DEKRA Automobil GmbH

ROAD SAFETY REPORT 2011
PEDESTRIANS AND CYCLISTS

Strategies to prevent accidents on Europe's roads

DEKRA

Accident numbers:
High risk potential for children and the elderly

Infrastructure:
Pedestrian crossings, cycle paths and street lighting

Vehicle safety:
Elements of active and passive safety

Visibly more safety

In the EU (EU 27) in 2010 there were an estimated 33,000 deaths resulting from road traffic accidents, approximately 40 per cent of which occurred in urban areas. Some 48 per cent of the road users killed in these accidents were pedestrians and cyclists. While there has been a clear downward trend in the numbers of pedestrians and cyclists killed in many EU countries, there cannot, however, be any talk of an all-clear. Children under 15 and elderly people over 65 are particularly at risk. Given that demographic trends are resulting in an ageing population, the latter will become, not only in Germany but elsewhere, an ever higher proportion of road users.

According to interim statistics from the Federal Office of Statistics (Statistisches Bundesamt), the number of road traffic deaths in Germany reached a historic low in 2010. The figure is likely to be 3,675, representing a significant reduction of almost 12 per cent compared with 2009, when 4,152 deaths were reported. This means that, although Germany fell short of the target set by the European Road Safety Charter, which was established in 2004, of reducing by half the number of deaths by 2010 compared to 2001 (6,977 deaths), by 47 per cent, it is on the right track. According to projections of the Federal Highway Research Institute (BASt), 520 pedestrians (2009: 591) and 375 cyclists (2009: 462) were killed in Germany in 2010. These two groups of road users still account for around 24 per cent of all road deaths.

For many years, DEKRA has shown a wide-ranging commitment to increased road safety, especially for pedestrians and cyclists. We were among the first to sign the EU Charter mentioned above and we are also offering our unstinting support for the action programme, which was re-launched as recently as July 2010, to further halve the number of road deaths by 2020 – one of the central objectives presented in the current EU Transport White Paper. DEKRA was also involved in the EU “APROSYS” (Advanced PROtection SYStems) project, which dealt with scientific and technological development in the area of passive safety. The project attached particular importance to improved protection systems in vehicles, including for pedestrians and cyclists.

Our experts are valued as competent discussion partners in national and international road safety fora, one of many examples being the FKT* Special Light systems Committee. In addition, our accident analysts are regularly called upon to determine the causes of road traffic accidents.

We must not forget either the Gulliver car campaigns conducted by DEKRA in many parts of Germany to show adults from which perspective children perceive cars and the risks attached to this perspective. In 2010, as part of the “Visibly more safety” campaign we were able to exceed the threshold of one million red caps with retro-reflective elements issued to children just starting school.

Also of interest in the context of this road safety report are the findings of a DEKRA survey conducted nationwide in spring 2011 on the coexistence of motorists and cyclists and increasing road safety for cyclists. Almost three quarters (73.1 per cent) of all respondents complained that cyclists frequently ignored traffic regulations. More than half (58.9 per cent) complained that motorists paid too little attention to cyclists. Just under half (49.1 per cent) even took the view that cyclists and motorists were often opponents rather than partners. This opinion was most often expressed by those aged between 25 and 39 (55.6 per

Dipl.-Ing. Clemens Klinke, Member of the Board of DEKRA SE and Chairman of the Management Board of DEKRA Automobil GmbH

cent) and least often by those aged 60 plus (35.9 per cent). 41.5 per cent complained that cyclists more often endangered pedestrians.

This report also discusses the relationship between drivers on the one hand and pedestrians and cyclists on the other, which, supported by facts and figures, was the focus of the survey. This is also true of infrastructure measures and vehicle technology systems relating to active and passive safety. Like the DEKRA Road Safety Report published last year this publication is intended first and foremost to create impetus and give advice. The aim of the report is twofold: firstly, to stimulate discussion among politicians, traffic and transport experts, manufacturers and scientific institutions and, secondly, to give advice to pedestrians, cyclists and all other road users to enable them, through their behaviour, greater risk awareness and compliance with safety standards, to further reduce the number of injuries and deaths on our roads.

* Fachausschuss Kraftfahrzeugtechnik des Bundesministeriums für Verkehr, Bau und Stadtentwicklung (Motor Vehicle Technology Committee of the Federal Ministry of Transport, Building and Urban Affairs)

IMPRINT

DEKRA Road Safety Report Pedestrians and Cyclists 2011

Publisher:
DEKRA Automobil GmbH
Handwerkstraße 15
70565 Stuttgart
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www.dekra.com
May 2011

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Layout: Florence Frieser, Simone Strobel

Publication: ETMservices, ein Geschäftsbereich der EuroTransportMedia Verlags- und Veranstaltungs-GmbH
Handwerkstraße 15 · 70565 Stuttgart
www.etmservices.de

Business Divisional Manager:
Thomas Göttl

Managing Director: Werner Bicker

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Translation: Martina Wütz

Picture credits: AXA Winterthur: page 12, 13, 23; A. Berg: p. 11, 16, 38, 40; ADFC: p. 48; ANWB/Vereniging: p. 24; J. Bilski: p. 54; BMVBS/F. Ossenbrink: p. 5; BMW: p. 11, 25, 45; Daimler: p. 45, 46, 47; DEKRA: p. 26–29, 37, 38, 42; A. Fischer: p. 8; Getty Images: p. 1 (A. Brown, Tim E. White); Hella: p. 46, 47; Hella/Volkswagen: p. 44; Hövding: p. 35; Imago: p. 3 (B. Friedel), 5 (Rust), 30 (P. Schneider), 32 (Steinach), 56 (F. Jason); I. Jüngst: p. 54; Krone: p. 55; T. Küppers: p. 3, 6, 8, 10, 14, 17, 19, 20, 21, 34, 35, 43, 48, 51, 52, 54; P. Maciejczak: p. 14; Scania/D. Boman: p. 55; Museum Kopenhagen: p. 7; W. Niewöhner: 39; M. Urban: p. 23; Volkswagen: p. 53; Wikipedia: p. 6; Archiv: p. 7, 34, 52.

Courtesy on the road – not only an ethical but also a legal requirement

How many driving licence holders we have in Germany can only be estimated. Reported figures range between 48 million and 54 million. So an impressive number of people living in this country once had to take a driving test. And paragraph 1 of the German Road Traffic Act features prominently in this test.

There, among other things, it is recalled that driving calls for constant courtesy to be paid to others and that every road user is required not to obstruct or inconvenience others more than is unavoidable. Unfortunately, this guiding principle is anything but omnipresent in the daily traffic situation on our roads. Indeed, every day many of us observe in some cases hair-raising examples of grossly inconsiderate and illegal behaviour. This is also true of the group of road users on which this report focuses: pedestrians and cyclists. We are also especially pleased with the rising popularity of cycling and our Ministry promotes it in many ways.

CONSISTENT PROSECUTION OF OFFENCES

However, elements that have a negative impact on the situation as a whole cannot be ignored. There is unmistakably a clearly visible group of cyclists who do not think that red lights, rules on the right of way, and even speed limits in urban areas apply to them as well. Adult cyclists in particular cause a nuisance by illegally cycling on pavements, harassing or even endangering the lives of, in some cases, elderly pedestrians. These cyclists are referred to in the press as "Kampfradler" (literally: combat cyclists).

Let me spell it out: that has to change if the public image of cycling is not to suffer! The competent national authorities responsible for prosecuting such offences are required to punish offenders rigorously.

It is a good sign that the number of pedestrians and cyclists killed on our roads has been falling consistently since 2000. However, our objective must be to significantly reduce the number of those injured and to increase the sense of security of the more vulnerable road users. It is the responsibility of all those who influence what happens on our roads – so every single one of us – to play our part in this.

All road users should make it a point of honour to meet the requirements of Section 1 of the German Road Traffic Act. Courtesy is a legal and, above all, social obligation!

Dr Peter Ramsauer, Federal Minister for Transport, Building and Urban Affairs

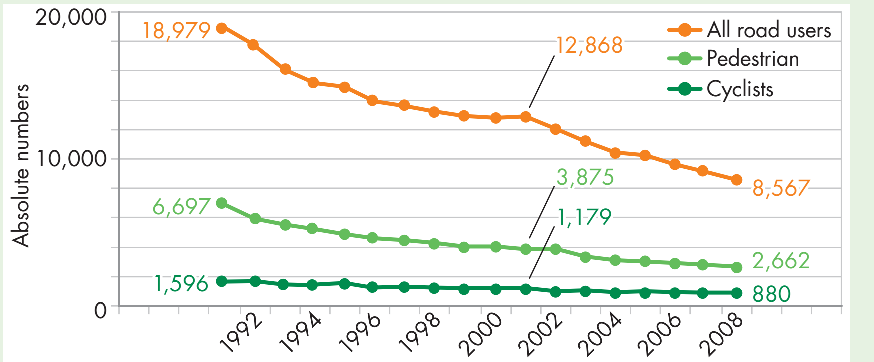
Where the weakest meet the strongest

Narrow roads, lots of cars, motorcycles, heavy goods vehicles, buses, trams, cyclists and pedestrians. Everywhere hustle and bustle and distraction. City traffic demands a great deal of all road users. Clearly too much when you look at the accident figures. Right across Europe approximately two thirds of all accidents occur in urban areas. Approximately 48 per cent of fatalities in city traffic are pedestrians and cyclists. Although accidents involving pedestrians and cyclists occur less frequently on country roads, the consequences, especially for pedestrians, are particularly serious. Urgent action is therefore needed, especially given changing mobility behaviour and demographic change.

Our towns and cities pulsate with life. There are people everywhere – on roads and pavements, in shops and squares. The traffic starts early in the morning: heavy goods vehicles delivering goods and unloading them at the verge of the road, the school run, cyclists, scooter drivers, motor-cyclists and motorists on their way to work. On top of this there are packed buses and trams. There is hustle and bustle throughout the entire day. Where there are people, mistakes happen. And, sooner or later, mistakes lead to accidents. Take Germany for example: according to the Federal Agency for Statistics in 2009 there were a total of 310,806 accidents resulting in personal injury, 213,361 of which, i.e. almost 70 per cent, occurred in urban areas.

1

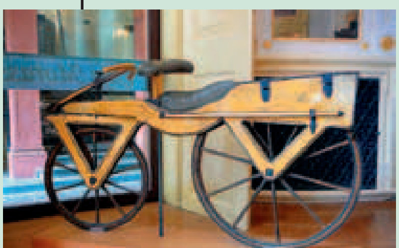
Deaths in accidents on urban roads (EU 15)



EU 15: Belgium, Denmark, Germany, Ireland, Greece, Spain, Finland, France, Italy, Luxembourg, Netherlands, Austria, Portugal, Sweden, United Kingdom*

Source: CARE EU Road Accident Database *England, Scotland, Wales and Northern Ireland

1817: Draisine, also known as 'running machine' (Fig. From approx. 1820). It was invented by the German Baron Karl von Drais in Mannheim in 1817. Being the first means of transport to make use of the two-wheeler principle, the Laufmaschine is regarded as the archetype of the bicycle.



1907: The oldest cycle path in Germany is the Offenbacher Alleenring with a structurally separated cycle path system, which was constructed in 1907.

1912: Installation of the first electrical traffic signal with red and green lights in the USA.

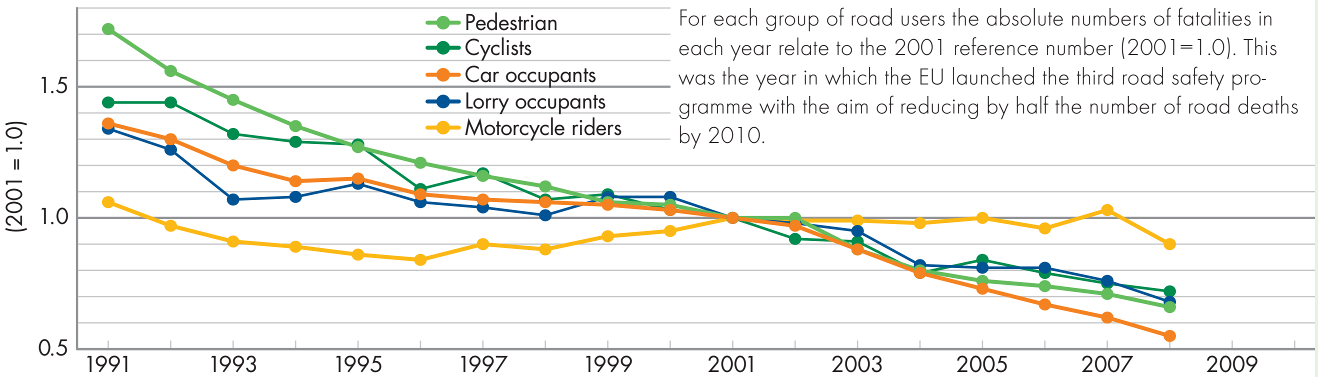
1914: The traffic light installation, which was erected on 5th August 1914 in Cleveland, USA, is the first regular traffic light in the world.

1815 | 1820 | 1900 | 1905 | 1910 | 1915

Safety-relevant milestones in the development of the motorcycle (selection)

2

Trend in road deaths (EU 15)



For each group of road users the absolute numbers of fatalities in each year relate to the 2001 reference number (2001=1.0). This was the year in which the EU launched the third road safety programme with the aim of reducing by half the number of road deaths by 2010.

EU 15: Belgium, Denmark, Germany, Ireland, Greece, Spain, Finland, France, Italy, Luxembourg, Netherlands, Austria, Portugal, Sweden, United Kingdom

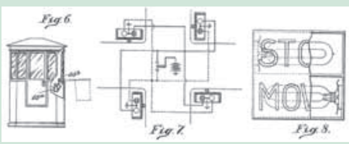
Source: CARE EU Road Accident Database (EU 15)

A comparison with other countries shows that these figures do not make Germany an isolated example. According to information provided by the Observatoire National Interministériel de la Sécurité Routière (National Interministerial Road Safety Observatory), for example, in France in 2009 around 70 per cent of accidents resulting in personal injury occurred in urban areas. In Italy, according to the Istituto Nazionale di Statistica (National Statistics Institute), in 2009 76 per cent of accidents resulting in personal injury occurred in urban areas. In Austria, according to Statistik Austria, the figure was just under 63 per cent and, in Spain, according to the Dirección General de Tráfico besi, it was 54 per cent.

Over the past few years, the numbers of pedestrians and cyclists fatally injured in the EU, particularly in Germany, have continued to fall (Figures 1 to 3). Yet they are some of the most vulnerable road users. On the basis of figures contained in the CARE 2008 database, they accounted for 48 per cent (EU-25) of road users fatally injured in accidents in urban areas. One of the main problems is that, being poorly protected and often inadequately illuminated, they are spotted

Dr Walter Eichendorf,
President of the German Traffic Safety Council

"Making road traffic safer for all road users in the spirit of Vision Zero is an ongoing task. Yet the 'more vulnerable' road users in particular need special protection and close attention. In 2009 more than 1,000 pedestrians and cyclists lost their lives on our roads. Many studies predict, for future mobility in Germany, a trend towards cycling and walking. This makes ecological sense and is beneficial to the health of road users – as long as they use the roads safely. It is therefore crucial to make special efforts to create the necessary infrastructure, including safe and convenient networks of walking and cycling paths. A major step towards improving the safety of vulnerable road users would be to reverse the establishment of the speed limit in urban areas: 30 km/h would become the general control speed in urban areas. However, the municipal authorities could introduce signage on all suitable roads for speed limits of 50, 60, 70 or even 80 km/h. Today, 50 km/h is the rule. 30 or 70 km/h speed limits must be signalled. Injuries to pedestrians and cyclists could be effectively prevented by changing the control limit. By providing suitable roads with signs indicating a 50 km/h or higher speed limit the flow of traffic would not have to suffer. This notwithstanding, every cyclist needs to be aware that he or she belongs to the group of vulnerable road users. Wearing a cycle helmet prevents head injuries or at least reduces their severity."



1917: The first automatic traffic signal is patented in the USA and the first traffic control tower is erected at an intersection in Detroit.

1921: The first road markings in the small English town of Sutton Coldfield to remove an accident black spot.

1931: The League of Nations in Geneva adopts the Convention on the Standardisation of Road Signs. It is ratified by 18 countries, but not by Germany.

1933: The first pedestrian lights in Europe are erected in Copenhagen, in Deutschland not until 1937 in Berlin.

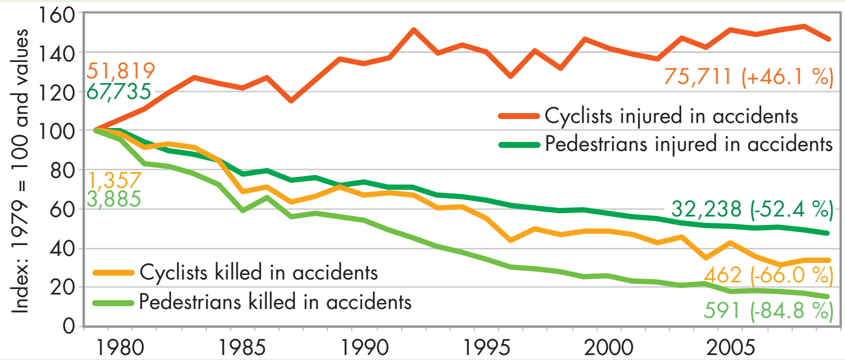
1920 1925 1930 1935 1940

Especially in town and city centres the bicycle has definitely become increasingly important as a recreational means of transport.

3

Pedestrians and cyclists killed in road traffic accidents since 1979 in Germany

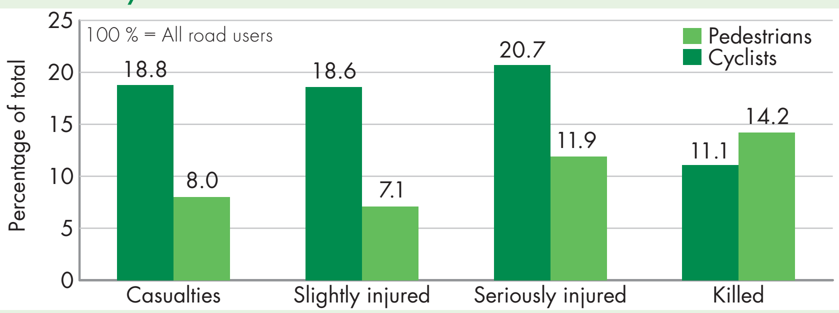
The numbers of cyclists and pedestrians killed in road traffic accidents and the number of pedestrian casualties (killed and injured) fell in Germany between 1979 and 2009. By contrast, the number of cyclists killed and injured increased.



