not need to take a CBT test to ride a moped, but must do so in order to ride any other motorcycle. However, CBT and/or motorcycle training is still strongly recommended.

To gain a full moped licence, the learner must pass both the theory test for motorcyclists and the moped practical test**.**

To gain a full motorcycle licence, the learner must pass the theory test for motorcyclists and either the A or A1 practical test**.**

A1 – light motorcycle licence
The A1 Test is taken on a machine between 75cc and 125cc and if passed entitles the holder to ride any motorcycle up to 125cc with a power output up to 11kW or 14.6 bhp, carry pillion passengers and use motorways.

A – standard motorcycle licence
The A Test is taken on a machine over 120cc but no more than 125cc and if passed entitles the holder to ride any motorcycle with a power output of up to 25kW or 33 bhp, carry pillion passengers and use motorways. After 2 years (not counting periods of disqualification) the rider qualifies to ride any size of motorcycle.

However, there are two ways the 2 year waiting period can be shortened:

Direct Access Scheme (DAS)
This allows riders over 21 years old take a test on a machine of at least 35 kW (46.6 bhp), and if they pass to ride any size of bike. Any instruction given on a machine that exceeds the normal learner motorcycle specification must be supervised at all times by a certified motorcycle instructor who should be in radio contact with the learner. All other provisional licence restrictions apply.

Accelerated Access
Riders who reach the age of 21 years during the two year period, can become entitled to ride larger bikes by passing a further test on a motorcycle of at least 35 kW (46.6 bhp). They may practise on bikes over 25 kW (33 bhp) under the same conditions as Direct Access, but revert to learner status while doing so. Failing the test does not affect their existing licence.

Future Changes to Motorcyclist Licensing
The harmonisation of driving licences across Europe is well underway. A Third Driver Licensing Directive is being developed, and although it is not clear what the final rules will be, it seems likely that they will include significant changes to motorcyclist licensing, possibly raising the age for direct access to larger machines from 21 to 24 years, setting age limits for smaller machines and a requirement to pass a test or take training when moving from smaller to larger motorcycles.

5.2 Age and Experience

There is a clear relationship between age and accident risk for motorcyclists. The two age groups with the highest risk are younger riders, aged 16 to 19 years, on mopeds and small engine motorcycles, and riders aged 20 to 49 years, but particularly those aged 30 to 39 years, on larger machines.

A TRL study[22] showed that the age distribution of motorcyclist casualties changed dramatically in the last two decades of the Twentieth Century. In 1980, over half of motorcyclist casualties were under 20 years old and less than 20% were aged over 30 years. By 1997, this pattern had reversed, with less than 20% of casualties being under 20 years old and over half more than 30 years old.

A survey of accident risk[23] throughout the 1990s showed that during the first half of that decade the number of younger motorcyclists (16 – 24 years) being killed or seriously injured fell substantially, but the number of older motorcyclists (25 – 59 years) being killed or seriously injured rose throughout the 1990s.

However, a study of fatal motorcyclist crashes between 1994 and 2002[24] found that the main change in motorcyclist fatalities since 1994/98 has been a large increase in deaths among 30 to 49 year old riders.

Another study[25] also found a strong link between age and accident liability for motorcyclists, and identified younger riders as the highest risk group. This study suggested that age is a stronger factor than experience (in contrast to car drivers for whom experience is thought to be a stronger link to accident risk than age), perhaps because as riders become more experienced they move onto large machines and more challenging rides. Other research shows that older riders were more likely to ride larger motorcycles.[23]

The In-depth study[26] suggested that more experienced riders were less likely to be at fault for the accidents in which they were involved, whereas less experienced riders were more likely to be at fault.

A New Zealand study[27] concluded that age was more important in motorcycle accident risk than experience. It compared 490 motorcycle riders who had been involved in road accidents on non-residential roads between 1993 and 1996, with a control group of 1,518 riders who had not been involved in an accident. Of the crash-involved riders, 18% were aged 15 - 19 years (as were 11% of the control group), 32% (and 26% respectively) were aged 20 - 24 years and 49% (and 63%) were aged 25 years and over. 21% of the crash-involved riders had less than two years riding experience, 30% had between 2 and 5 years experience and 50% had more than five years riding experience. The corresponding figures for the control group were 16%, 28% and 56%.

As age increased, accident rates decreased, so much so that riders aged 25 years or older had a 50% lower risk than those aged 15 - 19 years. It also showed that those with five or more years riding experience had a lower risk than those with less than two years. However, once age was taken into account, the study found little evidence that the amount of experience had a protective effect. The study also found that familiarity with the motorcycle being ridden significantly reduced accident risk.

A survey[28] of over 1,300 motorcyclists compared accidents and attitudes of riders with their age and motorcycling experience. Most (84%) were aged 25 years and over, 6% were aged up to 19 years and 10% were aged 20 - 24 years. Almost all (91%) had four or more years riding experience and only 2% had two years or less experience. The study found that younger riders had more accidents than older riders, irrespective of the amount of riding experience. In other words, younger riders with four or more years riding experience had more accidents than older riders with four or more years riding experience. The report concluded that younger riders have more accidents because they are young, rather than because they lack experience, and their accident risk is associated with a willingness to break the law and violate the rules of safe riding.

5.3 Training

Motorcycling requires more control skills than driving a car, but motorcyclists receive relatively little formal training, and there is much less opportunities for supervised on-road riding. Many graduate from smaller to larger machines without taking any further training.[29]

Unlicenced riders and improperly licenced riders were at great risk of being in an accident than riders who were properly trained and licenced.[30]

A review[31] of the motorcycle training industry in Britain showed that it is “very fragmented”, with many small training organisations, a wide range of different training qualifications and many different types of courses. The courses available include CBT (CBT instructors must be certified by the DSA), post-CBT/pre-test training, rider development, advanced rider training and rider assessment courses.

An evaluation of a one-day motorcycle training course[32] in 1987 (before CBT) compared a group of 78 riders who undertook the training programme, with a matched control group of 62 learner riders who received no training. Both groups were tested immediately after the training course and again two months later. The study concluded that the trained riders committed fewer errors immediately after they had been trained. Over the following two months the skills of both groups improved, but the trained group still committed fewer errors. The untrained riders committed two - two and half times as many errors, which were mainly poor rearward observation and problems maintaining balance.

A Canadian study[33] compared 346 trained riders with a control group of 346 untrained riders (matched for age and sex) over a five year period from 1979 to 1984. It concluded that age was the strongest predictor of motorcycle accident involvement. However, it also found that trained riders had a lower accident rate than untrained ones, and that their accidents tended to be less severe. Overall, the trained group had 64% fewer motorcycle accidents than the untrained group (they also had 32% fewer accidents in all vehicles, including motorcycles). The number of accidents for both groups decreased with each successive year following gaining their motorcycle licence. The study also found that the benefits of training in reducing accidents were stronger for riders aged 25 years or less than for older riders, and that the effects were stronger in the short term than in the long term.

Developments in Pre-test Training
All new riders must successfully complete Compulsory Basic Training (CBT). Then, to gain a full motorcycle licence, they must pass the theory test for motorcyclists and either the A or A1 practical test**.** It is recognised that learners need to be encouraged and helped to take an adequate level of training between CBT and taking the motorcycle test. The Government has the power to make such training compulsory, but at present is seeking to encourage riders to take training rather than force them to do so.[34]

Developments in Post-test Training
Recent years have seen significant developments in rider training. The Driving Standards Agency (DSA) is also working with motorcycling training providers to develop national standards for post-test training for all motorcyclists with full licences, particularly newly qualified riders, riders returning to motorcycling after a long break and riders who are changing to larger, more powerful machines.

It is likely that the Pass Plus scheme for car drivers (which provides extra supervised lessons after the driving test) will be extended to novice motorcyclists.

Bikesafe is an assessment ride with a Police motorcyclist who identifies any skills that the rider needs to improve, and if appropriate, recommends further training. These schemes are now available nationally and the syllabus has been standardised so that wherever a riders takes a Bikesafe assessment, the core elements should be the same. A note of caution was sounded in an evaluation of the Bikesafe Scotland scheme[35] which suggested that sometimes a rider's confidence could be raised without their safe riding abilities being raised to the same extent.

Following the model of Driver Improvement Schemes, Rider Improvement Schemes that the Police will be able to offer to riders as an alternative to prosecution for minor offences are being developed and evaluated. They will mirror the existing Driver Improvement schemes for car drivers, although they are only currently available in a few areas.

The Road Safety Bill will provide powers for training courses (that would apply equally to drivers and motorcyclists) to be offered for more serious offences, with reductions in the length of dis-qualification or the number of penalty points for offenders who successfully complete them.

Speed Awareness courses are being offered by some Police forces to drivers who exceed the speed limit by small amounts. Good practice guidelines for a national scheme have been developed and such schemes are available to motorcyclists as well as drivers.

The Department for Transport has commissioned research to investigate current training courses, identify good practice and develop guidelines for standardising the core elements of pre- and post-test motorcycle training. The research will also compare post-training accidents rates for different types of training. Hopefully, this research will plug a significant gap in our knowledge of most effective types of motorcyclist training.

A weakness of the motorcycle training system is the lack of a statutory register to ensure that motorcyclist instructors are trained, tested and monitored to minimum, national standards (similar to the one for car driving instructors are). These issues have been recognised in the Government's Motorcycling Strategy and a number of measures are underway to address them. Research is being conducted to develop training competencies and professional qualifications for motorcyclist trainers, and a voluntary registration scheme will be set up by the DSA.[36]

5.4 Fitness To Ride

As with drivers, it is essential that motorcyclists are fit to ride. It could be argued that any impairment due to alcohol, drugs, medicines or fatigue is likely to have a greater effect on motorcycle riders than car drivers because the rider must balance and control a two-wheeled vehicle.

Alcohol

Alcohol reduces the ability to concentrate, slows reaction time, creates over-confidence and increases the risk of being involved in an accident. It remains in the body for several hours after it has been consumed and may still affect a rider the morning afterwards.

In 2004, 423 motorcyclists failed breath tests, and 14% of riders who died were over the drink drive limit. However, motorcyclists are less likely to fail breath tests than car drivers, and a lower proportion of motorcyclists killed on the road were found to have been over the limit, compared with car driver fatalities.[37]

The In-depth Study of Motorcycle Accidents[38] found that alcohol was a factor in 3% of motorcyclist crashes where the rider was wholly or partly to blame, but it was a factor in only 1.3% of motorcycle accident where the other driver was to blame. This suggests that motorcyclists are more likely to be in an accident when they themselves are impaired by alcohol (or drugs) than when another driver is so impaired. A questionnaire survey of experienced motorcyclists was conducted as part of the same study, in which 85% of respondents said that they never rode when under the influence of alcohol or drugs, and the rest said they had done so only occasionally.

It goes without saying that motorcyclists should refrain from drinking any alcohol and riding, or riding when affected by drugs.

Drugs and Medication
There is no evidence to suggest that this is a greater problem for motorcyclists than for drivers, but the same issues relate to both groups. The In-depth Study found that drugs were involved in less than 0.25% of motorcycle crashes where the rider was wholly or partly to blame.

Motorcyclists should not ride if they feel affected by medicines (including some everyday medicines) or illegal drugs, or if they are taking medicine or undergoing any medical treatment which advises against driving or riding. Appropriate guidance from medical practitioners and pharmacists, and warning labels on medicines, are essential. Positive advice about alternatives to riding and advice to return to the GP if side-effects are experienced are just as important as warnings not to ride if affected by the medicine, or by the illness. Current developments in roadside tests for drugs and/or impairment should apply as much to motorcyclists, as to drivers.

The study of fatal accidents involving motorcyclists[39] found that 13% of the riders involved had been impaired by alcohol or drugs or both. This matches the percentage of fatally injured riders who were over the legal alcohol limit (see Table 14, page 11).

Fatigue
As with drivers, a tired motorcyclist is more likely to have a crash. Motorcyclists may have an increased susceptibility to fatigue because of noise, vibration and exposure to weather conditions. Unlike car drivers, they may feel unable to find a safe place to stop and sleep in their vehicle and so may be more tempted to keep going on long journeys.

In a questionnaire survey[40] of experienced riders, a quarter said that they never rode when tired, and less than 8% said that they regularly rode their motorcycle when they were tired. However, fatigue was involved in only 4 of 1,790 motorcycle accidents analysed.

Most of the research into fatigue has concentrated on drivers (although the Department for Transport has commissioned research to examine the role of fatigue in motorcyclist crashes), but the recommendations flowing from the existing research can be applied to motorcyclists:

- do not ride when feeling tired
- avoid riding in the early hours or when the rider would normally be asleep
- avoid starting a long distance ride after having worked a full day
- plan and take regular rest stops on long journeys - about every two hours
- try to avoid riding after a heavy meal
- do not drink and ride
- avoid riding if affected by drugs or medicines that may cause drowsiness.
- adopt a comfortable position with the instep resting on the footrests
- consider wearing internal ear protection (ear-plugs) to reduce noise
- wear comfortable clothing that provides physical protection and is appropriate to the weather
- Riders who begin to feel tired should stop somewhere safe, take drinks containing strong caffeine, find somewhere safe and take a short nap.

5.5 Inappropriate Speed

Speed surveys[41] show that on 30 mph built-up roads in 2004, almost half (48%) of motorcyclists exceeded the speed limit, compared with just over half (53%) of car drivers. On 40 mph built-up roads, 36% of motorcyclists exceeded the speed limit, compared with 27% of cars.

On non-built-up single carriageway roads with the national speed limit of 60 mph, 25% of motorcyclists exceeded the limit, compared with only 10% of car drivers. On non-built-up dual carriageways with the national speed limit of 70 mph, 48% exceeded the speed limit, with 21% travelling faster than 80 mph. On motorways, 59% of motorcyclists exceed the speed limit, with 28% going faster than 80 mph.

The risk and severity of injury increases with speed. Most motorcycle accidents occur at relatively low speeds, although fatal and serious injuries are more likely to be suffered at higher speeds.

Built-up roads (roads with speed limits of 40 mph or less) have the highest casualty rate for motorcyclists. Over two thirds of powered two wheeler casualties occur on built-up roads, despite the fact that they carry less than half of motorcyclist traffic. However, only one third of motorcyclist deaths occur on these roads. 60% of deaths occur on non-built up roads (speed limits over 40 mph). Only 2% of casualties and 3% of deaths occur on motorways, which also have the lowest motorcyclist casualty rate.

Over one third (38%) of the motorcyclists involved in fatal accidents in one study were considered to have been speeding before the collision.

The In-depth Study of Motorcycle Accidents[42] identified misjudging the speed required to negotiate a bend as the most common cause of motorcycle only crashes. Inappropriate speed (both exceeding the limit and riding within the limit but too fast for the conditions) was a contributory factor in 9.2% of the motorcycle accidents studied. However, 58% of the motorcyclists who responded to the questionnaire survey admitted to always or frequently breaking the speed limit, but only when they felt it was safe to do so. Over two-thirds of these experienced motorcyclists also admitted to sometimes miscalculating bends.

The European Experimental Vehicles Committee's review[43] of research into motorcycle accidents, also found that the majority of motorcycle collisions take place at fairly low speeds, between 30 and 60 kilometres per hour.

A TRL study[12] found that approximately 75% of motorcycle accidents occur at impact speeds of up to 48km/h (30 mph) and 96% at up to 64 km/h (40 mph). The study also found that almost all (93%) of the serious and fatal head injuries occur at speeds of up to 64km/h (40 mph).

These figures suggest that high speed riding and accidents are not the only area of concern, and that interventions should also be directed towards motorcycle riding at lower speeds.