Source: German Federal Agency for Statistics

4

Proportion of pedestrians and cyclists involved in accidents in 2009 in Germany



Source: German Federal Agency for Statistics

too late, or not at all, especially at twilight and at night. What is more, pedestrians and cyclists are often unaware of their role as the must venerable road users and of the risks associated with this. While the occupants of passenger cars and heavy goods vehicles in particular benefit from protective vehicle passenger compartments, safety belts, air-bags and driver assistance systems and fewer therefore are injured or die from year to year on the roads of Europe, the percentage of pedestrians and cyclists involved in accidents has remained at more or less the same high level. In the statistics relating to persons involved in accidents, vulnerable road users account for a relatively high share of almost 25 per cent throughout Europe.

DIVERSE ACCIDENT SITUATIONS IN URBAN AREAS

According to the figures of the Federal Agency for Statistics, since 1991 there has been a significant change in the distribution of road fatalities over the different modes of transport. While in Germany in 1991 17 per cent of all road fatalities were still pedestrians (1,918 out of a total of 11,300), this proportion fell to 14 per cent in 2009 (591 out of a total of 4,152). Conversely, the proportion of cyclists killed over the same period rose from 8.2 per cent (925 out of a total of 11,300) to 11 per cent (462 out of a total of 4,152) (Figure 4). This may well be due to the fact that, today, cycling is on the increase. This is also borne out by the cycle population, which increased over this period

1949: The pedestrian crossing or zebra crossing appears internationally for the first in the Geneva Protocol on Road Signs.

1952: The first zebra crossings are marked out in Germany.

1957: Introduction of a 50 km/h speed limit in built-up areas in Germany.

1961: In the GDR the traffic psychologist Karl Peglau invents the red-green pedestrian lights together with the traffic-light man.

1945 1950 1955 1960

by approximately 13 per cent to in excess of 80 million.

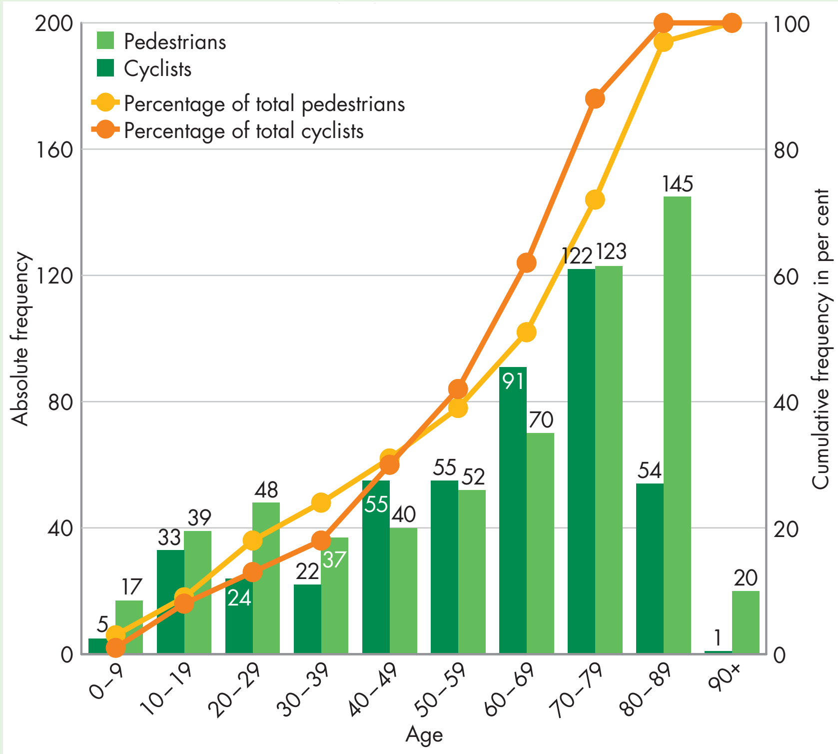
Elderly pedestrians and cyclists are most at risk (Figure 5). In 2009 in Germany, more than half the pedestrians killed and half the cyclists killed were over 65. By comparison, the over 65s make up only one fifth of the total population. Children are also a high risk group. Of children under 15 killed on the roads, 27 per cent were cyclists and 26 per cent were pedestrians, which is 53 per cent of all children killed in road traffic accidents.

In addition to the number of accidents, because there is a wide variety of road users on urban roads, the diversity of situations in which an accident is most likely to occur is correspondingly great. Parking cars, stop-and-go traffic, heavy goods vehicles with an open loading platform, bus-stops, cyclists, increasingly also drivers of e-bikes (electric bikes) with unexpectedly high acceleration, children at play, pedestrians suddenly crossing the road, clusters of traffic signs, viewing obstructions, poorly lit streets, sensory overload as a result of luminous advertising, and much more, require the full attention of all road users in urban areas.

This is particularly true given that a new source of danger on the roads has emerged in the form of e-bikes (electric two-wheeled vehicles, electric bicycles, electric motorcycles), in their stronger motorised version as electric mopeds. As well as the so-called pedelecs (Pedal Electric Cycle), which, with their rather low-level pedal-assist technology, pass for bicycles, there are now the, often identical, 'fast pedelecs' which, although mopeds, are often driven without the necessary type approval, compulsory insurance and without the prescribed full helmet. All these popular vehicles are currently experiencing a veritable boom, with sales figures doubling year on year. However, untrained drivers can achieve speeds of up to 45 km/h with the 'more potent version' of the e-bike, and this, in turn, poses the threat of misjudgement on the part of other road users. Motorists, seeing an elderly gentleman on a bicycle, may be forgiven for assuming that he is going along

5

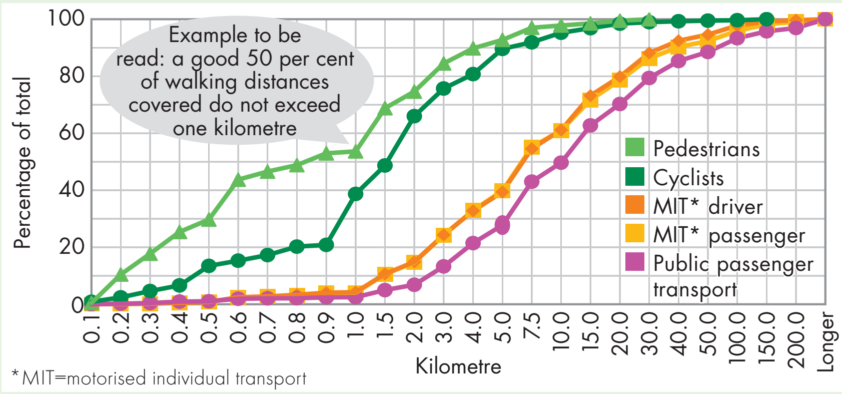
Fatally injured pedestrians and cyclists by age group in Germany



Source: German Federal Agency for Statistics

6

Travel distances by chief means of transport



Source: Result report entitled 'Mobility in Germany 2008', infas, DLR

1964: Priority for pedestrians on zebra crossings is introduced into the German Road Traffic Act on 1st June 1964.

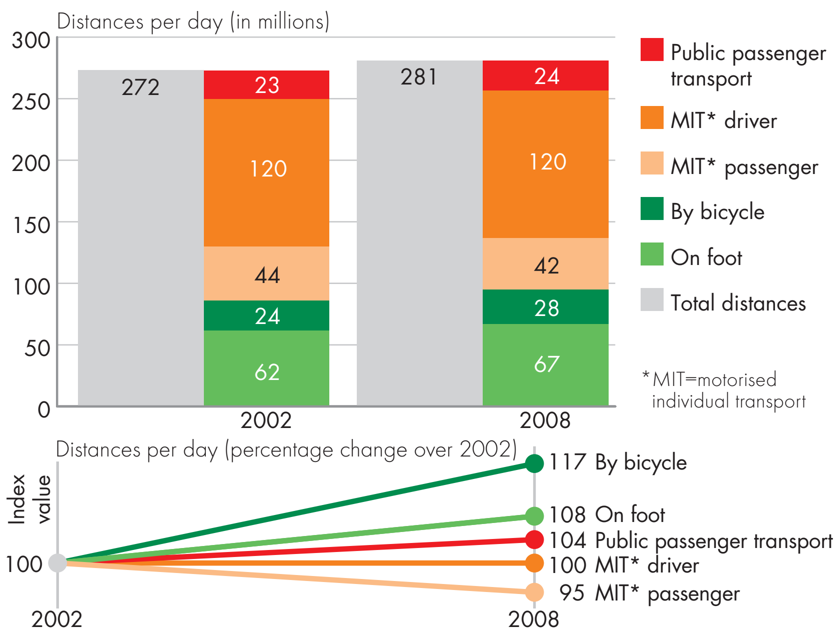
1968: The US Department of Transportation launches a programme to develop experimental security vehicles and initiates the international Technical Conference on the Enhanced Safety of Vehicles (ESV). Today, the conference takes place every two years.

1973: Introduction of the 0.8 per mill limit in Germany.

1979: A scientific working party of the Universities of Aachen, Berlin, Stuttgart and Darmstadt launches the UNI-CAR research project. The vehicle already had a 'soft face', which covered the entire front section, and kept the loads of an impacted pedestrian under tolerable biomechanical limits up to a speed of 45 km/h.

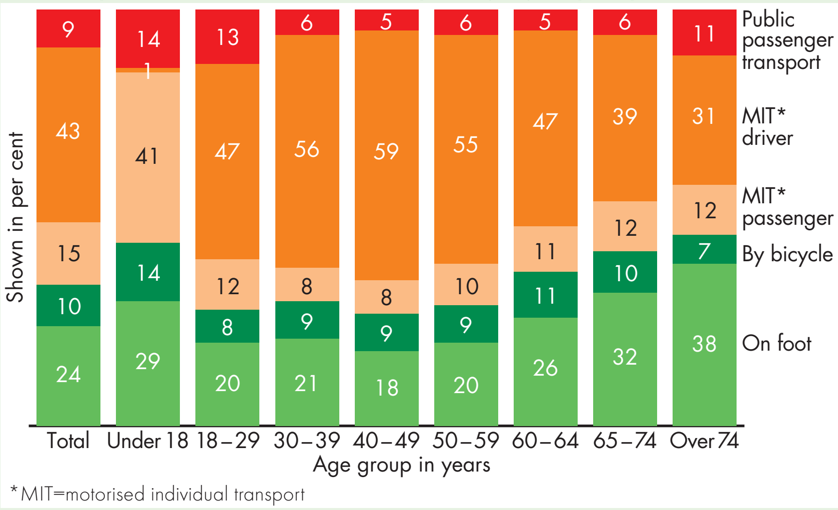
1965 1970 1975 1980

7 Volume of traffic by chief means of transport 2002 and 2008



Source: Result report entitled 'Mobility in Germany 2008', infas, DLR

8 Modal split of the volume of traffic per age group in per cent



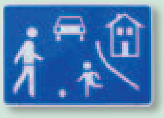
Source: Result report entitled 'Mobility in Germany 2008', infas, DLR

at a leisurely pace, but if he is riding an e-bike, he could be travelling at 40 km/h.

TRAFFIC AND VEHICLE DENSITY ON THE INCREASE

As far as the development of personal mobility is concerned, walking and cycling is increasingly becoming the means of local transport of choice for distances of up to five kilometres. This was the finding of a study entitled 'Mobility in Germany 2008', which was published by the Federal Ministry of Transport, Building and Urban Affairs (Figures 6 and 7). The study drawn up by infas Institut für angewandte Sozialforschung GmbH in Bonn in cooperation with the Institute for Transport Research of Deutsches Zentrum für Luft- und Raumfahrt e.V. in Berlin also states that shopping, errands and leisure activities account for two thirds of all journeys made. Journeys on foot and by bicycle represent a high proportion of journeys undertaken for purposes of recreation, shopping, education and private matters. However, the car is still the dominant means of transport both for journeys to the workplace and for urban business traffic.

Both in urban and non-urban areas, the other party most frequently involved in accidents in which pedestrians are killed is far and away the passenger car, followed by the commercial vehicle. All the parties involved face the enormous challenge of reducing the number and mitigating the consequences of such accidents even further through, among other things, appropriate measures taken in relation to vehicles and infrastructure – especially in view of the fact that vehicle and traffic density in the area of motorised private transport is likely to increase, especially in conurbations. A recent mobility study carried out by Shell in 2009 predicts that in Germany the car population is likely to rise to 49.5 million vehicles (currently 42 million) and that car mileage will increase to 590 billion kilometres (currently 588 billion) by 2030. At the same time, the demographic change of German society will continue apace. The



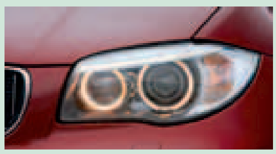
1980: Introduction of traffic-calmed zones into the German Road Traffic Act.

Between 1980 and 1990 reflectors on cycles are increasingly prescribed. Before 1980 only reflectors on the pedals and a small red reflector (cat's eye) at the rear were prescribed.

In 1992 a total of eleven reflectors at the front and rear and on the sides became obligator.

1983: Trial of 30 km/h zones in a pilot scheme.

1991: In a BMW 7 series car gas discharge lamps (Bosch) are offered as xenon lights in a car for the first time, initially only as dipped headlights.



1980 1985 1990 1995

proportion of over 65s in the population is expected to rise from today's 20 per cent to 28 per cent in 2030. In addition, the motorisation of women will increase from approximately 340 cars today to at least 430 cars per 1,000 women. A study carried out by Shell shows that both lower and higher age groups have the same status of motorisation (Figure 8). In particular, the motorisation of women in the over 50 age groups will increase considerably while that of older men will nonetheless increase slightly. This will result in increasing car motorisation and mobility in old age. Goods traffic will grow to an even greater extent than passenger car traffic on Germany's roads.

DRIVER ASSISTANCE SYSTEMS FOR GREATER PEDESTRIAN AND CYCLIST SAFETY

The increase in passenger car and heavy goods vehicle traffic will continue to put the most vulnerable road users at great risk. Both passenger car and heavy goods vehicle manufacturers have invested a lot of know-how and money in electronic driver assistance systems, which benefit pedestrians and cyclists in particular. Brake assist systems, collision warning with person recognition, the turning assistant for heavy goods vehicles, which monitors the blind spot in front of and at the side of the vehicle for pedestrians and cyclists and warns the driver accordingly, special night vision systems also with person recognition, and all-round camera surveillance systems with a warning function are just some examples. There are also passive safety measures such as optimised front parts, flexible bonnets and soft bumper systems, which are designed to help reduce the severity of the injuries sustained by pedestrians and cyclists. These aspects were also the focus of subproject 3 of APROSYS (Advanced PROtection SYStems) entitled Pedestrian and Cyclist Accidents, which is specifically devoted to the protection of pedestrians. 46 partners (universities, research institutions, suppliers and manufacturers), including DEKRA, took part.

Anyone who is used to right-hand traffic needs to be extremely careful in countries with left-hand traffic, even as a pedestrian.

The long since introduced lateral protection device for heavy goods vehicles for preventing cyclists or pedestrians from falling under the vehicle and in front of the rear wheels must not be forgotten in this connection. This notwithstanding, there is still a lot to do in terms of the safety of pedestrians and cyclists on our roads. To continue to make significant progress in this regard, the condition and the safety equipment of vehicles travelling on the road are just as important as human behaviour – whether at the wheel of a car or lorry, at the handlebar of a motorcycle, moped or cycle, on the pavement or when crossing from one side of a road to the other. Infrastructure of course makes an important contribution to increased road safety. Just a few aspects are cycle paths, zebra crossings, signs, Belisha beacons, light systems at road crossings, traffic signal installations, low-speed zones (30 kph) and traffic-calmed zones. The following chapters of this report show where there is a need for action and what countermeasures can be taken.

APROSYS Integrated Project on Advanced Protection Systems

APROSYS, the Integrated Project on Advanced Protection Systems, is concerned with scientific and technological developments in the domain of passive safety – focusing on human biomechanics, the crash performance of vehicles and infrastructure, and on protection systems for vehicle occupants, motorcyclists, pedestrians and cyclists.

1998: Introduction of the 0.5 per mill limit (without driving ban) in Germany. As of 1st April 2001 there will be driving bans and people will lose their driving licence if they have a blood alcohol level of more than 0.5 per mill.

2001: Since 2001, initially in the Mercedes CL, xenon high beam in the so-called bi-xenon headlamps. The same bulb is used for the dipped beam and high beam light. A shutter covering the beam path for the dipped beam is folded away and therefore the beam path is 'switched' to a high beam.

2004: The EU Commission launches the European Road Safety Charter. The declared objective is to halve the number of road deaths by 2010 compared to 2001.

25 000 LIVES TO SAVE European Road Safety Charter

2005: Entry into force of a European Directive on the construction of frontal structures of vehicles for the protection of pedestrians and other vulnerable road users (2003/102/EC). The Directive establishes limit values for the EU type approval of new types of vehicles not exceeding 2.5 tonnes which should not be exceeded in a collision between a vehicle and a pedestrian

2000 2005 2010 2015

High risk potential

In recent years the number of pedestrians and cyclists killed in road accidents has fallen considerably in most EU Member States. Nonetheless, pedestrians and cyclists are still the third and fourth biggest groups respectively – behind vehicle occupants and drivers of motorised two-wheelers – of road fatalities in Europe. Well over half the pedestrians and cyclists killed in road accidents lost their lives in urban areas, the most common other party being the passenger car. Children under 15 and elderly people over 65 are particularly at risk.

As vulnerable road users, pedestrians and cyclists are generally more at risk than vehicle occupants. Even when, for example, passenger cars, as the most common other party, travel comparatively slowly, injuries, some serious, are possible if there is a collision and pedestrians or cyclists collide with the front section of the vehicle and then collapse onto the road. The lighter weight of pedestrians and cyclists compared to that of vehicles is, according to the laws of physics, a further fundamental disadvantage. The danger lurks every day anew – especially given the fact that, according to the OECD, between 20 per cent and 40 per cent of all journeys are made on foot or by bicycle. Even though the numbers of pedestrians and cyclists killed on the roads have been falling for many years in most Member States, the statistics contained in the CARE database on accidents in Europe indicate that they continue to constitute a high proportion of all road deaths. According to CARE, in 2008 a total of 38,900 people were killed in road traffic accidents in the European Union (EU 27) (Figure 9). For 23 of the 27 Member States, CARE also shows the numbers of pedestrians and cyclists killed on the roads: 7,435 pedestrians died, which is 20.3 per cent of all fatalities on the roads. The number of cyclists killed on the roads in the 23 Member States is 2,395, which is 6.5 per cent of all road deaths.