5.6 Helmets and Clothing

Motorcycle Helmets

When a motorcyclist's head hits another object, it is of vital importance that the energy created in the impact is dissipated in a controlled manner in order to prevent or reduce the risk of brain injury. Head and brain injuries can be caused in very low speed accidents, and motorcycle helmets offer good protection against such injuries (although they do not guarantee protection).

In the UK, motorcyclists must wear a helmet when riding on the road. Helmets sold in the UK must comply with ECE Regulation 22 as amended, British Standard BS 6658 as amended or a European standard which offers a level of protection which is the same as, or better than, the British Standard.

A literature review[44] of the effectiveness of motorcycle helmets shows that helmets reduce the risk of fatal head injury by around 50%. It is sometimes suggested that the extra weight of a helmet actually increases the risk of neck injuries, but research has found no evidence to support this. Full faced helmets offer greater protection against facial and chin injuries than open-faced helmets, but may slightly increase the risk of injury to other parts of the head.

However, the study of fatal accidents involving motorcyclists[45] found that the helmet came off in 20% of fatal crashes (12% before the crash and 45% during the crash). There is also evidence that the protection offered against chin impacts is inadequate (riders who suffer chin impacts frequently suffer fractures to the base of the skull - the most threatening head injury).

Advances in Helmet Technology

As effective as motorcyclist helmets are, they can be improved. Research is underway to improve the standards for helmets and visors, which may lead to a rating scheme.[46]

It is also important that helmet design follows motorcycle user behaviour. With the growth in motorcycle use – especially as a mode of transport rather than a hobby – the types of accidents motorcyclists are involved in may change. If there are more accidents at 30 mph, then helmets should be primarily designed to mitigate these.

TRL research[47] found that current helmets were too stiff to provide the same protection at lower speeds as they do at higher speeds. At lower speeds, less energy is generated, but the helmet does not absorb it as efficiently and a larger percentage is transferred to the wearer's cranium. This suggests that helmet designs need to be optimised to make them more energy absorbent at lower speeds, and increase the range of severities that would be survivable for a rider wearing a helmet. An ideal helmet would efficiently absorb energy over a wider range of speeds.

Future helmet design also needs to focus on reducing the rotational acceleration of the rider's head upon impact. This is frequently a cause of brain injury, especially when combined with linear acceleration.

TRL's Motorcycle Helmet Assessment Project[48] assessed the relationship between helmet design and injury risk, and developed a new advanced helmet that offers better protection at a larger range of speeds. It was estimated that if all riders had had an advanced helmet in the year of the study, then 93 of the 578 (17%) motorcycle fatalities could have been prevented that year, as could 434 serious injuries.

Unfortunately, the estimated additional cost of the advanced helmet was £150. Real world use of the helmet and the rate at which motorcyclists invest in the technology must be taken into account in order to get a realistic evaluation of its actual casualty savings. Assuming that 10% of all helmet sales were the advanced helmet, in the first 5 years of their introduction, 28 lives would be saved and 130 serious injuries prevented.

Once the technology is readily available, a strong case for the extra investment needs to be put forward to motorcyclists to achieve rapid sustained sales growth. As mentioned previously, published comparative ratings for helmets would lead to more informed consumer choice.

Visors
Riders who use an open-faced helmet need to use a visor or goggles to protect their eyes from wind, rain, insects and road dirt. If they normally wear glasses or contact lenses they must wear them when riding. It is important that visors and goggles are kept clean, and replaced if they become heavily scratched as scratches which may distort the view, cause dazzle from oncoming vehicle headlights or cause sun glare. TRL's review of police reports of fatal accidents involving motorcyclists[49] identified impaired vision caused by problems with the rider's visor as being associated with crashes in which a rider hit a stationary object.

Some motorcyclists wear sunglasses, tinted visors or goggles, and have sought a change in the law to legalise very dark tints, with minimum light transmittance of 18%, for daytime use. Research[50] on the effect of tinted visors on seeing distances and signal light recognition on unlit roads at night, supports a minimum level of 50% transmittance. It found that very dark visors did not fundamentally help wearers to see better in bright conditions. This research was conducted on fully alert subjects with good eyesight wearing visors that were in good condition, and so may have under-estimated the potential problems caused by the use of dark tinted visors in less good conditions.

The Government has called on standards bodies to encourage the development of technical solutions to enable longer-term visor designs to lend themselves equally to both day and night time use.[51]

Riders should not wear tinted glasses, visors or goggles if riding in the dark, dusk or conditions of poor visibility.

Noise
Regular use of a motorcycle can damage a rider's hearing[52]. At 60 mph noise levels (mainly wind noise) inside motorcycle helmets can be in excess of 100dB[11]. Extended exposure to noise levels of over 90dB can lead to permanent hearing loss. Noise inside the helmet may prevent the rider from hearing audible signals, such as horns, sirens and traffic.

Noise levels vary with the style of helmet, whether the motorcycle has a windscreen and the position of the rider behind the screen. Research by the University of Southampton using a wind tunnel showed the main source of noise to be the turbulence at the edge of the windscreen's wake acting on the helmet. Low screens direct the turbulence to the wake of the helmet and improvements to the helmet seal around the neck can reduce noise levels on motorcycles with low screens. High windscreens direct the turbulence to the helmet visor and the forehead and improvements in the seal between the visor and the helmet result in an improvement. These modifications can reduce noise levels by 5 – 8 dB at the ear.

The easiest way for most motorcyclists to achieve a reduction in noise levels is to wear earplugs. These should be marked with British Standard BS EN 352-2:2002, the hearing protector standard for Ear Plugs. Many UK police forces now provide these for their motorcyclists as part of their health and safety policy. Riders using earplugs for the first time should monitor their speed carefully since the earplugs will reduce their level of feedback from the road environment.

VAT
In the UK motorcycle helmets have been VAT zero-rated since 1974. There were proposals in the European Commission to remove this exemption. Fortunately, the Government made it clear that the UK would not remove or reduce this exemption.[53]

5.7 Protective Clothing

Leg and arm injuries are common for motorcyclists who are involved in crashes, and leg injuries in particular can be serious, and often cause permanent disability. Good motorcycle clothing can protect motorcyclists from the wet and cold and from some types of injury. It is essential that it is comfortable to wear, does not impede the movements of the rider and provide protection from the elements - riders who are warm and dry are much more alert.

European standards have been developed for motorcyclist protective clothing (which must be CE marked). There is now a wide range of such clothing available, including one and two-piece suits, trousers, jackets, boots and gloves, which contain abrasion resistant materials, such as Gortex, leather or kevlar and padding or body armour to protect from impact injuries. Good gloves or gauntlets are essential when riding a motorcycle. They protect the rider's hands from cold, wet weather, and from injury if they fall off, and allow the rider to operate the controls easily. It is equally important to wear good boots or strong footwear that cover the ankle when riding.

However, as with helmets, there are accidents and injuries from which the best protective clothing is unable to protect the rider.

High Visibility Clothing

Protective clothing that contains fluorescent and reflective material will increase the conspicuity of the rider, and hence help to reduce the likelihood of an accident occurring in the first place. In tests of motorcyclists' daytime conspicuity[54], riders wearing a fluorescent jacket or waistcoat were detected by observers sooner than riders not wearing any high visibility garments.

When riding in the dark, riders should wear clothing that includes reflective materials on the legs and lower body, as this is where car headlights will shine.

5.8 Rider Behaviour - Conclusion

As with all road accidents, the causes and contributory factors of motorcycling accidents are varied and complex.

The rider's skills, training, experience and attitudes are fundamental to safe motorcycling (although by no means the only issues). One of the key approaches to improving motorcyclist safety is to ensure that riders receive appropriate training when they start (or re-start) to use a motorcycle, that they receive further training as they progress in their riding careers, especially as they progress from smaller to larger motorcycles.

Research is underway to establish the most effective type of training schemes for different groups of riders and to develop a range of appropriate courses.

6 OTHER ROAD USER BEHAVIOUR

Most motorcycle accidents involve a collision with another vehicle, usually with a car, but large vehicles also feature strongly. Although, there is much that motorcyclists can do to avoid such collisions, the behaviour of drivers is equally crucial.