On closer examination it emerges that, with 34.8 per cent, Romania has the high-

The CARE database

The CARE European Road Accident Database is a European Union database on road traffic accidents. It contains the statistics gathered by the EU Member States on individual accidents with ensuing loss of life in the countries concerned – broken down by road user, gender, means of transport, age of the road user killed and month in which the accident occurred. This high degree of individualisation enables detailed analyses of accidents to be carried out and provides a good basis on which to take targeted yet more efficient measures to increase road safety.

est proportion of pedestrian fatalities and, with 34.8 per cent, the Netherlands has the highest proportion of cyclist fatalities. In 2008 the majority of pedestrians were killed in Poland (1,882), while the majority of cyclists were killed in Germany (456).

EVOLUTION OF THE NUMBERS OF PEDESTRIANS KILLED

For the 10 Member States that, according to CARE, had the highest number of pedestrian fatalities in 2008, Figure 10 illustrates the evolution of the numbers since 1991. In Germany, the largest number of pedestrian fatalities was recorded in 1991 (1,918). By 2008, this figure had fallen by 1,327 to 591, a decrease of 69 per cent. In the United Kingdom, France, Spain and Italy the number of pedestrian fatalities fell significantly between 1991 and 2008. The unusual thing about Italy was that the number of pedestrian fatalities rose sharply between 1999 and 2002 and then fell right back again. Less satisfactory is the trend in Poland and Romania. For one thing, for both these countries CARE reports the greatest number of pedestrians killed on the road since 2003 in absolute terms; for another, no lasting downward trend is discernible in the progression of these figures. In Poland, as before, each year as many pedestrians are killed on the roads as in Germany in the early 1990s. In order to compare the relative fall in the numbers of fatally injured pedestrians, 2001 can be used as a starting point. In 2001 the Third European Road Safety Action Programme was launched. One of the objectives of this programme was to halve the number of people killed every year on the roads in Europe by the end of 2010. With a fall of 40.7 per cent (Figure 11), between 2001 and 2008 the number of pedestrians killed on the roads fell most appreciably in Spain, followed by Italy and France. When considered over the longer term, however, the exceptional result for Italy must be put into perspective. At the bottom of the table are Romania and Poland, where the number of pedestrians killed on the roads actually rose by 9 per cent. Seen as a whole, it is clear that, in order to reduce the numbers of pedestrian killed on the roads in the Europe Union, the positive trend in Member States such as Spain, Italy, France, the United Kingdom and Germany must continue in the future. In Poland and Romania, however, the potential to reverse the trend successfully through targeted road safety programmes is particularly great.

Car doors that open unexpectedly are a high accident risk for cyclists.

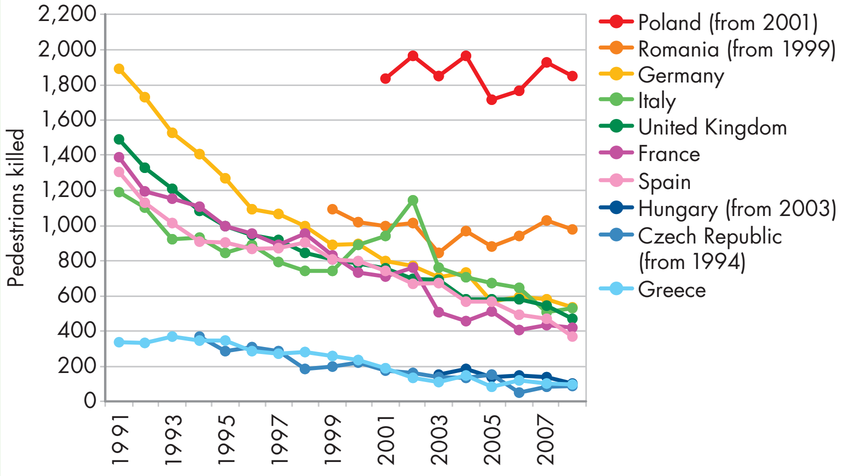
9 Road traffic fatalities in the EU (EU 27) in 2008

Number of road traffic fatalities (EU 27) as well as pedestrians and cyclists killed on the roads with their respective proportions in the individual Member States of the European Union on which relevant statistics are published in CARE (EU 23).

Country	Total number of deaths in road traffic accidents	Pedestrians killed	Proportion of pedestrians killed	Cyclists killed	Proportion of cyclists killed
Austria	679	102	15.0 %	62	9.1 %
Belgium	944	99	10.5 %	86	9.1 %
Bulgaria	1,061	n. d.	–	n. d.	–
Cyprus	82	n. d.	–	n. d.	–
Czech Republic	1,076	238	22.1 %	93	8.6 %
Denmark	406	58	14.3 %	54	13.3 %
Estonia	132	41	31.1 %	9	6.8 %
Finland	344	53	15.4 %	18	5.2 %
France	4,275	548	12.8 %	148	3.5 %
Germany	4,477	653	14.6 %	456	10.2 %
Greece	1,555	248	16.0 %	22	1.4 %
Hungary	996	251	25.2 %	109	10.9 %
Ireland	280	49	17.5 %	13	4.6 %
Italy	4,731	648	13.7 %	288	6.1 %
Latvia	316	105	33.2 %	15	4.8 %
Lithuania	499	n. d.	–	n. d.	–
Luxembourg	35	6	17.1 %	0	0 %
Malta	15	1	6.7 %	0	0 %
Netherlands	677	56	8.3 %	145	21.4 %
Poland	5,437	1,882	34.6 %	433	8.0 %
Portugal	885	155	17.5 %	42	4.8 %
Romania	3,061	1,065	34.8 %	179	5.9 %
Slovakia	558	n. d.	–	n. d.	–
Slovenia	214	39	18.2 %	17	7.9 %
Spain	3,100	502	16.2 %	59	1.9 %
Sweden	397	45	11.3 %	30	7.6 %
United Kingdom	2,645	591	22.3 %	117	4.4 %
EU 23	**36,705**	**7,435**	**20.3 %**	**2,395**	**6.5 %**
EU 27	**38,900**	n. d.	–	n. d.	–

Source: CARE EU Road Accident Database n.d.: no details

10 Pedestrians killed between 1991 and 2008 in selected Member States



Source: CARE EU Road Accident Database

Traffic signs indicating a crossing also sometimes impede

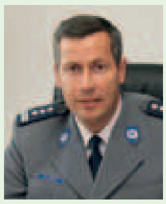
11 Trend in the numbers of pedestrians killed between 2001 and 2008 in selected Member States

State	Pedestrians killed in the year 2001	Pedestrians killed in the year 2008	Change Absolute	Change Relative
Spain	846	502	-344	-40.7 %
Italy	1,032	648	-384	-37.2 %
France	822	548	-274	-33.3 %
United Kingdom	858	591	-267	-31.1 %
Germany	900	653	-247	-27.4 %
Greece	338	248	-90	-26.6 %
Czech Republic	322	238	-84	-26.1 %
Hungary (2003 to 2008)	2003: 299	251	-48	-16.1 %
Romania	1,088	1,065	-23	-2.1 %
Poland	1,866	1,882	+16	+0.9 %

Source: CARE EU Road Accident Database

TREND IN THE NUMBERS OF CYCLISTS KILLED ON THE ROADS

As far as the cyclists killed on the roads are concerned, according to CARE, between 1991 and 2001 Germany had the highest numbers in absolute terms in all individual years (Figure 12). In 1991, 925 cyclists were killed. By 2008 this figure had fallen to 462, a drop of 50 per cent. Between 2002 and 2007 Poland recorded the highest number of cyclists killed on the roads. In 2008, with 433 cyclists killed on the roads in Poland, CARE recorded a lower number than for Germany for the first time. CARE recorded the third highest number of cyclists killed on the roads for Italy, where 458 cyclists died in 199, while in 2008 the figure was 288.



Inspector Marek Fidos, Manager of the Prevention and Road Traffic Bureau of the General Headquarters of the Police in Warsaw

"Over the last ten years the percentage of accidents involving pedestrians has fallen continuously – from 36.6 per cent in 2000 to 29 per cent in 2009. However, this status is still unsatisfactory. In 2009 1,477 pedestrians lost their lives and 12,328 sustained injuries on Polish roads. The majority of accidents with serious consequences for pedestrians occur in autumn and winter – partly as a result of factors such as the early approach of darkness, poor visibility and black ice. What is more, in 2009 there were 4,273 accidents involving pedal cyclists in Poland, with 370 pedal cyclists killed and 3,903 injured. The majority of accidents occurred in spring, as this is the time of year when most people use bicycles. The Polish police are therefore carrying out a whole series of activities to improve road safety. Such activities relate, for example, to the correct behaviour between pedestrians and motorists as well as the wearing of high-contrast clothing with reflective elements or fitting reflectors to cycles. Many campaigns are targeted directly at children and young people. Particularly noteworthy is the 'Arriving Safely by Bicycle' campaign, which has been running in the summer months for a couple of years now and is aimed at making cyclists more aware of the risks they run in road traffic and at improving compliance with the German Road Traffic Act. Another campaign deals specifically with the problem of limited visibility in autumn and winter. As well as having its own website this campaign is disseminated through advertising in the media, posters and through a TV commercial."

vision, especially when they are erected in such a way that a motorist is unable to see a pedestrian in good time.

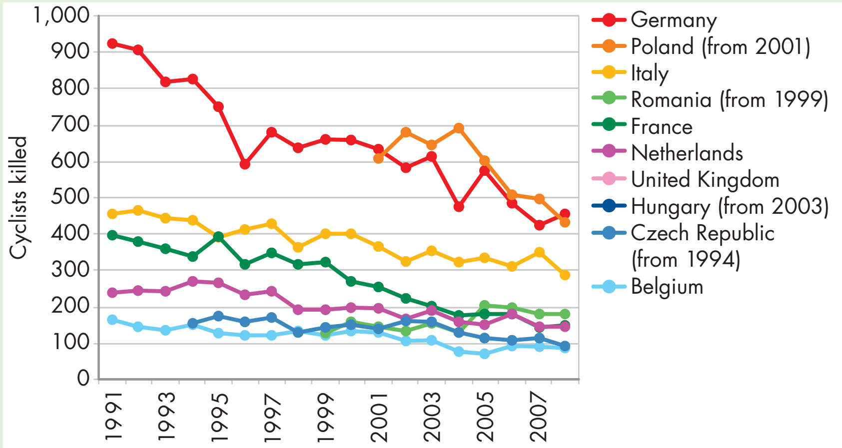
The fall in the number of cyclists killed on the roads between 2001 and 2008 was most apparent in France, where the numbers were down 42.2 per cent (Figure 13). In the shorter period from 2003 to 2008, the number of cyclists killed on the roads in Hungary fell by 38.8 per cent. Between 2001 and 2008, the second biggest drop in relative terms – down 34 per cent – was recorded in the Czech Republic, with Belgium in third place with a drop of 33.9 per cent. In Romania, however, the number of cyclists killed on the roads rose by 23.4 per cent. For a further reduction in these numbers throughout the EU, the long-term favourable trend in Germany needs to be sustained. It is also important that the fall in the number of cyclists killed on the roads observed in Poland since 2005 continues. A sustainable reduction in numbers must also continue in Italy. The longer-term trend in France can serve as a guide in this regard. The trend in the number of cyclists killed on the roads in Romania demonstrates the absolute need for the trend to be reversed.

KEY RISK FIGURES

When accidents involving pedestrians and cyclists are analysed to determine trends in absolute figures, reference is customarily made to population figures as well. Figure 14 contains the characteristic values calculated for 2008 with the available figures from the CARE database (EU 23) and the corresponding population figures published by EUROSTAT. From these figures the risk of inhabitants of a country being killed as cyclists or pedestrians in a road traffic accident is identified.

12

Cyclists killed between 1991 and 2008 in selected Member States

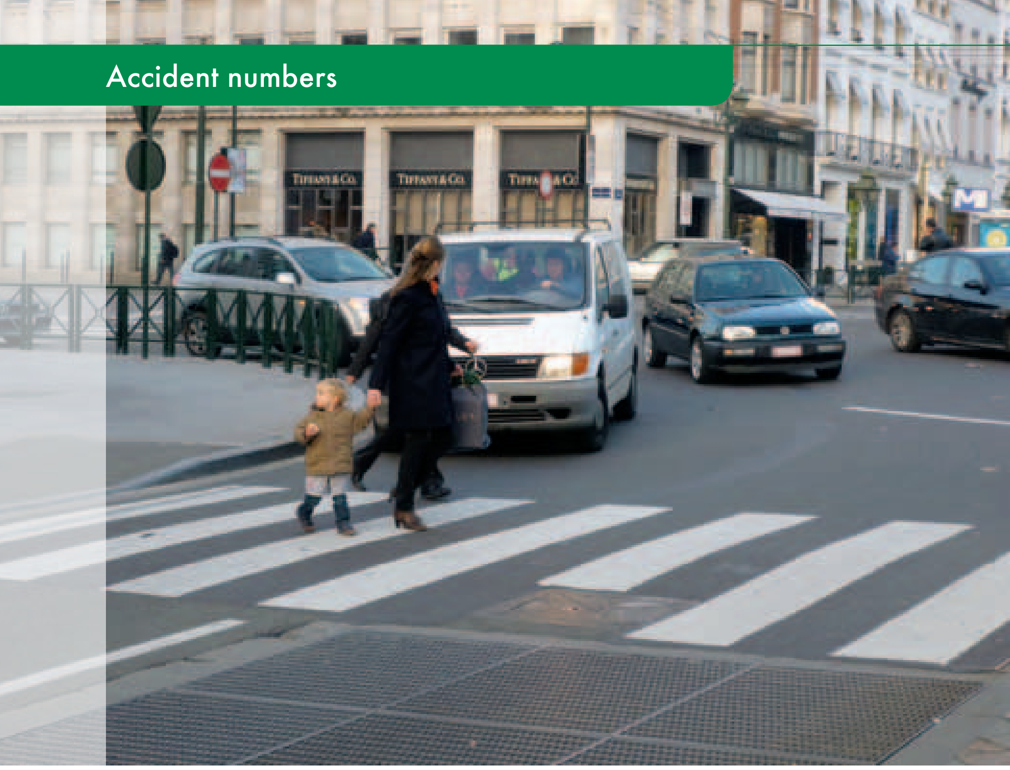


Source: CARE EU Road Accident Database

13 Trend in the numbers of cyclists killed between 2001 and 2008 in selected Member States

State	Cyclists killed in the year 2001	Cyclists killed in the year 2008	Change Absolute	Relative
France	256	148	-108	-42.2 %
Hungary (2003 to 2008)	in 2003: 178	109	-69	-38.8 %
Czech Republic	141	93	-48	-34.0 %
Belgium	130	86	-44	-33.9 %
Poland	610	433	-177	-29.0 %
Germany	635	456	-179	-28.2 %
Netherlands	195	145	-50	-25.6 %
Italy	366	288	-78	-21.3 %
United Kingdom	140	117	-23	-16.4 %
Romania	145	179	+34	+23.4 %

Source: CARE EU Road Accident Database



Where paths cross extreme caution and mutual consideration are of paramount importance.

On average, in the 23 EU Member States under consideration, more than 15 pedestrians and 5 cyclists per one million inhabitants are killed on the roads. Only in the Netherlands is the absolute number of cyclists killed on the roads (145) greater than the absolute number of pedestrians killed on the roads (56). This, too, means that the risk for cyclists in relation to the number of inhabitants (8.8 fatalities per one million inhabitants) is greater than the corresponding risk for pedestrians (3.4 fatalities per one million inhabitants).

These key figures alone are not, of course, a sufficient measurement parameter for the 'safety' of pedestrians and cyclists in the relevant States. This is because the proportion of the population who use the roads as pedestrians or cyclists has a significant impact. On the other hand, it

14 Key risk figures in 23 Member States of the EU in 2008

State	Inhabitants on 1st January 2008	Pedestrians killed in 2008		Cyclists killed in 2008	
		Absolute figure	Per 1 million inhabitants	Absolute figure	Per 1 million inhabitants
Austria	8,318,592	102	12.3	62	7.5
Belgium	10.666.866	99	9.3	86	8.1
Czech Republic	10,381,130	238	22.9	93	9.0
Denmark	5,475,791	58	10.6	54	9.9
Estonia	1,340,935	41	30.6	9	6.7
Finland	5,300,484	53	10.0	18	3.4
France	64,004,333	548	8.6	148	2.3
Germany	82,217,837	653	7.9	456	5.5
Greece	11,213,785	248	22.1	22	2.0
Hungary	10,045,401	251	25.0	109	10.7
Ireland	4,401,335	49	11.1	13	3.0
Italy	59,619,290	648	10.9	288	4.8
Latvia	2,270,894	105	46.2	15	6.6
Luxembourg	483,799	6	12.4	0	0.0
Malta	410,290	1	2.4	0	0.0
Netherlands	16,405,399	56	3.4	145	8.8
Poland	38,115,641	1,882	49.4	433	11.4
Portugal	10,617,575	155	14.6	42	4.0
Romania	21,528,627	1,065	49.5	179	8.3
Slovenia	2,010,269	39	19.4	17	8.5
Spain	45,283,259	502	44.8	59	1.3
Sweden	9,182,927	45	4.9	30	3.3
United Kingdom	61,191,951	591	9.7	117	1.9
EU 23	**480,486,410**	**7,435**	**15.5**	**2,395**	**5.0**

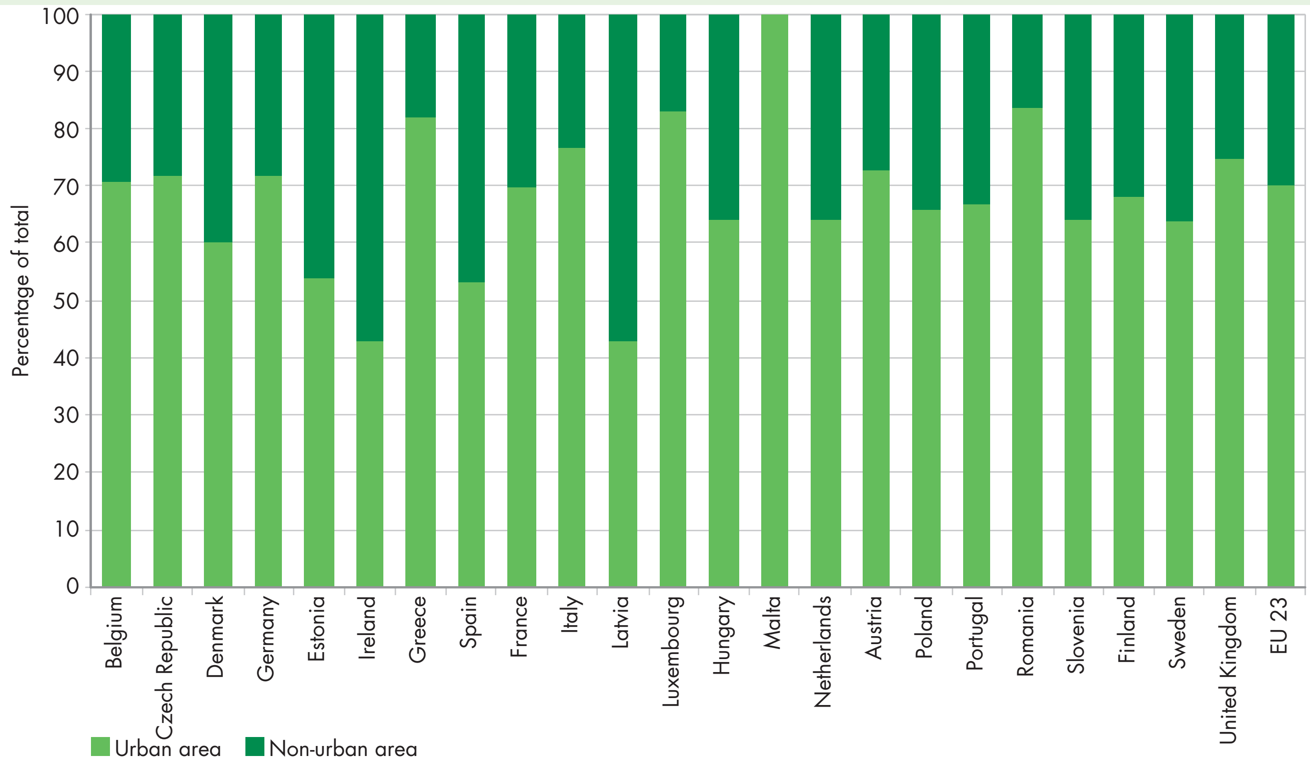
Source: CARE EU Road Accident Database. EUROSTAT

Crash test 2010 carried out by DEKRA and AXA Winterthur in Swiss Wildhaus: the collision with the opening door brings the electronic bike to an abrupt stop.

15

Proportions of pedestrians killed in urban and non-urban areas in 2008

Ireland (42.9 per cent) and Latvia (47.7 per cent) have the smallest proportion of pedestrians killed in urban areas. In all other States this proportion is over 50 per cent. The largest proportion of pedestrians killed in urban areas is in Romania (83.6 per cent), followed by Luxembourg (83.3 per cent), Greece (81.9 per cent), Italy (76.4 per cent) and the United Kingdom (74.8 per cent).

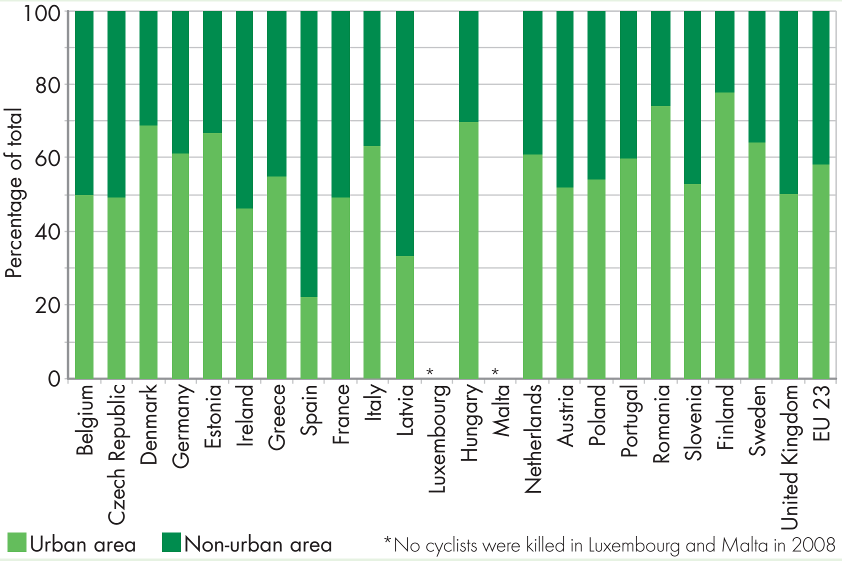


Source: CARE EU Road Accident Database

16

Proportions of cyclists killed in urban and non-urban areas in 2008

At 77.8 per cent the proportion of cyclists killed in urban areas was greatest in Finland, followed by Romania (74.3 per cent), Hungary (69.7 per cent), Denmark (68.5 per cent), Estonia (66.7 per cent), Sweden (64.3 per cent), Italy (63.2 per cent), Germany (61.0 per cent) and the Netherlands (60.7 per cent). The proportion of cyclists killed in urban areas was smallest in Spain (22.0 per cent), Latvia (33.3 per cent), Ireland (46.1 per cent), France (49.3 per cent), the Czech Republic (49.5 per cent) and Belgium (50.0 per cent). In the remaining States this proportion was over 50 per cent.



Source: CARE EU Road Accident Database

can be inferred from a higher-than-average key risk figure that there is a certain need for action to improve the safety of pedestrians and cyclists.

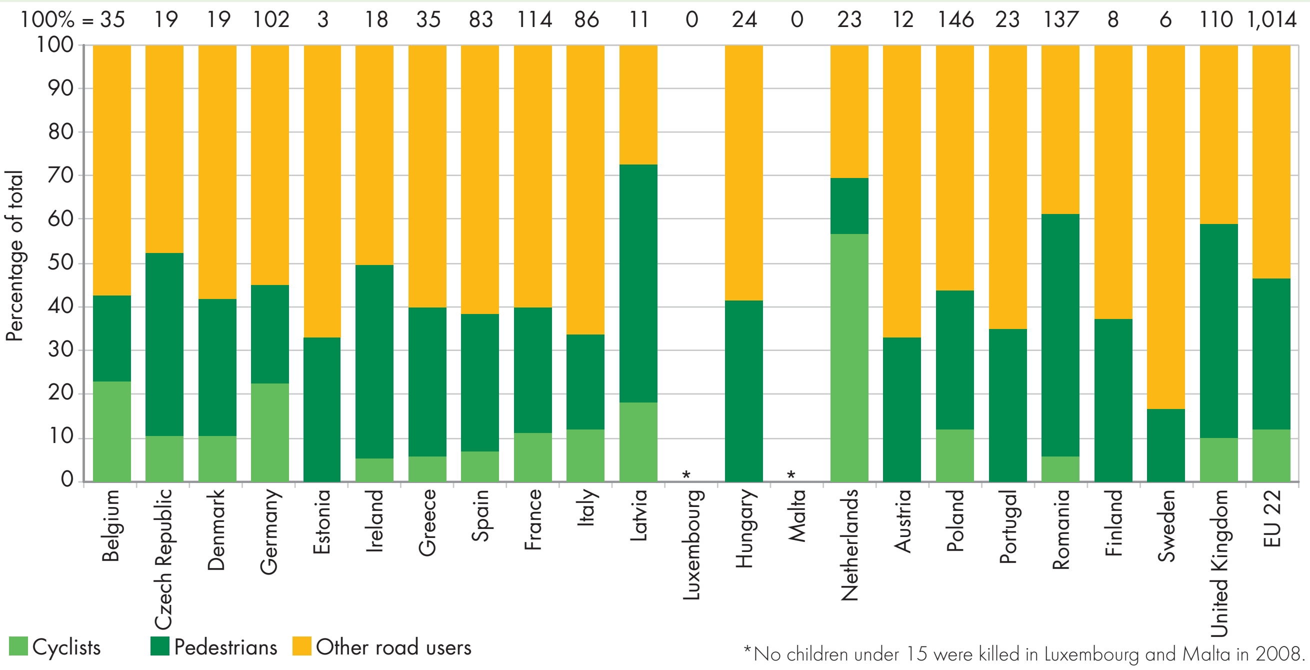
WHERE ACCIDENTS TAKE PLACE

The tables published by CARE also say something about where accidents take place. In the 23 EU Member States for which data exist, 70.1 per cent of pedestrians (Figure 15) and 58 per cent of cyclists (Figure 16) lost their lives in accidents in urban areas. It is therefore clear why research projects and measures to protect pedestrians and cyclists primarily focus on urban areas. While many of the protective measures developed for urban areas can be implemented with every chance of success in towns, cities and municipalities throughout Europe, a different picture emerges for protective measures in non-urban areas, especially as regards the protection of cyclists. For a cyclist in Latvia, who cycles to work every day across country areas, other measures are necessary than for a mountain biker in Austria with sporting ambitions. Precisely because of this great diversity, it is necessary to investigate the local causes of accidents thoroughly and to establish appropriate countermeasures for non-urban areas.

17

Children under 15 killed on the roads as a proportion of road users in 22 Member States of the European Union in 2008

In 2008, the majority of children under 15 lost their lives in road traffic accidents in Poland. At 73 per cent, Latvia had the largest proportion of children under 15 killed as pedestrians or cyclists. The number of pedestrians killed as a proportion of all children under 15 killed was largest in Romania and in the United Kingdom, and the number of cyclists killed as a proportion of all children under 15 killed was largest in the Netherlands and Belgium.



Source: Federal Agency for Statistics with reference to the CARE EU Road Accident Database

Country roads are also not without risk, often of death, for cyclists due to the relatively high speeds at which cars travel.

AGE GROUPS PARTICULARLY AT RISK: CHILDREN AND THE ELDERLY

It can generally be said that pedestrians and cyclists in all age groups are at high risk of being involved in a road traffic accident. However, children under 15 and elderly people over 65 are particularly at risk. The statistics in the CARE database leave no doubt about this. In the 22 Member States of the European Union on which relevant statistics exist, in 2008 1,014 children under 15 were killed, 355 children

Traffic signs often block the view of children.

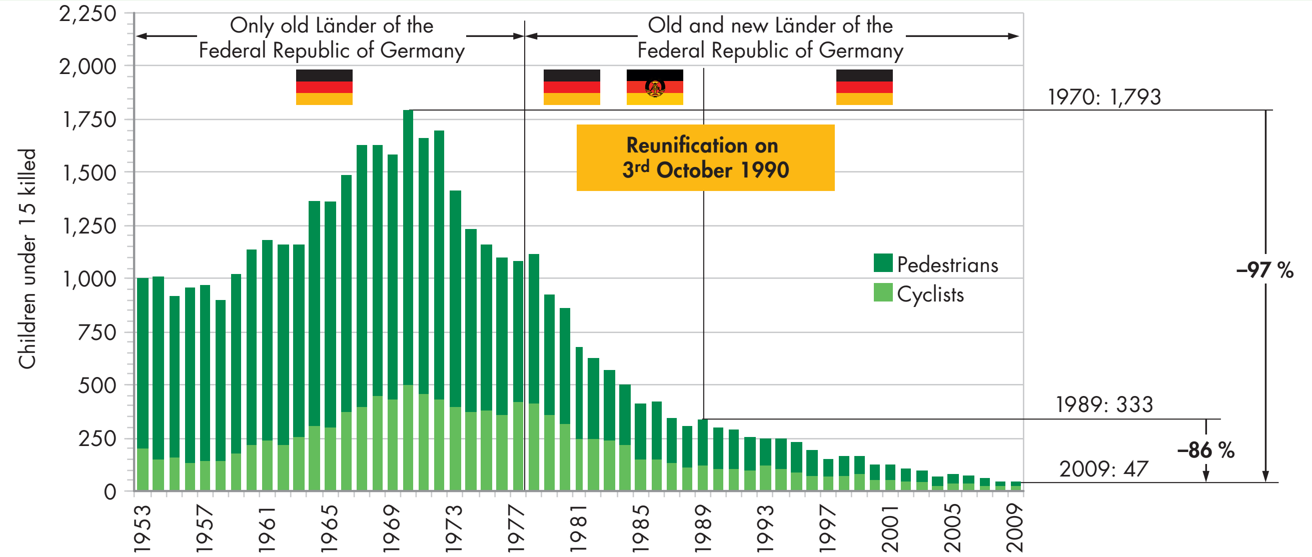
18 Children under 15 killed as pedestrians or as cyclists in 22 Member States of the European Union (EU 22)

State	Inhabitants under 15 (millions)	Pedestrians killed under 15	Pedestrians killed per million inhabitants under 15	Cyclists killed under 15	Cyclists killed per million inhabitants under 15
Austria	1.278	4	3.1	0	0.0
Belgium	1.800	7	3.9	8	4.4
Czech Republic	1.477	8	5.4	2	1.4
Denmark	1.010	6	5.9	2	2.0
Estonia	0.199	1	5.0	0	0.0
Finland	0.895	3	3.4	0	0.0
France	11.810	33	2.8	13	1.1
Germany	11.282	23	2.0	23	2.0
Greece	1.601	12	7.5	2	1.3
Hungary	1.509	10	6.6	0	0.0
Ireland	0.905	8	8.8	1	1.1
Italy	8.367	19	2.3	10	1.2
Latvia	0.312	6	19.2	2	6.4
Luxembourg	0.088	0	0.0	0	0.0
Malta	0.067	0	0.0	0	0.0
Netherlands	2.936	3	1.0	13	4.4
Poland	5.901	47	8.0	17	2.9
Portugal	1.629	8	4.9	0	0.0
Romania	3.279	76	23.2	8	2.4
Spain	6.620	26	3.9	6	0.9
Sweden	1.542	1	0.7	0	0.0
United Kingdom	10.737	54	5.0	11	1.0
EU 22	75.244	355	4.7	118	1.6

Source: CARE EU Road Accident Database

19

Historical development of children under 15 killed as pedestrians and cyclists on the roads in Germany between 1953 and 2009



Source: Federal Agency for Statistics

as pedestrians (= 35 per cent) and 118 as cyclists (= 12 per cent). That is a total of 473 fatalities, which is 47 per cent. Just as relevant as the absolute figures are the numbers of fatalities in relation to the population figures of the relevant age group. These figures correspond to the risk of being killed, as a pedestrian or cyclist, in the State concerned. Such key figures for children under 15 for, again, 22 Member States of the European Union can be calculated on the basis of the available data from the CARE database (Figure 18). Accordingly, per one million habitants in this age group, on average just under five children under 15 were killed on the roads as pedestrians and just under two children under 15 as cyclists. In both categories, the figures recorded in Denmark, Latvia, Poland and Romania were above these average values. There is, therefore, an urgent need for target-group oriented measures to be implemented, particularly in the especially high-risk EU Member States.

ACCIDENTS INVOLVING CHILDREN UNDER 15 IN GERMANY

Despite considerable progress in recent years, the example of Germany shows how necessary it is to take appropriate steps to reduce the numbers of children under 15 who are killed or injured on the roads. According to the latest report by the German Federal Agency for Statistics, in Germany one child under 15 is injured, on average, every 17 minutes and one

The Gulliver car campaigns conducted by DEKRA in many parts of Germany are intended to show adults from which perspective children perceive cars and the risks attached to this perspective.

child is killed, on average, every four days. In 2009, 30,845 children under 15 were involved in accidents on German roads, 90 of whom were killed. Of these, 27 per cent were cyclists and 26 per cent were pedestrians (Figure 20). In relation to the all-time high in 1970 (1,793 fatalities, only the old Länder of the Federal Republic of Germany) the number of children under 15 killed as cyclists or as pedestrians fell by 97 per cent; in relation to the relative maximum value of 333 fatalities for the new and old Länder in 1989, the year preceding reunification, the number fell by 86 per cent (Figure 19).

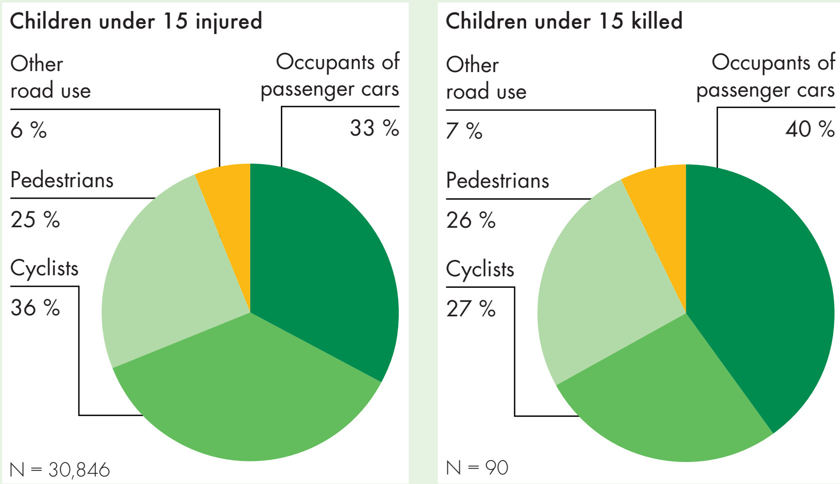
When crossing a road, children often do not pay attention to the traffic.