There are many accidents in which the motorcyclist is using the road responsibly and safely, but is put at risk because a driver fails to do the same. Drivers need to be aware of the characteristics, needs and vulnerability of motorcyclists.

The in-depth study of motorcycle accidents[55] showed that right of way violations accounted for about 38% of motorcycle accidents. They were usually the fault of the other road user, who was usually a driver. Most occurred at T-junctions, although they also happened at crossroads and roundabouts. About two-thirds of these types of crashes, where the rider was not to blame, the driver failed to see a rider who was in clear view (and was often seen by other road users). In about 12% of these cases, the driver failed to see the motorcyclist even though s/he was wearing high visibility garments or using daytime running lights.

Earlier research[9] reached similar conclusions, finding that nearly two-thirds (62%) of motorcycle accidents were primarily caused by the other road users. Half of the accidents were caused by car drivers, and 10% by pedestrians. Two-thirds of motorcycle accidents where the driver was at fault were due to the driver failing to anticipate the action of other traffic.

A great deal of emphasis has been placed on the need for motorcyclists to be as conspicuous as possible with day time running lights and riders wearing fluorescent and reflective clothing and an increased frontal area[56]. Other research[57] has concentrated on the attitudes of drivers having found that drivers who are involved in collisions with motorcycles have less familiarity with motorcycles. Even with their increased popularity, motorcycles are still comparatively uncommon on our streets and drivers fail to consider them when making decisions at junctions.

Research[58] has identified a third factor involved in this type of collision. When waiting at junctions, drivers estimate the time-to-arrival for smaller, closer vehicles such as motorcycles as later than for larger, further away, vehicles such as cars and vans. This research suggests that drivers will underestimate how close a motorcycle is and pull out into smaller gaps than they would for a car or van. This optical illusion has serious consequences for motorcyclists, and drivers need to be made aware when at junctions, not only to look out for motorcycles but, to assume that the motorcycle they see is closer to the junction than they appear to be.

The Department for Transport has commissioned research into drivers attitudes and skills in relation to motorcyclists.

When overtaking a motorcyclist, drivers should give the rider the same amount of passing space as if overtaking another four-wheeled motor vehicle. Drivers of large vehicles in particular need to give motorcyclists plenty of room when overtaking them, as two wheelers are easily affected by side wind and the draught created by overtaking vehicles. Two wheelers may need to suddenly avoid a pot hole, debris or spillage on the road, and drivers should be prepared for unexpected movements, and keep a safe distance between themselves and motorcyclists.

Other Road User Behaviour - Conclusion
While motorcyclists can help themselves by increasing their conspicuity, it is essential that drivers are aware that motorcyclists may be present on any road, at any time.

Given that motorcyclists are more difficult to spot, drivers must be aware of the need to look carefully for them. The slogan “Think Bike” is as relevant today as it ever was. Government road safety publicity campaigns rightly target drivers with key messages to raise their awareness that they need to look out for motorcyclists, especially at junctions.

Further research into the behavioural aspects of drivers in regard to motorcyclists is needed to help develop appropriate counter-measures.

7 MOTORCYCLE DESIGN

Improvements to the design and construction of cars over the last 10 or 20 years have resulted in very substantial reductions in deaths and injuries on the road. This has not been the case with changes to the design of motorcycles.

7.1 Engine Size

The term motorcycle encompasses a wide variety of vehicles, from small low-powered mopeds and scooters to large, high powered motorcycles capable of reaching speeds of 200 mph and more.

The In-depth study of motorcycle accidents[59] showed that riders 100 – 250 cc motorcycles tended to be younger and riders of 500 cc and over machines tended to be older riders. Riders of motorcycles of 600 cc and above were more likely to be involved in crashes on bends, and riders of motorcycles with 900 cc and above were more likely to be involved in overtaking or filtering accidents.

The TRL study of motorcyclists deaths between 1994 and 2002[60] found that large motorcycles were more likely to have travelling excessively fast than smaller motorcycles, and their riders were more likely to have been riding poorly, before their fatal crash. Riders of smaller machines were more likely to have judged their own path poorly.

A 1988 TRL report[61] recorded the engine size of accident-involved motorcycles between 1984 and 1986, along with National Travel Survey data and data on the number of registered motorcycles to explore the relationship between engine size and casualty rates. There were marked differences in the use of motorcycles of different engine sizes. Larger machines did more of their mileage on non built-up roads, tended to be ridden by older riders, were more likely to carry pillion passengers and were used more in the Summer than the Winter months.

The study found that accident rates per kilometre travelled fell with increasing engine capacity, possibly because larger machines tended to be used by more experienced riders. However, riders of larger machines were more likely to be killed or injured than riders of small machines. In particular, increased engine size was associated with a higher proportion of accidents and casualties on non-built up roads. Riders of more powerful motorcycles also tended to have a higher proportion of accidents at night, and while going ahead on a bend or while overtaking.

New Zealand law restricts motorcyclists with a learner or restricted licence to riding motorcycles with an engine capacity of 250cc or less. A study[62] of its effects found no consistent pattern of risk increasing with the cubic capacity of the motorcycle, and suggested that cubic capacity is a poor measure of engine power. The findings suggested that if cubic capacity was to remain the sole basis for restricting learner and restricted licence holders, consideration should be given to having a substantially lower capacity than 250cc.

In the 1960s and 1970s, most sports motorcycles were capable of producing 40 - 50 bhp with top speeds of 115 -120 mph. Today, outputs of 75 - 90 (even 130) bhp, with top speeds not far short of 200 mph, are quite common. It is inevitable that many riders will want to use the machine's maximum capability and to test their vehicle's limits. Even within legal speed limits, such powerful machines require exceptional levels of skill.

In the early 1990's a proposed European Commission limit of 100 bhp on motorcycles failed, partly because it was not possible to demonstrate a link between bhp and accident risk. Therefore, it was not possible to show that imposing a limit would reduce the number of motorcycle accidents.

Having said that, there is little justification for manufacturer's producing such powerful motorcycles (or cars, of course) that are capable of speeds of more than twice the maximum speed limit for road use.

There is on-going research and development of intelligent speed adaptation for cars that would limit their top speed to the speed limit of the road on which it was driving. This development process could also be applied to motorcycles, although any such devices will need to be specifically designed for two-wheelers and not simply transferred from four wheel vehicles.

7.2 Braking

Braking, especially in an emergency, is one of the most difficult tasks encountered when riding a motorcycle. Errors in braking can easily lead to skidding, capsizing or the vehicle becoming unstable. Front and rear motorcycle brakes are usually operated separately (unlike a car's which are linked) and so the rider has to decide which brake to apply, when and what proportion of front and rear braking to use according to the situation and road surface (some motorcycles do have coupled brakes). Some manufacturers are now fitting Combined Braking Systems (CBS) that operate both brakes and distribute the braking force to the front and rear wheels to improve stability when braking.[63]

TRL research[12] shows that the incorrect use of motorcycle brakes is considered to be a factor in many motorcycle accidents. Over a third of riders used only the rear brake and 11% used only the front brake. Even in an emergency, 19% of riders only used their rear brakes and 3% only used their front one. One study estimated that correct braking, using the full braking capability of the motorcycle, could prevent 30% of motorcycle accidents, although this study was conducted before ABS was available for motorcycles.

ABS

ABS brakes for motorcycles have been commercially available since 1988, and are now being fitted to a wide range of machines. It should be noted that the characteristics of braking systems for motorcycles are different from those of cars; and in particular, it is not possible to steer when applying ABS brakes on a motorcycle.

It is important to ensure that riders understand how advanced braking systems work and receive training in their use. Training courses to help riders to become accustomed to ABS technology and its advantages should be encouraged. For example, a scheme similar to the Bosch ESP-erience could help in raising the awareness.