ELDERLY PEOPLE OVER 65 ARE ALSO AT HIGH RISK

Taking the statistics from the CARE database once again as a basis, in the 22 EU Member States for which data exist, 7,379 elderly people over 65 were killed on the roads in 2008 (Figure 21). That is 20.2 per cent of all 36,454 road users killed in the same year in the 22 Member States. In the age group under consideration, 2,956 elderly people lost their lives as pedestrians, 928 as cyclists and 3,495 as other road users (for the most part as occupants of passenger cars). The proportion of fatally injured pedestrians and cyclists in the age group was therefore 52.6 per cent. A closer scrutiny of the key risk figures (Figure 22) shows that, in the 22 EU Member States more than 36 elderly people over 65 were killed on the roads as pedestrians and more than 11 elderly people over 65 were killed

20

Types of road use by children under 15 injured or killed in accidents in 2009 in Germany

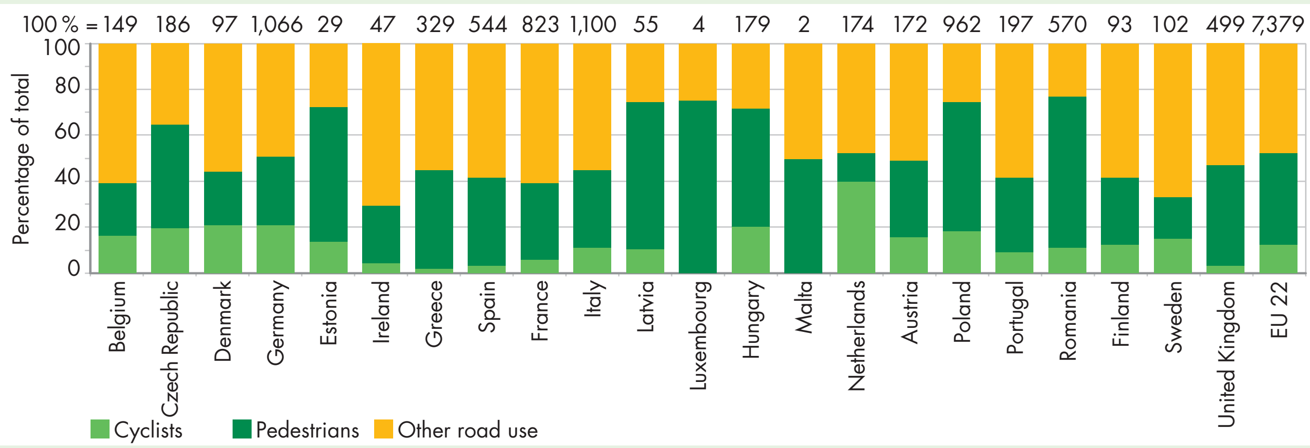


Source: Federal Agency for Statistics

21

Elderly people over 65 killed on the roads as a proportion of road users in 22 Member States of the European Union in 2008

In 2008, the majority of elderly people over 65 lost their lives in road traffic accidents in Italy (total of 1,100 elderly people, 368 as pedestrians and 126 as cyclists). In second place was Germany with 1,066 elderly people over 65 killed, 325 of whom were pedestrians and 218 cyclists. At 78 per cent, Romania had the largest proportion of elderly people over 65 killed as pedestrians or cyclists. Here, 570 elderly people in this age group lost their lives, 280 as pedestrians and 63 as cyclists.



Source: Federal Agency for Statistics with reference to the CARE EU Road Accident Database

22 Elderly people over 65 killed as pedestrians or cyclists and associated inhabitant numbers of the age group concerned and key risk values related to these inhabitant numbers

State	Inhabitants over 65 (millions)	Pedestrians killed over 65	Pedestrians killed per million inhabitants over 65	Cyclists killed over 65	Cyclists killed per million inhabitants over 65
Belgium	1.818	34	18.7	24	13.2
Denmark	0.853	23	27.0	20	23.5
Germany	16.519	325	19.7	218	13.2
Estonia	0.230	17	73.6	4	17.4
Finland	0.875	28	32.0	11	12.6
France	10.492	268	25.5	51	4.9
Greece	2.090	142	67.9	5	2.4
Ireland	0.478	12	25.1	2	4.2
Italy	11.946	368	30.8	126	10.6
Latvia	0.391	35	89.6	6	15.4
Luxembourg	0.067	3	44.5	0	0.0
Malta	0.055	1	18.0	0	0.0
Netherlands	2.415	22	9.1	69	28.6
Austria	1.425	58	40.7	26	18.3
Poland	5.128	550	107.3	168	32.8
Portugal	1.671	66	39.5	17	10.2
Romania	3.203	380	118.6	63	19.7
Sweden	1.608	19	11.8	15	9.3
Spain	7.515	212	28.2	15	2.0
Czech Republic	1.512	84	5.6	36	23.8
Hungary	1.478	92	62.3	36	24.4
United Kingdom	9.433	217	23.0	16	1.7
EU 22	81.202	2.956	36.4	928	11.4

Source: Federal Agency for Statistics with reference to the CARE EU Road Accident Database

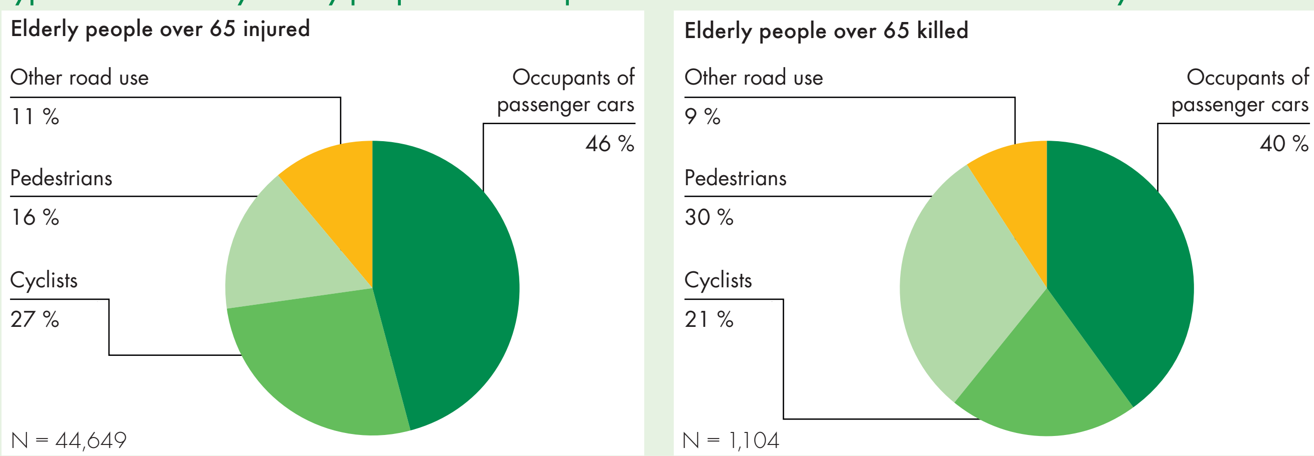
on the roads as cyclists – in each case in relation to one million inhabitants in this age group. In both categories, the figures recorded in Estonia, Latvia, Hungary, Austria, Poland, Portugal, Romania and Finland were above these average values. As with children under 15, target-group oriented measures need to be implemented for this age group.

ACCIDENTS INVOLVING ELDERLY PEOPLE OVER 65 IN GERMANY

Due to the democratic trend in Germany the significance of road traffic accidents involving older people is constantly increasing. At present, 20 per cent of the population of the Federal Republic of Germany belong to the over 65 age group. On 20th October 2010 the Federal Agency for Statistics published its latest special report entitled Road Traffic Accidents Involving Elderly People 2009. According to the report, in 2009 44,649 elderly people over 65 were involved in accidents on German roads, 1,104 of whom were killed. In relation to all 4,152 fatally injured road users in 2009 in Germany, the proportion of elderly people over 65 is now 27 per cent and therefore 7 per cent higher than their proportion of the population as a whole.

With regard to the ability to perceive and to perform on the roads as well as the general state of health, this group of elderly road users is identified as very heterogeneous. However, generally speaking, a person's physical resilience to accident loads decreases appreciably with increasing age. As elderly people frequently use the roads as so-called vulnerable pedestrians and cyclists, they are exposed to a relatively high risk and are seriously injured or even killed in accidents (Figure 23). Both in the case

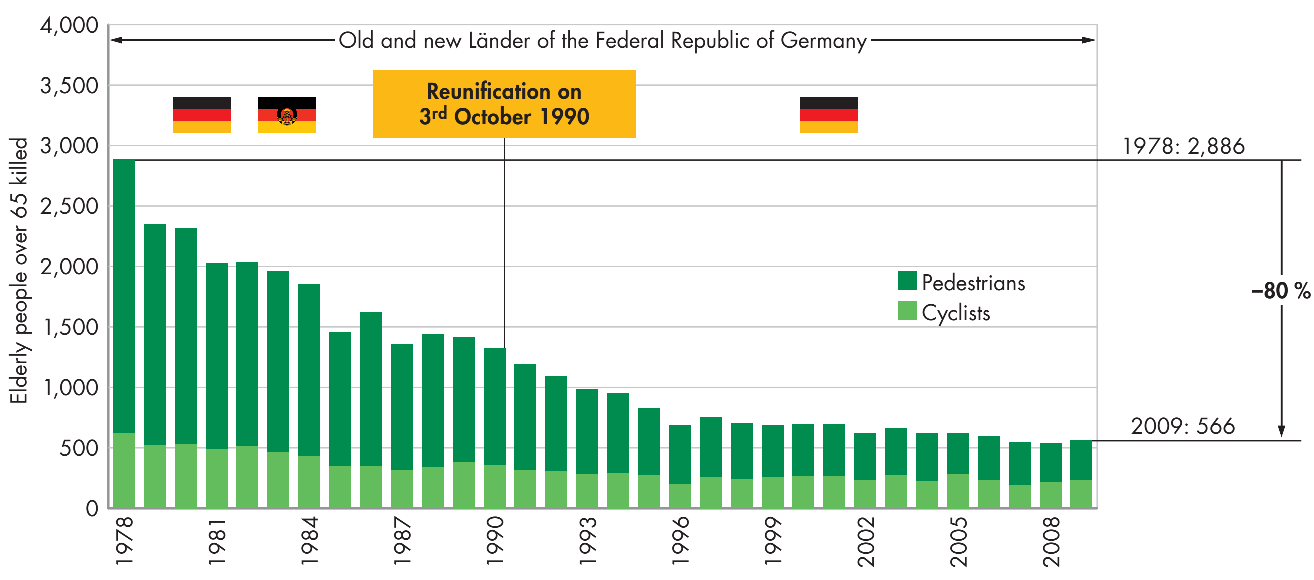
23 Types of road use by elderly people over 65 injured or killed in accidents in 2009 in Germany



Source: Federal Agency for Statistics

24

Historical development of elderly people over 65 killed as pedestrians and cyclists on the roads in Germany between 1953 and 2009



Source: Federal Agency for Statistics

Jack Short, Secretary General of the International Transport Forum of the OECD

"Walking and cycling are the simplest, cheapest and most environmentally friendly modes of transport. But just how safe is it here, in Europe, to get around on foot or by bicycle? Does the proven or perceived risk of accidents argue against this sustainable form of mobility? In Europe, walking and cycling are some eight to ten times more dangerous than travelling by car. In the OECD countries, pedestrians and cyclists account for between 14 per cent and 50 per cent of road deaths, with this proportion being even higher in less developed countries. Particularly in urban areas, speed restrictions are crucial in order to save human lives and to prevent serious injuries, to which young and elderly road users are exposed every day. Speeds of 30 kilometres an hour can reduce the risk of a pedestrian sustaining a fatal injury by over 80 per cent compared to a speed of 50 kilometres an hour. The introduction of a general speed limit of 30 kilometres an hour in towns and city centres and residential areas must therefore be given serious consideration. Walking and cycling are healthy, but they must also be safe. The safety and well-being of pedestrians and cyclists must therefore be considered a top priority by our governments in the planning and management of the road traffic network."

Jeroen van Dorp, ANWB – Royal Dutch Touring Club, The Hague (Netherlands)

"In the Netherlands there are 16.6 million inhabitants, 13.6 million cyclists and 18 million cycles. We have a long cycling tradition and cyclists are everywhere on the roads and in the squares in the Netherlands and are a permanent component of road traffic. That is good for our environment, reduces fuel consumption and, last but not least, improves the general level of public health. However, there is also the other side of the coin: in 2008, of the 720 road traffic fatalities, 145 were cyclists, which is 21 per cent, making it the biggest proportion of all cyclists killed on the roads in the 27 EU Member States. In its 'Policy orientations on road safety 2011-2020' the European Commission defined seven strategic objectives. These include improved education and training of road users, increased monitoring and enforcement of road rules, safer road infrastructure and better protection of vulnerable road users. Within the framework of these objectives we are developing in the Netherlands a two-pronged approach to improve the situation specifically for cyclists: adaptation and creation of an infrastructure, a transport system and a legal basis which take account of the differences between all road users; participation of each individual road user in this process and providing them with the necessary tools to take on this role."

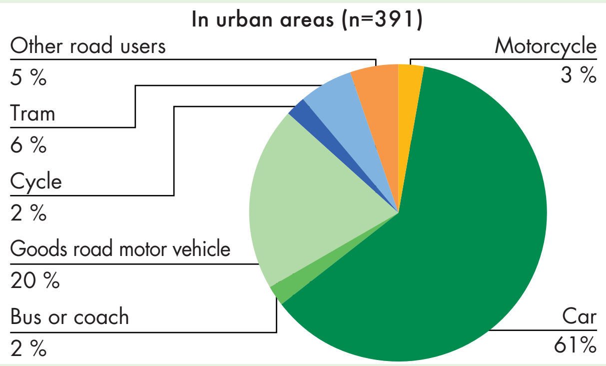
of elderly people over 65 who are injured and those who are killed on the roads, the proportion of pedestrians and cyclists together is over 50 per cent. Admittedly, compared to the all-time high in 1978, the number of elderly people over 65 who are killed on the roads as pedestrians and cyclists has fallen by 80 per cent.

OTHER PARTIES INVOLVED IN ACCIDENTS AND TYPICAL ACCIDENT SITUATIONS

Both in urban and non-urban areas, the other party most frequently involved in accidents in which pedestrians and cyclists are killed is far and away the passenger car, followed by the commercial vehicle. In third place, in accidents in urban areas in which pedestrians are killed, is the tram. This is worth mentioning because trams only run in a few cities and they are also frequently separated from other road traffic. What is striking in the case of accidents occurring both

25

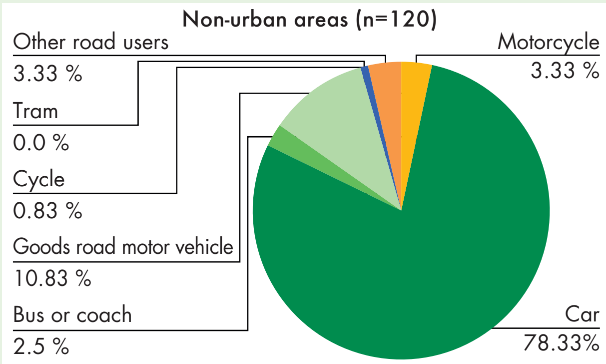
Other parties involved in accidents in which pedestrians are killed in urban areas in Germany in 2009



Source: Federal Agency for Statistics

26

Other parties involved in accidents in which pedestrians are killed in non-urban areas in Germany in 2009



Source: Federal Agency for Statistics

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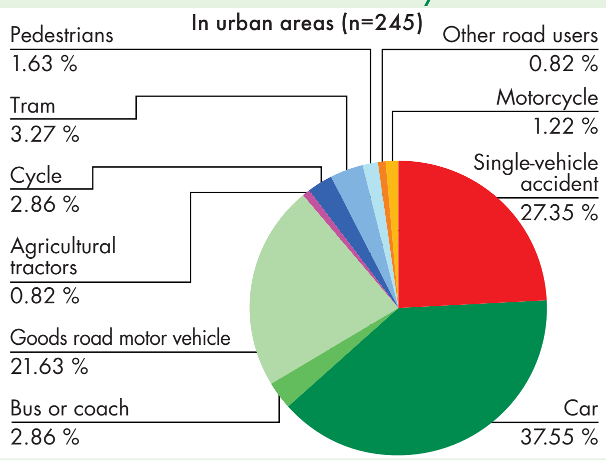
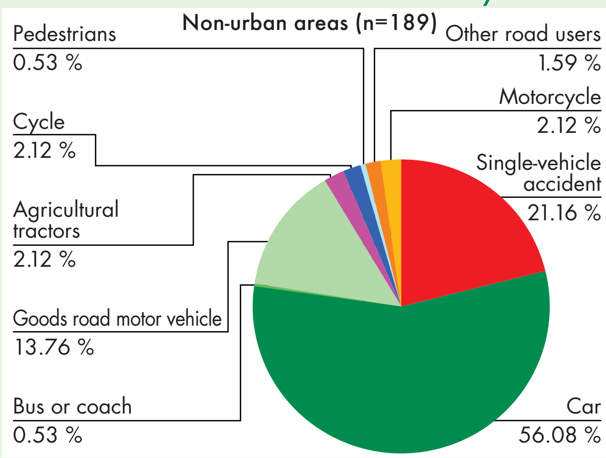
Other parties involved in accidents in which cyclists are killed in urban areas in Germany in 2009



Source: Federal Agency for Statistics

28

Other parties involved in accidents in which cyclists are killed in non-urban urban areas in Germany in 2009



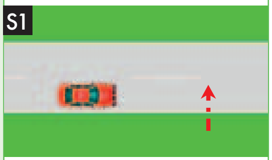
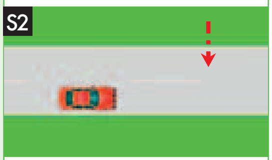
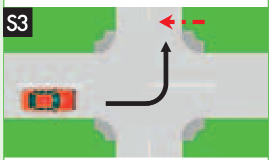
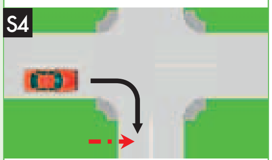
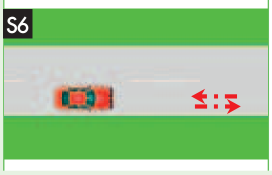
Source: Federal Agency for Statistics

in urban and non-urban areas in which cyclists were killed is the comparatively high proportion of accidents in which no other party was involved (Figures 25 to 28).

As far as accident situations involving pedestrians are concerned, the fFPS Initiative (forward-looking Frontal Protection Systems) analyses the databases of various institutions. The analysis identified six typical accident situations (Figure 29), which are to be found in all EU Member States. Although the clustering of the situations varies, the individual satiations themselves are found everywhere. The types of situation 'crossing pedestrian' on a straight road with and without obscuration (S1, S2 or S5) are most frequently documented internationally. Turning-off situations (S3 + S4) are to be found much less frequently than crossing accidents. The more typical situation for country roads and motorways involving a pedestrian walking along the edge of the carriageway is reflected in situation S6.

29

Typical accident situations involving pedestrians

Accident constellation	Description
S1 	Car travels straight ahead at a speed of 45 to 50 km/h, adult pedestrian (height: average 172 cm), crosses the road from the right at normal speed (5 km/h), driver reaction – braking manoeuvre.
S2 	Car travels straight ahead at a speed of 55 to 60 km/h, child pedestrian (height: average 120 cm), crosses the road from the left at running speed (10 km/h), driver reaction – braking manoeuvre, remarkably frequently during the dark or at twilight.
S3 	Car turning left at a speed of between 20 and 25 km/h, adult pedestrian (height: average 172 cm) crosses the road from the right at normal speed (5 km/h), driver reacts by braking.
S4 	Car turning right at a speed of between 10 and 15 km/h, adult pedestrian (height: average 172 cm), crosses the road from the right at normal speed (5 km/h), driver reacts by braking.
S5 	Car travels straight ahead, child pedestrian (height: average 120 cm) tries to cross the road from the right, speed of the car (>45 to 50 km/h), sight obstructed by parked vehicles, driver reacts with braking manoeuvre.
S6 	Car travels straight ahead, adult pedestrian (height: average 172 cm) moves in the same or in the opposite direction, typically darkness, car travelling at high speed (>70 km/h), often serious or fatal injuries.

Source: fFPS (forward-looking Frontal Protection Systems) working group

Children are often immersed in their own world – they are therefore at greater risk from approaching vehicles.

Striking examples of accidents in detail

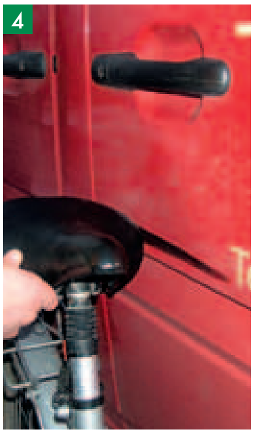
1 Final positions of the bicycle and the goods vehicle

2 Relative collision position of the bicycle and the goods vehicle

3 Damage to the bicycle

4 Rubbing mark caused by the saddle

5 Damage to the mirror caused by contact with the cyclist



Example 1

CYCLIST TURNS LEFT WITHOUT GIVING ANY HAND SIGNALS AND IS HIT BY A GOODS VEHICLE

The events leading up to the accident:
A goods vehicle was travelling along a main road in an urban area. A cyclist, who was travelling in the same direction on the cycle path running along the right verge of the road, suddenly turned left in order to cross the road. Even though the driver of the goods vehicle immediately took evasive action, the cyclist was hit and was so severely injured that he died on the spot.

Parties involved:
Goods vehicle
Cyclist

Consequences of the accident / injuries:
Cyclist fatally injured

Cause / problem:
When cyclists turn or change lane without giving any hand signals, this often takes the other, often much faster road users, by surprise. It is then often too late to prevent an accident by applying the brakes fully or by swerving.

Rear-view mirrors, which bicycles are generally not equipped with, can only be compensated for to a certain extent by a backward look over the shoulder, as the achievable angle of sight is not enough for the cyclist to see the entire relevant area behind the cycle. In this particular case, the cyclist was under the influence of alcohol. He sustained the fatal injuries on impact with the road. He was not wearing a helmet.

Accident prevention / motivation for road safety measures:
Only the timely and clear indication of a change of direction or lane can alert other road users to the impending manoeuvre. This is true not only for the hand signals given by cyclists but also for all drivers. For cyclists, too, a backward look over the shoulder prior to a change of direction or lane is crucial. Driving under the influence of alcohol is prohibited for good reason. This also applies to cyclists. A cycle helmet would have been able to mitigate the consequences of the injuries.

Example 2

PEDESTRIAN CROSSES THE ROAD WHEN THE LIGHTS ARE AT RED AND IS HIT BY A CAR

The events leading up to the accident:
A pedestrian was crossing a road with three lanes in each direction and a central lane on a pedestrian crossing regulated by traffic lights. The accident occurred at night and the street lighting was in operation.

After the pedestrian had crossed the first carriageway and the central lane at red he continued to cross the other carriageway and was hit by a car travelling along the left-hand lane. As a result, he struck the front of the vehicle and the windscreen and was so severely injured that he died shortly after being admitted to hospital.

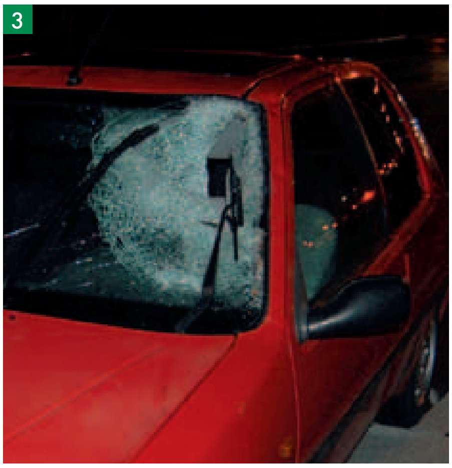
Parties involved:
Car
Cyclist

Consequences of the accident / injuries:
Pedestrian fatally injured

Cause / problem:
It was possible to clearly reconstruct the crossing of the road on the basis of witness statements and an analysis of the traffic light circuit. The initial speed of the car was determined by a DEKRA expert. It was 60-70 km/h and was therefore above the speed limit of 50 km/hl at the scene of the accident.

Accident prevention / motivation for road safety measures:
Even if it is not apparent that a vehicle is approaching, pedestrians are always well advised to wait at the pedestrian lights until they change to green. It is also important, however, that they look in both directions before they start to cross.

Exceeding the speed limit by around 10 km/h is seen by many motorists as a trifling offence. Many are unaware, however, that this significantly increases the braking distance and the impact energy during a collision. In this particular case, although an accident would have occurred even if the speed limit had not been exceeded, the consequences of the injuries would not have been quite so dramatic for the pedestrian.



1 Scene of the accident from the direction of travel of the car
2 Scene of the collision in the area of the pedestrian crossing
3 Damage to the car caused by the head impact
4 Leg impact in the area of the lights
5 Damage to the vehicle on the roof spar

1 *View of the driver of the car when stopped at the zebra crossing*

2 *Direction of approach of the inline skater*

3 *Impact and bounce marks on the hood*

4 *Marks on the front of the vehicle*

5 *Marked position of the car*

Example 3

INLINE SKATER IS HIT BY A CAR ON A ZEBRA CROSSING

The events leading up to the accident:

An inline skater was hit by a car in the area of a pedestrian crossing in broad daylight and dry, summer weather. The driver of the car had stopped in front of the zebra crossing to give way to some pedestrians. When he set off again he hit the inline skater as she was starting to cross the road. She was flung onto the hood and then fell onto the road. Although the car was travelling at very low speed, she sustained fatal chest and lung injuries.

Parties involved:

Car
Inline skater

Consequences of the accident / injuries:

Inline skater fatally injured
Car driver in shock

Cause / problem:

The inline skater approached the pedestrian crossing in a trajectory that appeared to the driver of the car to be diagonally from the front to the right. When he set off again he could not gauge whether the inline skater intended to cross the road or to continue parallel to the road. The inline skater was moving at a much greater speed than was customary for a pedestrian.

Accident prevention / motivation for road safety measures::

Inline skaters are ranked equally with pedestrians under German law, although neither their speed nor their space requirements are anywhere near the same. Before inline skaters cross a pedestrian crossing they must reduce their speed accordingly. As in the case of pedestrians, they must not cross a zebra crossing until they are sure that the drivers of oncoming vehicles have stopped to give them priority.

Motorists must pay special attention at zebra crossings. It is better to be safe than sorry. Before they set off again they must make sure that a pedestrian or a child on a cycle does not suddenly step onto or drive on the zebra crossing from the side of the road.

Example 4

LORRY DRIVER FAILS TO SEE A CYCLIST WHEN TURNING RIGHT

The events leading up to the accident:
After the lights had changed from red to green, the driver of a construction site lorry set off and turned right. During the turning manoeuvre he hit a cyclist wanting to continue straight on across the crossroads in the original direction of travel of the lorry. The cyclist fell to the road as a result of the collision and was then run over by the right rear wheel of the lorry, sustaining life-threatening injuries.

Parties involved:
Lorry
Cyclist

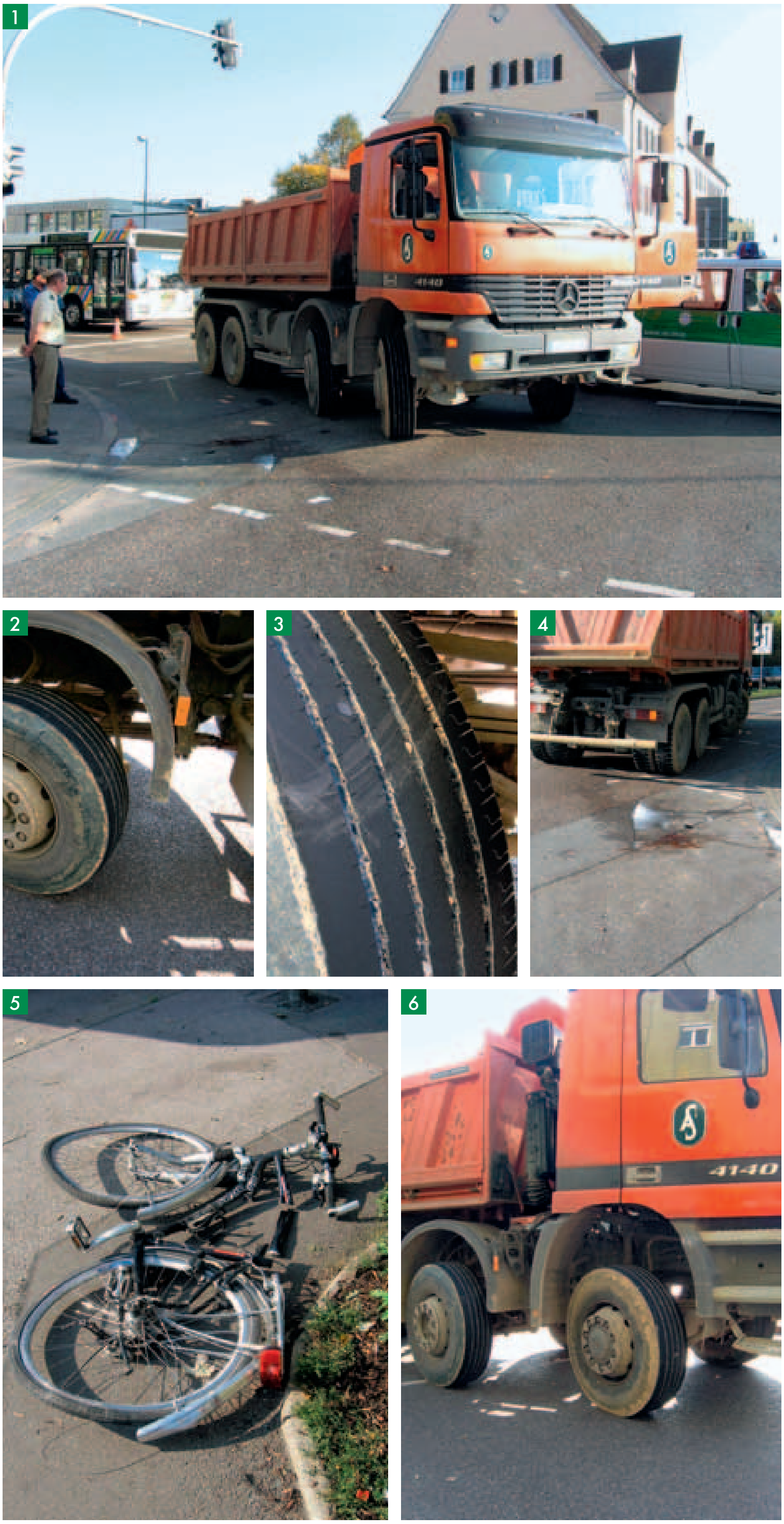
Consequences of the accident / injuries:
Cyclist left with life-threatening injuries

Cause / problem:
Because of the size of the vehicle the direct sight of the lorry driver is very limited. In the case of a construction site vehicle this effect is magnified because of its great height. Although extensive mirror systems appreciably reduce the invisible area, there is still a so-called 'blind spot', which affects the right side of the vehicle in particular. In addition, it is often very difficult to see pedestrians and cyclists in the rear-view mirror.

Accident prevention / motivation for road safety measures:
Only those who have personally sat in the driver's seat of a lorry know how restricted the all-round visibility from the cab is. Particularly when lorries make right-hand turns this problem leads, time and again, to serious accidents. Thanks to new mirror systems, improvements have been made, but the remaining risk is still too high.

Pedestrians and cyclists need to be aware that lorry drivers simply do not see them or can easily overlook them when they are turning right. It is important that they seek direct eye contact with the driver and that they do not cross the road until the lorry has come to a complete standstill.

Nor should lorry drivers underestimate the risk of failing to see a pedestrian or cyclist, and they must take the necessary care when performing turning manoeuvres. They must always be aware that pedestrians and cyclists have priority when they are crossing the road into which the lorry is turning – unless this is regulated otherwise by pedestrian lights.



1 Position of the construction site lorry at the time of the collision
2 Initial impact marks on the second axle
3 Contact marks on the tyre tread
4 Final position of the lorry and marks on the road
5 Damage to the cycle
6 Final position of the lorry

Better co-existence on the roads

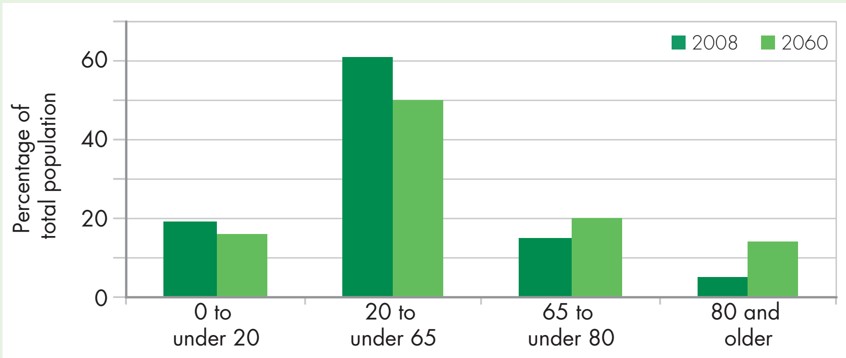
Lack of awareness of risk, inappropriate behaviour, too little consideration for each other, aggression: when road accidents occur, the human factor plays a major role. The consequences are especially serious for vulnerable road users such as pedestrians and cyclists, with elderly road users and children being particularly affected.

As already explained in the section entitled 'Examples of accidents', the demographic trend is a topic that has been under discussion for years. The results of the twelfth coordinated population projection indicate that, over the next two decades, the balance will shift significantly in the direction of the elderly. In 2030, the 65s and over will form 29 per cent of the population in Germany. In 2060, one third of the population will be at least 65 years of age (Figure 30). The total population will fall from 82 million today to approximately 65 to 70 million in 2060. Then, there will be almost as many 80-year-olds and over as under 20s. In the future, older citizens will therefore be of particular importance for all areas of society – particularly as road users.

Currently, almost 50 per cent of Germans over 65 have a driving licence (Figure 31). In absolute figures, this corresponds to approximately 8.75 million driving licences in this age group. The trend in past and future decades (Figure 32) clearly indicates that older drivers will constitute a growing proportion in the years to come. According to the study already cited in the introduction, 'Mobility in Germany 2008', it is clear that, in comparison to 2002 and 2008, the over-65 age group has become the fastest growing percentage of traffic volume, whereas the distances covered by younger road users have fallen.

30

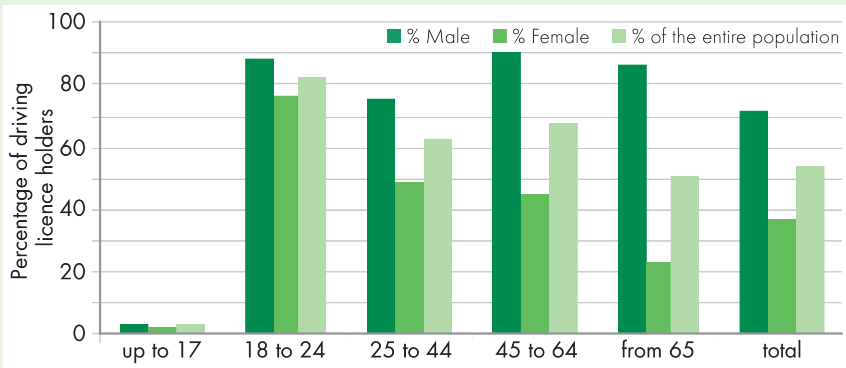
Population broken down by age group in Germany



Source: Federal Agency for Statistics

31

Percentage of driving licence holders broken down by age group in Germany



Source: Federal Agency for Statistics, Federal Motor Transport Authority

The frequency of accidents involving the elderly has risen in recent years in line with the rise in the number of over 65s (Figure 33). There has been a rise in the number of elderly people involved in accidents, while the number of elderly people killed in accidents is down. This reflects the rise in the number of elderly road users, accompanied by an improvement in vehicle and traffic safety and in emergency medical services, and decreasing mortality rates. It is therefore necessary to focus on the elderly who are injured in road traffic accidents. It is worth noting that similar accident loads lead to much more serious injuries and lower levels of recovery among the elderly than the young. Age-related diseases and health impairments increase the risk of the elderly dying as a result of an accident (Figure 34).

INAPPROPRIATE BEHAVIOUR ON THE PART OF ELDERLY ROAD USERS

Looking at the numbers of elderly people over 65 in particular, it is striking that, in 2009 in Germany, of the elderly who died on the roads, 40 per cent were car occupants, 30 per cent were pedestrians and 21 per cent were cyclists. However, a detailed analysis of the statistics would show that over half the pedestrians killed (57 per cent) and every other cyclist killed were 65 years old or older, whereas only one in five car occupants killed were in the elderly age group.

This means that the elderly are a particularly vulnerable group on the roads. However, this vulnerability does not relate to a generally decreasing disability or physical and mental aptitude to drive a car. Rather, elderly road users are particularly vulnerable when they use the roads as cyclists or pedestrians.

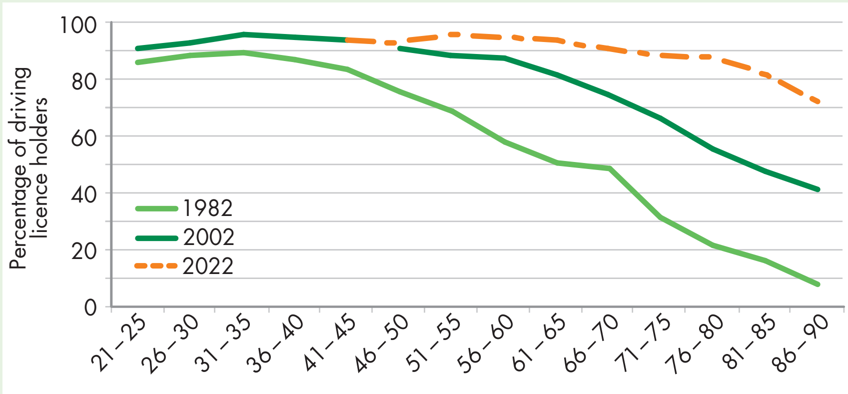
Elderly pedestrians experience difficulties such as, for example, overestimating gaps in time, misjudgements at crossings with traffic lights or zebra crossings, or pavements that are too high, which divert their attention from the flow of traffic. Official statistics show that, in 2009, in cases of accidents resulting in personal injury, 2,169 were the result of inappropriate behaviour on the part of pedestrians in the over-65 age group (Figure 35). With a proportion of 80 per cent, inappropriate behaviour when crossing the road was the predominant cause of accident.