Publicity needs to encourage riders to invest in machines with ABS to help the spread of this technology. A high level of fitment of ABS should be seen as an important step forward in motorcycle safety in future. The government would like to see wider implementation of these systems on all motorcycles.[1]

7.3 Daytime Running Lights

Drivers involved in a collision with a motorcycle often claim that they did not see the motorcycle. It has been suggested that motorcyclists should be required to use their headlights during the day as this may help to reduce accidents. The Road Vehicles Lighting Regulations permit, but do not require, the use of daytime running lights by any vehicle, not just motorcycles. However, research into daytime running lights on motorcycles (and on all motor vehicles) is somewhat contradictory at present.

In tests of motorcyclists' daytime conspicuity[64] the best results were from motorcycles using a 40W large headlamp (dipped) or a pair of daytime running lights.

A review of literature on the effectiveness of daytime running lights for motorcycles is contained in the European Experimental Vehicles Committee report on motorcycle safety.[11] It states that a study in four US states showed a reduction of 41% in accidents during daytime following a law requiring daytime use of motorcycle headlights.

A study in Singapore[65] found that the introduction of daytime running lights for motorcycles in 1995 has reduced the number of fatal and serious injury accidents, although had no significant effect on slight accidents.

A report by the SWOV Institute in the Netherlands[66] indicates that the introduction of daytime running lights in Austria reduced motorcyclist casualties during the day by 16%, and estimates that the Europe-wide introduction of a similar law would reduce motorcyclist casualties in the EU by around 7%.

However, road trials by TRL in the early 1990s found that over 70% of motorcycles in Great Britain were fitted with headlamps that were ineffective as a conspicuity aid either by day or night.[12] This suggests that there would be little benefit in motorcycles using their normal headlights during the day. Specifically designed daytime running lights (separate from the normal headlights) may be more effective.

Some motorcycle manufacturers are now fitting automatic headlamp on systems so that the motorcycle's lights are always on, a move which RoSPA supports.

Some countries are considering the mandatory introduction of the use of daytime running lights for all vehicles. However, there is concern that this may adversely affect motorcyclists, in that if all vehicles use headlamps during the day, the relative conspicuity of two-wheelers will be reduced.

The Government has no plans to introduce mandatory daytime running lights for motorcyclists or for all vehicles, and would only consider this option if it was supported by evidence of its likely effectiveness, and after considering any increased environmental costs (in CO_2 terms) due to the energy to power the lights. However, the Highway Code does advise motorcyclists that using dipped headlights in daylight may increase their conspicuity.

7.4 Leg Protectors

Leg injuries account for approximately 60% of serious injuries to motorcyclists, and frequently lead to permanent disability. Leg protectors have been suggested as a way of reducing such injuries. Leg protecting fairings have been shown to reduce injuries but may also alter the motion of the motorcycle during and after an impact and it is, therefore, important to ensure that any changes proposed do not increase the risk of injury.

Research has resulted in contradictory claims for the efficacy of leg protectors, with some studies suggesting that they would reduce leg injuries, but others suggesting that they might even increase the risk of other injuries.

TRL research[12, 67] over a number of years has investigated whether leg protectors would significantly reduce the incidence and severity of leg injuries to motorcyclists. Crash tests of different types of motorcycles, with and without leg protectors, were designed and conducted by TRL. They concluded that leg injuries would have occurred in 55% of the crash tests on motorcycles without leg protectors, but in only 12% of those with leg protectors. They also concluded that the leg protectors used would not have increased the risk of head injuries, and in some cases actually showed potential for reducing them.

However, crash tests conducted by the International Motorcycle Manufacturers Association[11] produced different results, in which leg protection was found to be beneficial in three out of eight pairs of tests, but detrimental in five pairs of the eight tests. Overall, this study concluded that leg protectors increased the net risk of head and leg injuries. A later series of tests by the same organisation found that leg protectors were beneficial in 2 out of 7 tests, detrimental in 4 out of 7 test and made no difference in one test. Further tests by TRL reached the opposite conclusion, finding 'substantial benefits', and recommended further development and research.[68]

7.5 Airbags

Airbags are well-established for cars, but not so for motorcycles. Some research estimates that 25% of serious leg injuries, and up to 40% of serious and fatal head injuries, might be prevented by airbags.

There are many problems with applying airbag technology to motorcycles. The riders and vehicles vary widely in mass, the seating position of the rider, and the diversity in motion of both the rider and motorcycle, will all affect the outcome of the collision. There can also be compatibility problems between the airbag and the rider's helmet, due to helmet shapes also having wide design variations, which can result in a severe neck injury.

Airbags in cars are designed to absorb impact, whereas motorcycle airbags need to absorb (or partially absorb) impact and influence the trajectory of the rider (in order to raise the rider's head above the edge of the car roof and to direct the rider's body upwards to reduce the impact against the side of the car).

Motorcycle airbags need to be deployed more quickly (within the first 20ms of an impact) than car airbags and the impact detection systems that trigger a car airbag cannot be used on motorcycles for various reasons[11].

Motorcycle accidents involve a wide range of impact configurations, including frontal impacts where the motorcycle strikes an object head-on and side impacts where a vehicle strikes the motorcycle. Motorcycle airbags are likely to be useful in collisions of a motorcycle into the side or rear of another vehicle, and in oblique angle impacts.

The European Experimental Vehicles Committee report[69] reviewed a range of impact tests in which medium sized motorcycles were run into cars. Where airbags were not used the head of the dummy impacted against the edge of the roof. In tests with airbags the change in trajectory meant that head contact with the car was avoided completely, and the motorcyclist's body deflected into a higher movement path.

Not all research has been so positive. Some has suggested that airbags may increase injuries, particularly to the neck.[70]

However, technical solutions will be developed. Eventually, sensors will record the rider's position and weight and the impact speed, so that an adaptive airbag would deploy to protect the rider if the circumstances warranted it, having taken these variables into account. Airbags have the potential to reduce the severity of head, neck and torso injuries, which are the areas of a motorcyclist's body that are most at risk from suffering a fatal injury. When the technology is ready, manufacturers should be encouraged to fit airbags as standard through the range of bikes.

7.6 Tyres

The tyres are the only part of the motorcycle in contact with the road. The type and condition of tyres on a motorcycle have a significant effect on the vehicle's handling, steering, cornering, braking and stability. It is essential that the correct type of tyres is used and they are kept in a good condition at the correct pressure all the time and replaced as soon as necessary.[71]

Many manufacturers recommend specific tyres for their motorcycle. This ensures that the most suitable type of tyre for that particular machine is used, and riders should always use tyres recommended by the manufacturer when replacing them. It is also important that the tyres are suitable for the speed capability of the motorcycle and its load capacity.

Tyres need to be kept at the correct pressure (which may vary depending on whether a pillion passenger and/or fully loaded panniers are being carried). Over-inflated or under-inflated tyres will affect the safe handling of a motorcycle and may contribute to an accident. Tyre pressures should be checked at least once a week. Good tread depth is also crucial, especially in the wet. In the UK, the minimum tread depth for motorcycles over 50 cc is 1mm across ¾ of the width of the tread pattern and visible tread on the remaining ¼. For motorcycles up to 50 cc, all groves of the original tread pattern must be visible.[72] However, it is also important to replace tyres before they reach the minimum tread depth, and many have tread wear indicators in the tyres to show when the tyre should be replaced. Tyre manufacturers recommend a minimum tread depth of 2 mm.[73]

7.7 A concern increasingly expressed is that there appears to be a thriving after-market of products and services to help motorcycle owners adapt their motorcycles after they have purchased them. These adaptations often significantly change the capabilities and handling of the machines, which the rider may not fully understand or e able to cope with in all situations.

7.8 Motorcycle Design - Conclusion

Motorcycles are complex, powerful vehicles that have improved immensely over recent years. However, some of these improvements require further development and there remain a number of areas where the safety performance of motorcycles could be further improved.

In its Motorcycling Strategy, the Government has said that it will consider the potential for a consumer information assessment programme for motorcycles to assess whether it might lead to improvements in motorcycle safety in the way that the EURONCAP programme has led to significant improvements in car design.