DRIVING EXPERIENCE COMPENSATES FOR AGE-RELATED IMPAIRMENTS

Older drivers have to compensate for impairments caused by age. The performance of the sensory organs and of the body declines with increasing age. The sensory organs are responsible for providing information on the environment and are thus fundamental to the human action based on it. For example, the reaction rate for carrying out an activity depends on how fast the necessary information is available. From the age of forty the functions of the eye, such as the eye's ability to project objects at different distances sharply on the retina, diminish (amplitude of accommodation). In addition, while sensitivity to glare increases, visual acuity diminishes. Individual weaknesses of a sensory organ can mostly be compensated

32

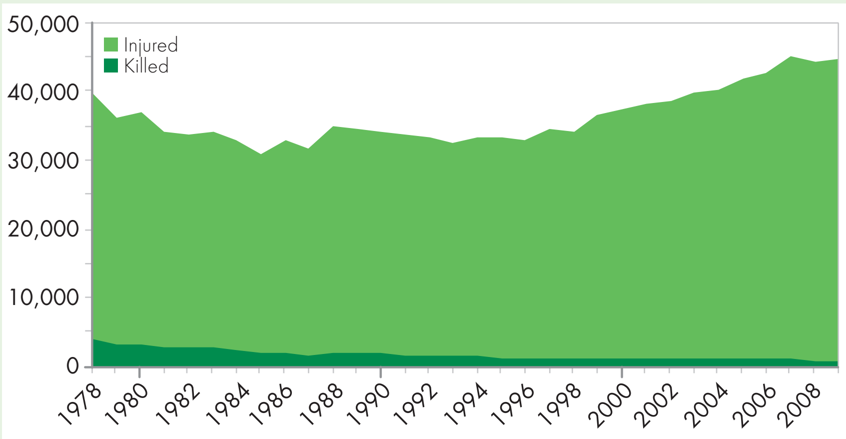
Driving licence availability in Germany by age group



Source: KONTIV (Continuous Survey on Mobility in Germany) and own calculations (D. Glaser and W. Schubert, 2006)

33

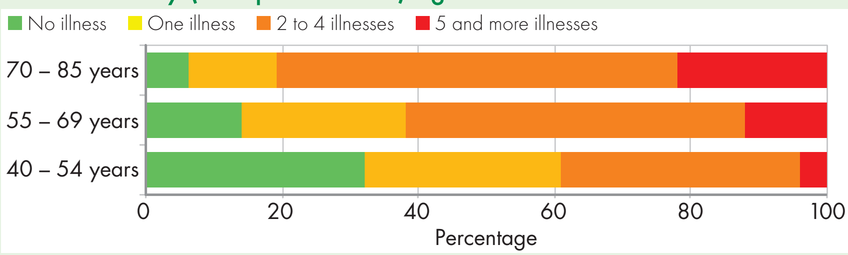
Trend in the number of persons aged 65 and over injured and killed on the roads in Germany from 1978 to 2009



Source: Federal Agency for Statistics

34

Multi-morbidity (multiple illnesses) aged

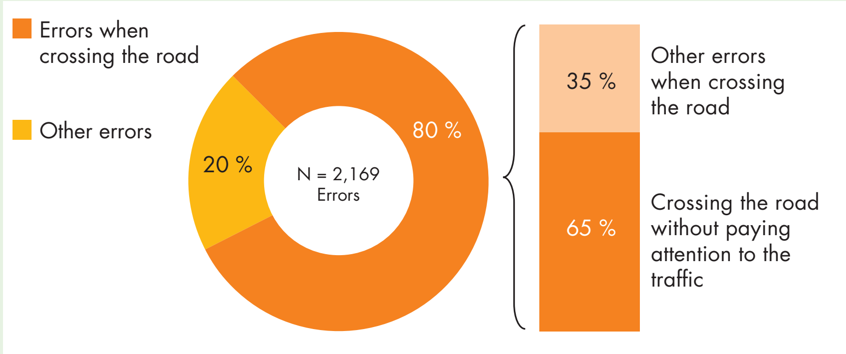


Source: Survey on the Aged (Alterssurvey), 2002 for, as the blind are able to compensate for their blindness through their sense of hearing and touch. With increasing age, however, it is not just one sensory organ that is functionally restricted but several. The resulting functional restrictions lead to high psychological stress and cannot always be readily counter-balanced. This is compounded by increasing restrictions of physical agility and strength.

The age-related changes described above can be used to explain the specific causes of accidents among elderly road users, which, for the most part, relate to their ability to get their bearings in the world around them. The age-related limitations to which older drivers are subject because of their age are, however, counteracted to some extent by their general experience and their driving experience.

35

Inappropriate behaviour of pedestrians aged 65 and over in road traffic accidents in Germany in 2009



Source: Federal Agency for Statistics

ELDERLY PEDESTRIANS AND CYCLISTS

Elderly people are exposed to particular dangers not only as a result of their sensory impairments, as mentioned above, but also due to the misperception of their own performance, such as their own speed when crossing roads, for example. Accident statistics have already shown that it is elderly pedestrians who are particularly at risk. The traffic-related risk of death to which an elderly pedestrian is exposed is 3.6 times that of a 25 to 64 year-old, with 74 per cent of accidents being caused by drivers and not by the elderly road users themselves. Although the number of pedestrians killed on the roads in 2009 fell by 9 per cent overall, deaths among older pedestrians were up by 3.4 per cent.

For elderly pedestrians the following traffic characteristics are especially dangerous:

- the excessive speed of motor traffic,
- roads that are too wide,
- lack of crossing facilities, and
- non-existent or poor pavements.

A variety of measures are conceivable for the prevention of accidents involving the elderly. Particularly congested traffic areas can be made elderly-friendly through 30 km/h zones or 20 km/h zones, central islands, acoustic traffic light signals or lowered kerbs.

However, the elderly are more at risk as cyclists than they are on foot. The risk of death to which an elderly cyclist is exposed is 5.8 times that of a 24 to 64 year-old. The problem for elderly cyclists is not frequent traffic rule violations but rather motorised traffic. To prevent accidents, cycling should be made safer. This is possible through expanding the network of cycle paths, providing traffic light installations for cycle paths, and slowing down motor traffic. It is also necessary to explain to motorists the specific characteristics of the elderly as cyclists and as pedestrians. On the other hand, it must be clearly explained to the elderly how they, as road users, can avoid risks.

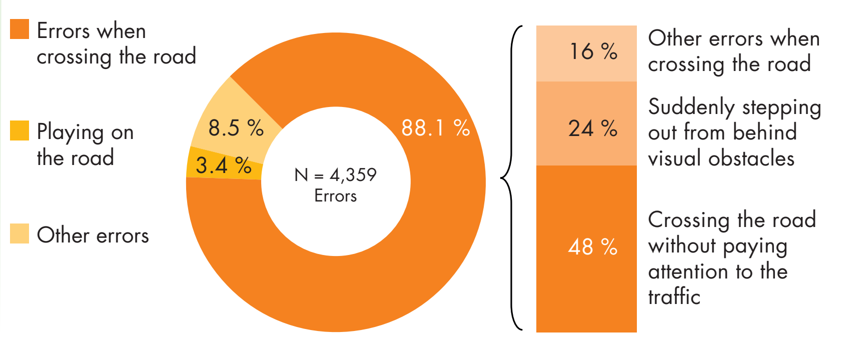
HAZARD IDENTIFICATION BY CHILDREN ON THE ROADS

According to the report on accidents involving children published by the Federal Agency for Statistics (StBA) in September 2010, in 2009 in Germany 24 per cent of all pedestrians involved in road traffic accidents were children under 15. According to the StBA, however, there are age-related differences with regard to the type of accident. Of children under 6 involved in accidents, 58 per cent were car passengers and 26 per cent were pedestrians. Of children between 6 and 10 involved in accident, 35 per cent were car passengers, 33 per cent were pedestrians, and 27 per cent were cyclists. Children over 10 were most frequently involved in accidents as cyclist (50 per cent).

The fact is that the sharp increase in road traffic in the last 20 years has been accompanied by greater danger to children

36

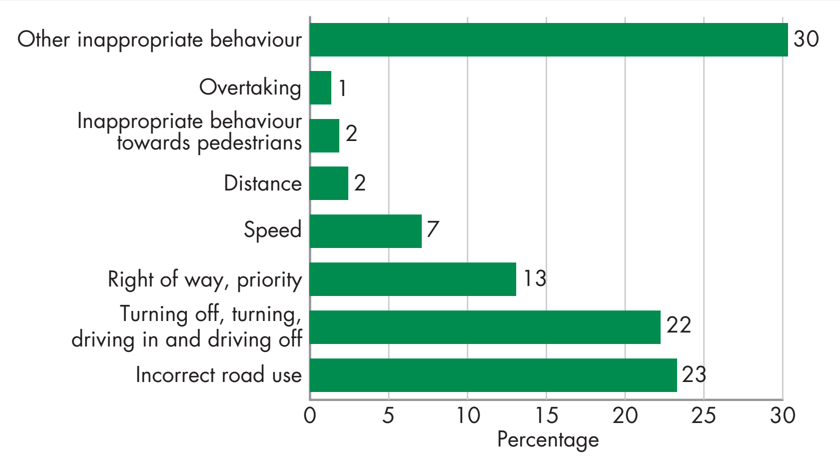
Inappropriate behaviour of pedestrians aged 6 to 14 in road traffic accidents in Germany in 2009



Source: Federal Agency for Statistics

37

Inappropriate behaviour of cyclists aged 6 to 14 in road traffic accidents in Germany in 2009



Source: Federal Agency for Statistics

who, for example, play at the side of the road unsupervised. At the same time, however, the independent mobility of children is an important stage in their development. Children experience their roads as dangers particularly as pedestrians and cyclists. According to a survey conducted in the mid-1990s, 70 per cent of the 1,347 children from years three to six who answered the survey were able to name danger spots on their way to school. 26 per cent of another group of pupils surveyed had personally experienced at least one road traffic accident, the most frequent type of accident being a collision between a child riding a cycle and a car.

The children surveyed named the following dangers on the way to school from their point of view:

- speeding cars,
- carelessly turning vehicles,
- cars parked on pavements and cycle paths,
- dangerous visual obstacles close to crossings;
- no or too narrow pavements,
- adverse traffic light phasing,
- lack of crossing facilities,
- no cycle paths,
- motorists going through a red light or not stopping at a zebra crossing,
- reckless drivers at entrances and exits (where cars drive across pavements),
- no lighting, as well as
- over-crowded school buses.

These data are also reflected in the accident statistics, according to which more than half of accidents involving children are not caused by the children themselves but the inappropriate behaviour of motorists. To improve their situation, most of all children wanted crossing for pedestrians (e.g. zebra crossings and pedestrian signals), less car traffic, safer roadside playing areas, a 30 km/h speeding limit as well as greater safety for cyclists and inline skaters.

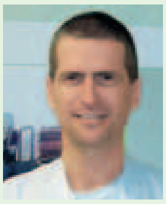
Inappropriate behaviour on the roads especially on the part of children between 6 and 14 years of age should not, of course, be underestimated. For children involved in accidents resulting in personal in 2009 in Germany, a total of 4,359 incidences of inappropriate behaviour were recorded (Figure 36). The most frequent incidences related to errors when crossing the road – for the most part without paying attention to the traffic, followed by suddenly stepping out from behind visual obstacles. For children between 6 and 14 years of age involved in accidents as cyclists, a total of 7,769 incidences of inappropriate behaviour were recorded. In top spot was incorrect road use and being on the wrong side of the road, followed by errors when turning off, turning, or joining and leaving traffic. Failing to give right of way or priority to other road users followed in third place (Figure 37). One reason for this inappropriate behaviour is the, in a child, as yet underdeveloped ability to adopt other perspectives.

RECIPROCAL ADOPTION OF PERSPECTIVES

From a developmental point of view, the ability to put oneself in another person's place is not immediately available after birth. It usually develops when children are in primary school. The thinking of young children is egocentric. They believe that what they personally see and feel is perceived by everyone else in the same way. Their thinking is associated with concrete vision, and it is only possible for children under seven to establish a correlation with their own traffic reality. However, they are not yet able to link several facts or categories together.

Over the course of their development, children gradually lose this egocentric vision and are increasingly able to put themselves in another person's place and, for example, make eye contact with vehicle drivers. Although they can combine several dimensions, when perceiving speed for example, it is not until they are approximately ten years old that they are able to apply their knowledge to unknown situations. Not until they reach this age do children have the ability to combine dimensions logically and abstractly, in recognising, anticipating and avoiding danger, for example. They can fully empathise with other people and bear individual responsibility.

A human being's willingness to learn and adapt should always be encouraged, as a human being is in a position to pursue



Dr Rainer Zinser, specialist for surgery, trauma surgery and emergency medicine as well as senior physician in the Central Emergency Department of the St Elisabeth Hospital in Ravensburg

"In the case of accidents involving cyclists, we often see shoulder girdle and chest injuries as well as leg injuries. But we also see, in particular, head injuries with accompanying injuries to the brain of differing degrees of severity. Despite operations and excellent rehabilitation possibilities, cerebrocranial injuries can leave serious, lifelong impairments. A number of studies have shown that, in comparable accident scenarios with comparable severity, bicycle helmets significantly reduce the number of serious head injuries and that the head remains completely unharmed more often than without a helmet. However, some studies were unable to demonstrate the protective effect of the helmet to this extent and claimed that the helmet had adverse effects by increasing the mass and the diameter of the head, which could translate into a higher likelihood of cervical spine injuries. However, in my many years of experience as an accident surgeon in trans-regional trauma centres I have not been able to observe cervical spine injuries caused by the wearing of a helmet. Both as an accident surgeon and an active cyclist, after carefully weighing up the pros and the cons, I consider the wearing of a helmet by cyclists to be a sensible and very important means of preventing or reducing head injuries. It is, of course, important that helmets comply with the recognised test standards (ANSI or SNELL)."

Children perceive road traffic from a different perspective.

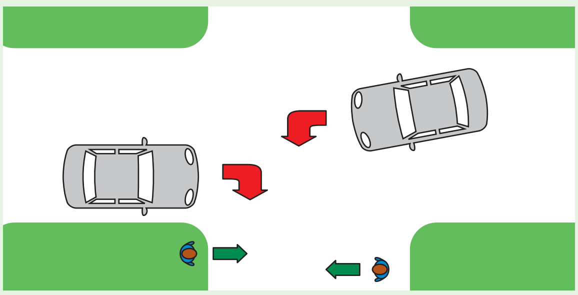
lifelong learning, also as regards using the roads. The following factors are important for learning as an adult:

- the learner's need for knowledge,
- the learner's self-concept,
- the learner's previous experience,
- willingness to learn,
- orientation towards the learning process, and
- motivation to learn.

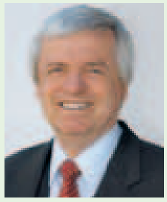
That the ability to adopt other perspectives and the capacity for learning, regardless of age, play a special role in behaviour towards traffic is shown in the fact they have been listed as a special objective of traffic-psychological consultancy under Section 71 of the German Ordinance on Drivers' Licences (Fahrerlaubnis-Verordnung). Drivers who have violated the traffic rules are once again to be put in a position where they can empathise with other people and their behaviour. This enables them to predict and anticipate the behaviour of others and to incorporate the possible alternative behaviours of other road users in their own behaviour towards traffic. Reflecting on their own abilities in road traffic, understanding their limited competence in complex driving situations, and improving behaviour planning play a role. All in all, therefore, an anticipatory driving style, avoiding conflict-laden situations and therefore reducing the risk of accident, can be learned.

German Road Traffic Act (StVO) Section 9

Time and again drivers collide with cyclists and, in particular, pedestrians, when turning. This is often attributable to uncertainty on the part of many drivers as to the applicable rules concerning right of way and priority. When a vehicle turns, the driver must pay special attention to pedestrians. Pedestrians crossing the road into which the vehicle is turning have priority. Irrespective of the direction in which the pedestrian is walking and whether the vehicle is turning right or left, the pedestrian must be allowed to cross the road. It is also irrelevant whether the vehicle is turning into a more major or more minor road. Although this regulation is very clear, pedestrians must also be careful of course when crossing the road. Behaving defensively is always safer than insisting on priority.



Notwithstanding other applicable rules of right of way and priority (apart from pedestrian lights) both motorists must let both pedestrians cross, before they react themselves. The legal basis for this is Section 9 (3) StVO.



Prof. Dr rer. nat. Wolfgang Schubert,
First Chairman of the German Association of Traffic Psychology Association (DGVP)

"The over-65 age group is particularly vulnerable, due in part to the increasingly declining perceptiveness of road users. It would be sensible for elderly drivers to voluntarily take part in preventive medical checkups focussing on their physical and mental aptitude to drive motor vehicles. This would safeguard their own individual mobility and protect them from accidents caused by age-related impairments. This could be organised in the form of a bonus system with incentives such as discounts on premium rates, motor vehicle tax concessions or similar. It should be possible for elderly road users to take steps, of their own volition, to promote, maintain and restore their – not just automotive – mobility, so that they can derive the benefit of continuing to actively participate in traffic."

AGGRESSION BREEDS AGGRESSION

The causes of aggressive behaviour on the roads are varied. One of the causes may be an underlying personality trait of aggressiveness on the part of the road user concerned. Or a situation-related aggressiveness might have a bearing, because the person concerned is frustrated, angry or annoyed. Moreover, the assessment of supposedly aggressive behaviour may also lead to aggression on the roads. For example, a cyclist cycles too far into the middle of the road, a motorist enforces his right of way, a pedestrian crosses the street too slowly. A provocative intention is for the most part automatically attributed to all these road users, without other reasons for their behaviour, such as their need for security, lack of experience or simply thoughtlessness, being taken into account. Frustration, agitation and confinement make people aggressive. Even if the frustration is felt off the road, it is vented much more strongly on the road, because the situation in the car promotes aggression. The following mental processes are of special relevance here:

- The traffic situation is only fleeting and ends quickly.
- The other person is perceived of less as a human being than a vehicle.
- People are anonymous.
- There are hardly any consequences to fear.