8 THE ENVIRONMENT

Road Design is of particular importance to motorcycle riders since bad design features can increase risks to them. Features that are unnoticed by a car driver can be dangerous for a motorcycle rider. For example, features such as steel manhole covers positioned on the line round a bend, white paint on the road where a rider needs to change direction and loose grit gathering on the road surface can all prove dangerous if not lethal to motorcycle riders.

Therefore, it is important for engineers to consult with motorcycle riders at the design, implementation and safety audit stages to ensure that roads are easy for motorcyclists to read and have no sudden surprises.

The publication by the Institute of Highway Incorporated Engineers (IHIE) of Guidelines for Motorcycling[74] in 2005 was a significant and welcome development in ensuring that the needs of motorcyclists are considered when designing, constructing, changing and maintaining the road environment. It should help to educate engineers on the specific engineering needs of riders.

8.1 Road Surface

A good road surface with a high co-efficient of friction is of particular importance to a motorcycle rider, particularly when braking or cornering. A motorcycle also has different handling qualities because it has 2 wheels instead of 4. Engineers must take these differences into account when designing new roads, re-designing existing ones and doing safety audits. Being two wheelers, motorcyclists are more susceptible to difficulties and hazards created by the design, construction, maintenance and surface condition of roads. They are particularly vulnerable to

- changes in the level of friction of road surfaces
- pot holes
- uneven surfaces
- poor repairs to the surface
- spillages
- drain covers
- debris
- road markings.

Other road surface hazards include leaves which can appear dry but may be soggy underneath, tram tracks, gravel, melted tar in hot weather which may reduce tyre grip or roads that become greasy and slippery in summer during rainstorms.

Skidding

Skidding occurs in about 30% of the personal injury accidents in the wet for motorcycles[12], and as discussed in section 3.18, the accident risk for larger motorcyclists is greater on dry, rural roads.

Road Markings
Raised road markings can cause problems for motorcyclists, either by affecting their stability or by retaining water on the surface, resulting in a loss of adhesion between the tyres and the road. The use of bitumen for repairs can lead to difficulties, especially when the road surface is wet, as it leads to reduced friction and skid resistance. A better repair substance is needed to replace bitumen.

Maintenance
Maintenance is a particular safety issue for motorcyclists because of their need for a good road surface with a high co-efficient of friction. It is good practice for Authorities to set up and run a system where road users can report problems such as potholes. To maintain credibility the system must have good response times and reinstatement work must be done to a high quality.

8.2 Traffic Calming
Traffic calming is a proven, effective highway engineering measure to reduce speed-related accidents. It benefits all road users. Traffic calming features need to be effective in reducing motorcyclists' speed while at the same time not inadvertently causing additional hazards to two wheelers. For example, traffic calming measures should be sited far enough away from junctions and bends so that they can be approached with the motorcycle vertical. It is essential that traffic calming design guides provide suitable advice and options for achieving this balance. They also need to be well maintained and visible under all lighting and weather conditions.

8.3 Street Furniture
Street furniture may hinder visibility and cause serious injury to motorcyclists who collide with objects while sliding along the road after an accident. Street furniture should be as far back from the road as possible, and where necessary, protected by appropriate fencing, that does not itself cause an injury hazard to motorcyclists.

8.4 Crash Barriers
Crash barriers are a concern for motorcyclists. They tend to be tested using four wheel vehicles, and present certain hazards to motorcyclists. Exposed parts of support posts concentrate impact forces on the motorcyclist's body, and the edges of horizontal beams or wire rope may cause laceration injuries.

The European Experimental Vehicle Committee reported[75] that one study of motorcycle accidents involving crash barriers found that 15% of motorcyclist fatalities were caused by a direct impact of the rider against the barrier. A study in France[76] found that collisions with crash barriers accounted for 8% of motorcyclist fatalities, and 13% of fatalities on rural roads. It also found that collisions with crash barriers were more likely to result in the motorcyclist being killed than other types of accidents.

The British Motorcyclist Federation[77] believes that smooth, featureless barriers, such as concrete or water-filled ones cause the least problems for motorcyclists. Barriers with energy absorbing protectors are also being developed which could lessen injuries suffered by motorcyclists colliding with them. Barriers should be tested with both two and four wheel vehicles. Highways Authorities are now installing motorcycle-friendly barriers at key sites.

8.5 Bus Lanes

The government's advice on bus lanes[78] recommends against allowing motorcycles to use bus lanes, although Local Authorities can permit them if they choose. For several years now, motorcycle groups have called for motorcyclists to be allowed to use bus lanes, along with pedal cyclists and taxis, and several Local Authorities have allowed them to do so. The results of these trials have not yet been published, but interim data has not identified any safety problems created by motorcyclists being allowed to use bus lanes.[79] The Department for Transport is currently considering its position regarding the use of bus lanes by motorcyclists. Pedal cycle organisations are opposed to motorcyclists being allowed into the bus lanes.

RoSPA has not supported the use of bus lanes by motorcyclists. However, this policy will be reviewed once the results of the various trials have been published.

8.6 Advanced Stop Lines

Advanced Stop Lines for pedal cyclists are now commonly provided at junctions. They are designed to allow the cyclist to stop in a position where he or she can be clearly seen by drivers. As with bus lanes, motorcycle groups are now seeking to be allowed to use the Advanced Stop Lines as well. Not surprisingly, pedal cyclist groups strongly oppose this.

A number of trials are underway which Transport for London is monitoring, although the results to date have been inconclusive.[80]

8.7 Bends and Night-time Crashes

Accidents on bends on non-built-up roads, and night time accidents are a particular problem for motorcyclists. Design solutions to reduce these risks should be considered, especially at sites, routes and areas where accident data indicates that there is a motorcycle accident problem.

8.8 The Environment - Conclusion

Although not a major cause of motorcycle accidents, motorcyclists are particularly vulnerable to road surface hazards and it is essential that the needs and particular vulnerability of two-wheelers are considered carefully by highway designers, engineers and that high standards of road maintenance are provided.

9 CONCLUSION AND POLICY STATEMENT

Motorcycling is an increasingly popular form of transport. However, motorcyclists are also one of the most vulnerable road users. Despite forming only 1% of road traffic, motorcyclists account for 20% (one in five) of road deaths and serious injuries.

In 2004, 585 motorcyclists were killed on the road, 6,063 were seriously injured and just under 19,000 were slightly injured. Motorcyclist casualties had been rising since the late 1990s, because motorcycling has increased, but 2004 saw a significant drop in the number of motorcycle users killed and injured, although motorcyclist mileage also fell.

Much of the increase in motorcyclist casualties may be due to the increase in the amount of motorcycling. The rate of motorcyclist killed or seriously injured casualties per billion kilometres travelled in 2004 had fallen by 23% from its 1994 - 98 level. Nevertheless, motorcyclist casualty rates are much higher than other road users.

The vast majority (93%) of motorcyclist casualties are riders, with passengers forming just 7% of casualties. Motorcyclist casualties are predominately male.

The two age groups with the highest risk are younger riders, aged 16 to 19 years, on mopeds and small engine motorcycles, and riders aged 20 to 49 years, but particularly those aged 30 to 39 years, on larger machines.

Almost three quarters (72%) of motorcyclist casualties occur on built-up roads (roads with a speed limit of up to 40 mph), even though such roads carry less than half of motorcycle traffic. However, 59% of motorcyclist deaths occur on non built-up roads, 38% on built-up roads and 2.5% on motorways. The reverse is true for moped users: 64% of moped deaths occur on built-up roads and 36% on non-built-up roads. The fatality rate for motorcyclists is much higher on rural roads than on urban roads.

Motorcyclist casualties are highly seasonal. Fatalities and overall casualties peak during the Spring and Summer months, which reflecting increased riding during this period.

The vast majority of motorcycle accidents occur in fine weather and on dry roads.

There are a number of common types of crashes involving motorcyclists:

- Failure to negotiate bends on rural A roads
- Collision at junctions
- Collision while overtaking
- Rider losing control without another vehicle being involved.

Bends
This tends to be the fault of the rider, often because s/he approaches the bend too fast and/or mis-judges the curve of the bend. They occur more often on leisure rides. Riders involved in this type of accident are more likely to be inexperienced.

Junctions
This tends to be the fault of a driver who fails to see a rider who was in clear view (and was often seen by other road users). In about 12% of these cases, the driver failed to see the motorcyclist even though s/he was wearing high visibility garments or using daytime running lights.

Overtaking
This usually involves poor overtaking by a rider, although it also includes riders 'filtering' through stationary or slow moving traffic, in which case it is a driver who is more likely to be at fault.

Losing Control
Almost one in five (18%) motorcycle accidents involve the motorcyclist losing control, without any other road user being involved. They are due to rider error, poor road surfaces and avoiding other road users. They seem to be more common on rural roads and often linked to excessive speed, alcohol, other impairment or careless/reckless behaviour.

Education and publicity measures should focus on these types of crashes, and include riding on rural as well as urban roads.

Age and Experience
The two age groups with the highest risk are younger riders, aged 16 to 19 years, on mopeds and small engine motorcycles, and riders aged 20 to 49 years, but particularly those aged 30 to 39 years, on larger machines. The main change in motorcyclist fatalities since 1994/98 has been a large increase in deaths among 30 to 49 year old riders.

Training
The rider's skills, training, experience and attitudes are fundamental to safe motorcycling (although by no means the only issues). One of the key approaches to improving motorcyclist safety is to ensure that riders receive appropriate training when they start (or re-start) to use a motorcycle, that they receive further training as they progress in their riding careers, especially as they progress from smaller to larger motorcycles.

The motorcycle training industry in Britain is "very fragmented", with many small training organisations, a wide range of different training qualifications and many different types of courses. Motorcyclists receive relatively little formal training, and many graduate from smaller to larger machines without taking any further training.

Research is underway to investigate current training courses, identify good practice and develop guidelines for standardising the core elements of pre- and post-test motorcycle training. Hopefully, this research will plug a significant gap in our knowledge of most effective types of motorcyclist training.

Statutory Register of Motorcyclist Instructors

A weakness of the motorcycle training system is the lack of a statutory register to ensure that motorcyclist instructors are trained, tested and monitored to minimum, national standards (similar to the one for car driving instructors). This has been recognised in the Government's Motorcycling Strategy and research is being conducted to develop training competencies and professional qualifications for motorcyclist trainers. A voluntary registration scheme will be set up by the DSA. Subject to an evaluation of its effectiveness, this should become a compulsory register.

Learners need to be encouraged and helped to take an adequate level of training between CBT and the motorcycle test. The Government has the power to make such training compulsory, but at present is seeking to encourage riders to take training rather than force them to do so.

Post-Test Training

Recent years have seen significant developments in rider training. The Driving Standards Agency (DSA) is also working with motorcycling training providers to develop national standards for post-test training for all motorcyclists with full licences, particularly newly qualified riders, riders returning to motorcycling after a long break and riders who are changing to larger, more powerful machines.

The Pass Plus scheme (which provides extra supervised lessons after the car driving test) should be extended to novice motorcyclists.

Motorcyclists should be encouraged and helped to continue to develop their riding skills and abilities, especially as they progress from smaller to larger machines. To this end, Bikesafe schemes, post-test rider development training and advanced motorcyclist training should all be promoted widely.

Following the model of Driver Improvement Schemes, Rider Improvement Schemes for motorcyclists are being developed and evaluated. The measures in the Road Safety Bill to provide powers for driver training courses (that would apply equally to drivers and motorcyclists) to be offered for more serious offences are supported. Speed Awareness courses are being offered by some Police forces to drivers who exceed the speed limit by small amounts. Good practice guidelines for a national scheme have been developed and such schemes will be available to motorcyclists as well as drivers.

Fitness to Ride
Riders of two-wheeled motor vehicles are probably more susceptible (than drivers) to anything that impairs their riding ability, especially alcohol, drugs and medicines and fatigue. However, there is no evidence that motorcycle accidents involving these factors are more prevalent than such accidents involving drivers.

Alcohol
In 2004, 423 motorcyclists failed breath tests, and 14% of riders who died were over the drink drive limit. However, motorcyclists are less likely to fail breath tests than car drivers, and a lower proportion of motorcyclists killed on the road were found to have been over the limit, compared with car driver fatalities

It goes without saying that motorcyclists should refrain from drinking any alcohol and riding.

Drugs and Medicines
There is no evidence to suggest that this is a greater problem for motorcyclists than for drivers, but the same issues relate to both groups. An In-depth Study of motorcycle CCIDENTS found that drugs were involved in less than 0.25% of motorcycle crashes where the rider was wholly or partly to blame. However, a different study of fatal accidents involving motorcyclists found that 13% of the riders had been impaired by alcohol or drugs or both.

Motorcyclists should not ride if they feel affected by medicines (including some everyday medicines) or illegal drugs, or if they are taking medicine or undergoing any medical treatment which advises against driving or riding. Appropriate guidance from medical practitioners and pharmacists, and warning labels on medicines, are essential. Positive advice about alternatives to riding and advice to return to the GP if side-effects are experienced are just as important as warnings not to ride if affected by the medicine, or by the illness. Current developments in roadside tests for drugs and/or impairment should apply as much to motorcyclists, as to drivers.

Fatigue
A tired motorcyclist is more likely to crash. Motorcyclists may have an increased susceptibility to fatigue because of noise, vibration and exposure to weather conditions. However, fatigue was involved in only 4 of 1,790 motorcycle accidents analysed in a study of motorcycle crashes.

It is more difficult for motorcyclists to find a safe place to stop and sleep and so they may be more tempted to keep going on long journeys. Riders should avoid starting a long distance ride after having worked a full day, and should take a break about every two hours. Riders who begin to feel tired should stop somewhere safe, take drinks containing strong caffeine and take a short nap. If sleepiness persists, they should find somewhere to stop overnight.

Inappropriate Speed

Almost half of motorcyclists exceed the speed limit on 30 mph built-up roads (over half of car drivers do so) and over one third of motorcyclists exceed the speed limit on 40 mph built-up roads (compared with 27% of cars). On non-built-up single carriageway roads with the national speed limit of 60 mph, 25% of motorcyclists exceeded the limit (compared with only 10% of car drivers), and on non-built-up dual carriageways almost half of motorcyclists exceed the 70 mph speed limit. On motorways, 59% of motorcyclists exceed the speed limit, with 28% going faster than 80 mph.

Most motorcycle accidents occur at relatively low speeds, although fatal and serious injuries are more likely to be suffered at higher speeds.

Built-up roads with speed limits of 40 mph or less have the highest casualty rate for motorcyclists. However, only one third of motorcyclist deaths occur on these roads. 60% of deaths occur on non-built up roads with speed limits over 40 mph.

Over one third (38%) of the motorcyclists involved in fatal accidents in one study were considered to have been speeding before the collision. Another study identified misjudging the speed required to negotiate a bend as the most common cause of motorcycle only crashes.

Speed management should be directed to both high and low speed motorcycle riding.

Helmets

Motorcycle helmets are a proven, effective safety measure that reduces the risk of receiving head and brain injuries in an accident. All motorcyclists should wear an approved motorcycle helmet whenever they ride.

As effective as motorcyclist helmets are, they can be improved. Research is underway to improve the standards for helmets and visors, and to develop ones that can provide protection in a wider range of impact speeds. Improvements in motorcycle helmets will save even more motorcyclists' lives.

Riders should not wear tinted glasses, visors or goggles if riding in the dark, dusk or conditions of poor visibility. In daylight they should not use tints that are below the legal minimum levels of light transmittance. It is important that visors and goggles are kept clean, and replaced if they become heavily scratched as scratches which may distort the view, cause dazzle from oncoming vehicle headlights or cause sun glare.

Noise levels are a problem for motorcyclists. They can damage a rider's hearing, and may prevent the rider from hearing audible signals, such as horns, sirens and traffic. The easiest way for most motorcyclists to achieve a reduction in noise levels is to wear earplugs that conform to the appropriate British Standard. Riders using earplugs for the first time should monitor their speed carefully since the earplugs will reduce their level of feedback from the road environment.

VAT

Any future attempts to remove or reduce the UK VAT zero rating on motorcycle helmets should be rejected.

Protective Clothing

Good motorcycle clothing can protect motorcyclists from the wet and cold and from some types of injury. It is essential that it is comfortable to wear, does not impede the movements of the rider and provides protection from the elements - riders who are warm and dry are much more alert. European standards have been developed for motorcyclist protective clothing (which must be CE marked),and there is now a wide range of such clothing available. However, as with helmets, there are accidents and injuries from which the best protective clothing is unable to protect the rider.

High Visibility Clothing

Protective clothing that contains fluorescent and reflective material will increase the conspicuity of the rider, and hence help to reduce the likelihood of an accident occurring in the first place. Research is needed to establish the most effective type and format of high visibility garments for motorcyclists.

Other Road Users

Most motorcycle accidents involve a collision with another vehicle, usually with a car. Although, there is much that motorcyclists can do to avoid such collisions, the behaviour of drivers is equally crucial. There are many accidents in which the motorcyclist is using the road responsibly and safely, but is put at risk because a driver fails to do the same. Drivers need to be aware of the characteristics, needs and vulnerability of motorcyclists.

Motorcycle accidents at junctions in urban areas are usually the fault of drivers who fail to see a rider who is in clear view, and in some cases even wearing high visibility garments or using daytime running lights.

Government road safety publicity campaigns rightly target drivers with key messages to raise their awareness that they need to look out for motorcyclists, especially at junctions, and should continue to do so. It is essential that drivers are aware that motorcyclists may be present on any road, at any time.

Further research into the behavioural aspects of drivers in regard to motorcyclists is underway and hopefully will help identify further strategies to improve the attitudes, skills and behaviour of drivers towards motorcyclists.

Motorcycle Size

The term motorcycle encompasses a wide variety of vehicles, from small low-powered mopeds and scooters to large, high powered motorcycles capable of reaching speeds of 200 mph and more. As with cars, RoSPA does not believe that there is any justification for producing such powerful vehicles that can so easily reach speeds of more than twice the maximum speed limit.

Younger riders tend to ride smaller machines (100 – 250 cc) and older riders tend to ride larger motorcycles (500 cc and over, but especially 900 cc and above). Riders of more powerful motorcycles are associated with a higher proportion of accidents and casualties on non-built up roads, at night, on bends or while overtaking, and crashes due to speeding or other poor behaviour.

A Feasibility Study into the development of intelligent speed adaptation devices for motorcycles is needed.

Brakes

Braking, especially in an emergency, is one of the most difficult tasks of riding a motorcycle. Errors in braking may easily lead to skidding, capsizing or the vehicle becoming unstable. Incorrect use of motorcycle brakes is considered to be a factor in many motorcycle accidents. ABS brakes for motorcycles have been commercially available since 1988, and are now being fitted to a wide range of machines – a move which should be encouraged. Other advances in motorcycle brakes are being developed, including Combined Braking Systems (CBS) that operate both brakes and distribute the braking force to the front and rear wheels to improve stability when braking. It is important to ensure that riders understand how advanced braking systems work and receive training in their use.

Daytime Running Lights

Research suggests that motorcycles using specifically designed daytime running lights are more easily seen by other road users in daylight. Motorcyclists may voluntarily choose to use their headlights during the day to increase their conspicuity, and the Highway Code advises that using headlights during the day may increase motorcyclists' conspicuity.

Leg Protectors

Leg injuries are common amongst motorcyclist casualties, and often serious, leading to long term or permanent disability. Leg protectors have been suggested as a way of reducing such injuries. Unfortunately, research continues to produce inconsistent results, with some studies suggesting that they would reduce leg injuries, but others suggesting that they might even increase the risk of other injuries. Further research and development is required to establish the most effective design(s) for particular types of motorcycles.

Airbags

Airbags in cars are designed to absorb impact, whereas airbags for motorcycles need to absorb (or partially absorb) impact and influence the trajectory of the rider (to raise the rider's head above the edge of the car roof and to direct the rider's body upwards to reduce the impact against the side of the car). Initial research suggests that appropriately designed motorcycle airbags may be beneficial in reducing injuries to motorcyclists, but further development is required to produce effective, practical and affordable systems for different types of motorcycles.

Tyres

The type and condition of tyres on a motorcycle have a significant effect on its handling, steering, cornering, braking and stability. It is essential that the correct type of tyres is used and they are kept in a good condition at the correct pressure all the time and replaced as soon as necessary.

Motorcycle Assessment Programme

The EURONCAP programme that crash test cars and rates them on the results has led to significant improvements in car design, and raised the public's awareness of the importance of considering safety issues when choosing a new car. A similar programme for motorcycles may also lead to consumer-led and competition-driven improvements in motorcycle design.

Road Design
Road Design is of particular importance to motorcycle riders. Features that are unnoticed by a car driver can be dangerous for a motorcycle rider. For example, steel manhole covers positioned on the line round a bend, white paint on the road where a rider needs to change direction and loose grit gathering on the road surface can all prove dangerous if not lethal to motorcycle riders.

Therefore, it is important for engineers to consult with motorcycle riders at the design, implementation and safety audit stages to ensure that roads are easy for motorcyclists to read and have no sudden surprises.

The Institute of Highway Incorporated Engineers (IHIE) Guidelines for Motorcycling was a significant and welcome development in ensuring that the needs of motorcyclists are considered when designing, constructing, changing and maintaining the road environment.

Road Surface
Motorcyclists are more susceptible to difficulties and hazards created by the design, construction, maintenance and surface condition of roads. It is essential that the particular needs and vulnerability of two-wheelers are considered carefully by highway designers, engineers and that appropriate road maintenance is maintained.

Road Markings
Raised road markings can also cause problems for motorcyclists, either by affecting their stability or by retaining water on the surface, which results in a loss of adhesion between the tyres and the road surface. The use of bitumen can cause problems for motorcyclists, especially when the road surface is wet, and therefore, alternative repair substances need to be developed.

Traffic Calming
Traffic calming is a proven, effective highway engineering measure to reduce speed-related accidents, and benefits all road users. Traffic calming features need to be effective in reducing motorcyclists' speed while at the same time not inadvertently causing additional hazards to two wheelers. They also need to be well maintained and visible under all lighting and weather conditions. It is essential that traffic calming design guides provide suitable advice and options for achieving this balance.

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Bus Lanes

The government's advice on bus lanes recommends against allowing motorcycles to use bus lanes, although Local Authorities can permit them if they choose. For several years now, motorcycle groups have called for motorcyclists to be allowed to use bus lanes, along with pedal cyclists and taxis, and several Local Authorities have allowed them to do so. Pedal cycle organisations are opposed to motorcyclists being allowed into the bus lanes.

Trials are underway and interim data has not identified any safety problems created by motorcyclists being allowed to use bus lanes. RoSPA has not supported the proposal for motorcyclists to be allowed to use bus lanes. However, this policy will be reviewed once the results of the various trials have been published.

Advanced Stop Lines

Advanced Stop Lines for pedal cyclists are commonly provided at junctions to allow the cyclist to stop in a position where he or she can be clearly seen by drivers. As with bus lanes, motorcycle groups are now seeking to be allowed to use the Advanced Stop Lines as well. Not surprisingly, pedal cyclist groups strongly oppose this. A number of trials are underway which Transport for London is monitoring, although the results to date have been inconclusive.

Bends and Night-time Crashes

Accidents on bends on non-built-up roads, and night time accidents are a particular problem for motorcyclists. Design solutions to reduce these risks should be considered, especially at sites, routes and areas where accident data indicates that there is a motorcycle accident problem.

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