Anyone or anything that gets in the way of a motorist travelling at speed, either as cyclist, pedestrian, narrow road, speed limit, police officer or radar device, provokes the driver. The driver then flashes his lights, sounds his horn, taps his forehead, flies into a rage, badmouths or even physically assaults the other person.

International analyses claim that between one and two thirds of road traffic accidents are caused by aggressive behaviour. New drivers do not exhibit the highest proportion of aggressive behaviour, since a certain amount of driving experience and vehicle control has to be gained in order to be able to display aggressive behaviour on the roads.

Suitable bicycle helmets

When purchasing a suitable bicycle helmet care should be taken to ensure that it has been tested and that it at least complies with the standard DIN EN 1078 'Helmets for cyclists and for users of skateboards and roller skates'. It is also important that the helmet is adjusted to fit the relevant head shape; the helmet should not be too tight or too loose.

By far the most widely used helmet is the **cross-country bicycle helmet** with a shock-absorbing interior shell made of foam and also a thin layer of plastic. The smooth and highly resistant surface contributes to preventing head injuries and, in the event of a fall, makes it easier for the head to slide smoothly along the road, which is very important. Because of its special resistance, the **hard-shell helmet** is preferred in the area of sport. There is a layer of plastic on top of the foam and these helmets also often have a chin guard as special face protection. The hard-shell helmet works in a similar way to the cross-country bicycle helmet. On the other hand, **soft-shell helmets** should be avoided because they do not have a hard plastic outer shell and provide very little protection against head injuries. Another negative point is the soft surface, which, in the event of a fall, does not slide along the road satisfactorily. This increases the risk of a whiplash injury.

A new type of head protection comes from Sweden. The so-called 'Hövding' – 'chief' in English – looks like a shawl placed around the neck, which can also be integrated into articles of clothing. In the event of a fall, sensors activate the airbag contained in the shawl, which then wraps around the head in an instant. Although there are very convincing video recordings of this, just how functional and practical, and hence protective, this version actually is still has to be scrutinised in great detail.

Crossing the road safely

In addition to vehicle-specific safety elements and the human factor, the road infrastructure also plays a decisive role in increasing the safety of pedestrians and cyclists on the roads. Crossing facilities, cycle paths and road lighting are three central aspects.

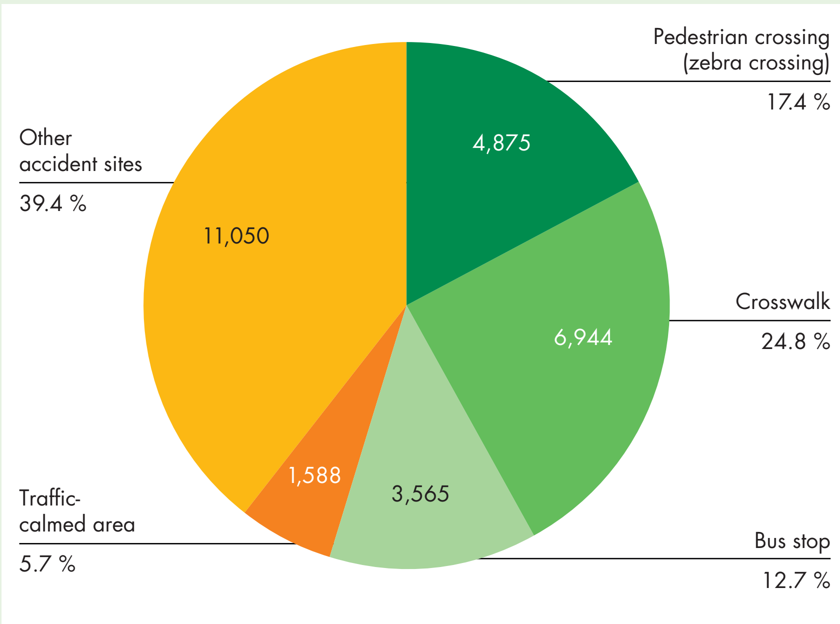
Analyses confirm over and over again what is only to be expected: most accidents between pedestrians and motor vehicles occur when their paths cross (Figure 38). The Road Traffic Act governs the legal bases for a pedestrian crossing a road and also for a vehicle approaching and crossing a pedestrian crossing. In addition to general requirements governing priority in certain driving manoeuvres, such as turning or driving over a pavement, the Road Traffic Act also covers crossing installations, such as pedestrian crossings (zebra crossings for example) and traffic signal installations (traffic lights).

Depending on traffic density, road width, the speed limit, pedestrian traffic and urban planning aspects, other crossing facilities are also suitable. The objective is always to make it easy for pedestrians to cross the road safely while, at the same time, not obstructing vehicle traffic too much. The Recommendations for Pedestrian Traffic Facilities (EFA 2002) contain different systems ranging from simple measures, such as speed reduction ramps, through the special design of pedestrian crossings and traffic lights to the spatial separation of traffic flows by means of overpasses and underpasses.

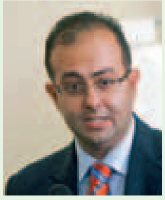
38

Road traffic accidents and the consequences of accidents in urban areas in Germany by characteristic and special feature of the accident site and by type of accident

About 60 per cent of personal injury accidents (killed or injured) and collisions between vehicles and pedestrians in urban areas in 2009 in Germany occurred on pedestrian crossings, on crosswalks, at bus stops or in traffic-calmed areas.



Source: Federal Agency for Statistics



Francesco Mazzone,
Automobile Club d'Italia (ACI), Rome (Italy)

"Under the auspices of the Fédération Internationale de l'Automobile (FIA) 18 automobile clubs carried out a pan-European survey on pedestrian crossings. Between 2007 and 2010 independent studies were conducted to find out how safe the transport infrastructure in 23 Member States is. Some 800 pedestrian crossings were tested. "The only way to cross a road is to confidently head for the flow of traffic, ideally in a group, best of all with a nun in tow!" That is no mere joke, but often the reality. In many countries, the pedestrian has priority, at least from the time they stand on the pavement and wait to use the crossing. However, this behaviour would be very dangerous in Italy, where, in the past, drivers only had to give priority to pedestrians when they were already on the road. This rule was changed last July thanks to pressure from, among others, the ACI on the relevant authorities. But not only the rules and the behaviour of road users need to be improved; at pedestrian crossings the traffic light phases for pedestrians are often too short, there are no traffic island, cars are parked too close to crossings and make it more difficult for pedestrians to see approaching traffic. We should not therefore expect things to change on their own. Now is the time to act! That is why the ACI, along with 17 other automobile organisations, launched the 'Walk Safe' awareness campaign as part of the EuroTEST Initiatives of the FIA, in 2008. During the campaign, the participants tested pedestrian crossings in the largest European cities. There was also an educational video aimed at improving the behaviour of drivers and pedestrians."

It should always be borne in mind that the crossings must not involve pedestrians having to make major detours, that they are designed accordingly, and that they can be used by all without discrimination. Otherwise they would not be accepted. Neither a dark and narrow underpass accessed by means of steep steps nor the best traffic lights away from the main pedestrian flows is therefore a sensible option. As a rule, pedestrians choose the direct route. The facilities must also be designed without barriers for the disabled and they must meet the requirements of vulnerable pedestrians such as children and the elderly. There must also be ground surface indicators and guide strips to ensure that they can be used safely by blind and partially sighted people.

REMOVING VISUAL OBSTACLES

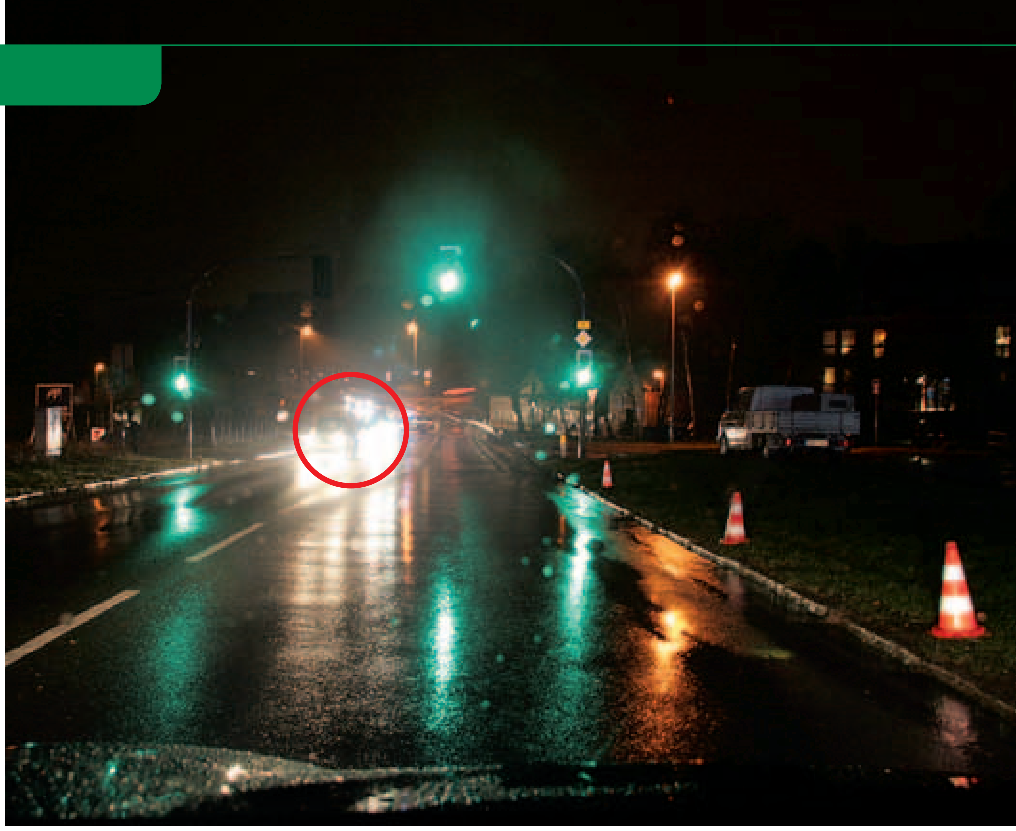
The ability of vehicle drivers to see crossing facilities and approaching pedestrians in good time is the basis for a safe crossing. For this reason, crossing facilities in tight curves or behind humps in the road are counter-productive, as they incorrectly give pedestrians the impression that they are safe. Obstacles at the side of the road which make it difficult or impossible to see approaching pedestrians and, conversely, do not allow pedestrians to notice road traffic in good time must also be avoided.

Unfortunately, however, advertising hoardings are approved and erected in these areas of very heavy traffic out of financial interests. Even traffic signs indicating crossings often constitute visual obstacles. It is also important to take appropriate measures to prevent people from parking their vehicles in the field of vision.

A good way of making it easier for pedestrians to cross the road is through the creation of central islands. The road can be crossed sequentially and the pedestrian only needs to concentrate on traffic coming from one direction. It is of course important to ensure that the central island lies on the normal walking line and does not require the pedestrian to make any detours. This point must be taken into account, in particular, in the design of nodes; if it were not, the drivers of turning vehicles would not be able to assess whether pedestrians wanted to cross the road or not. In addition, the traffic signs erected on the central islands must not hide crossing pedestrians.

Protruding lateral areas have the advantage that, before they cross the road pedestrians are not hidden by parked

Protruding lateral areas guarantee that children too are clearly visible.



At night on a rain-soaked road pedestrians on crossings are very difficult to see.

vehicles, plants in the lateral spaces or such like, the crossing distance is shortened, and drivers recognise the crossing as such through the design. Narrower lanes reduce speed. Speed reduction ramps adapted to the needs of the blind or coloured markings in the pavement are recommended in access and egress areas, in which vehicles frequently cross over the pavement. This will alert drivers to the right of way of pedestrians, who, in turn, are made aware of the crossing vehicles.

REGULATIONS GOVERNING PEDESTRIAN CROSSINGS

The priority rules of the Road Traffic Act (StVO) govern the crossing of roads. At zebra crossings and at pedestrian signals showing green the pedestrian has priority, even over all vehicles turning into the road being crossed. In all other cases, vehicle traffic has priority. Section 25 (3) of the StVO states on crossing the road: pedestrians must cross the road quickly by the shortest route at right angles to the direction of travel and, if the traffic situation requires it, at crossings or junctions, at traffic lights inside road markings or on pedestrian crossings (traffic sign 93). If pedestrians cross the road at crossings or junctions, the pedestrian crossings located there or the markings on traffic lights must be used. If a vehicle crosses over a pavement the pedestrians using the pavement have priority.

The behaviour of drivers towards pedestrians is regulated in Section 26 of the StVO, which states that, at pedestrian crossings, vehicles (with the exception of rail vehicles) must allow pedestrians as well as electrical wheelchair and wheelchair users who manifestly want to use the crossing to cross the road. In addition, not only must vehicles drive up to the crossing at moderate speed, they must also wait, if necessary.

It is interesting to take a look beyond Germany's borders in this regard. In the United Kingdom, for example, according to the British Highway Code, a pedestrian may not cross the road until the vehicles have stopped to enable him to do so. This is very different to Germany, where vehicles do not have to stop until a pedestrian has stepped onto the road. As far as France is concerned, the Code de la Route states that, when crossing the road, pedestrians

In large cities cycles are increasingly available for rent for short distances.

must take account of their own visibility as well as the distance and the speed of the approaching vehicles. Pedestrians are required to use the crossings intended for them to use if they are less than 50 metres away. At the same time, every driver is required to give priority to a pedestrian who is crossing the road in compliance with the regulations or who clearly indicates that he intends to do so, and to stop if necessary. This rule is to a large extent similar to the German regulation and differs massively from the UK rule. In the United Kingdom, simply the discernable intention of the pedestrian to want to cross the road does not require the driver to stop.

In the Austrian StVO a zebra crossing is called a 'Schutzweg' (literally a 'protective pathway'). The rules are very similar to the German regulations. Depending on the signage there is also a cyclist crossing. In addition, pedestrians and wheelchair users must use the zebra crossing to cross the road if it is not more than 25 metres away. In Switzerland zebra crossings are called 'Fußgängerstreifen' (or 'pedestrian crossings'). Their characteristic feature is that the stripes are yellow. The legal position is similar to that in the UK. The pedestrian has priority but must not step onto the pedestrian crossing unexpectedly. Vehicles must stop if the pedestrian is already on the crossing or is waiting at the side of the road and clearly wants to cross the road. A pedestrian crossing must be used if it is not more than 50 metres away from where the pedestrian is. Additional traffic signs are not compulsory. Vehicles must not stop or park within ten metres of a pedestrian crossing.

In conclusion, in the United Kingdom the priority of the pedestrian when crossing the road is clearly less pronounced than in Germany and France. Yet this does not have to be disadvantageous for the safety of the pedestrian if all parties are aware of the rules and the rules are applied accordingly. However, a quite obvious disadvantage is that, in a unified Europe, traffic signs – and, ironically, those for the most vulnerable users – have different meanings in different countries. An approximation is desirable. In any event, as a pedestrian or a cyclist, one is always well advised to take account of other road users, to be alert to them, and not to put one's trust solely in one's priority when crossing the road. With an awareness of their own weakness, to anticipate the errors of other drivers and to forego one's own priority if need by can be recommended to pedestrians and cyclists as a 'survival strategy'.

Bus stop risk

Bus and tram stops constitute a link between pedestrians and the local public transport network. Depending on the mode of transport and the design, however, bus and tram stops are also interfaces with private motorised transport. The requirement that bus and tram stops can easily be reached by the mode of transport concerned and that they are located in areas frequented by pedestrians means that they often present a higher risk because pedestrians have to cross lanes and tram lines. The design of the stop is also particularly important, depending on the public transport vehicles used, the density of the traffic and the structural options. The so-called bus boarder is recommended more for roads with traffic density, as it impedes the flow of traffic and also entails a poor visual relationship between the crossing passengers and other road users.

The stop at the edge of the road is only suitable for roads with no parked vehicles. In combination with a central island it is particularly safe. The disadvantage is the lack of space for a bus shelter, pavement and cycle path. The bus bay is suitable for roads with higher traffic density, but there is also less space for a bus shelter and it is also in conflict with cycle paths and pavements.

A good design for a stop combines many individual, seemingly simple aspects, but it is these, seemingly simple, aspects that also have an impact on the risk of accident.

The following factors can help to minimise the risk at bus and tram stops:

- non-slip coverings,
- good lighting and waiting areas with an unrestricted view,
- coloured safety strips,
- keeping them free from ice and snow,
- illuminated displays providing passengers with information,
- adapted floor height for barrier-free boarding and alighting,
- safety niches under the edge of the platform and
- free emergency call devices.

Cycle paths at bus stops risk

The routing of a cycle path at a bus stop is also a problem that is frequently discussed. There is no across-the-board good solution but a variety of solutions, depending on local conditions. Routing the cycle path as shown in the top picture reduces conflicts for passengers but increases problems for the bus driver, who has to cross the cycle path on leaving the bus stop area. The cycle path in the bottom picture runs behind the bus shelter. Boarding and alighting bus passengers are not in direct conflict with cyclists. The conflict shifts to the time when the passengers leave the stop areas.

Bus shelters

Bus shelters should provide as unrestricted a view as possible. If surfaces are to be used for advertising purposes, from a safety point of view the rear wall is the ideal surface. Advertising on the side surfaces conceals the waiting passengers fully or partially from other road users. Advertising that is mounted on the left of the bus shelter from the perspective of the people waiting is particularly to be avoided, as it prevents waiting passengers, bus drivers and other road users from seeing each other.

This cycle path leads to a dead-end.

LATEST TECHNICAL ADVANCES

To reduce the number of pedestrians who are victims of accidents at crossings throughout Europe, the duration of the green, flashing green and amber phases must be sufficiently long for the road to be cleared and, in addition, it must ensured, especially at heavily used crossings, that the crossing can be recognised as such by motorists in good time both during the day and at night, either through appropriate signage or road markings. It is just as important that the crossing is adequately lit and that pedestrians on the crossing and those waiting on the pavement can be seen by drivers in good time even in poor weather.

Yet adequate street lighting is a major problem in many places. In Germany, for example, according to the booklet for local authorities entitled ‘More Efficient Street Lighting’, which was issued in 2009 by the Ministry of the Environment of Baden-Württemberg, more than a third of current street lighting in Germany is over 20 years old and is often technically obsolete. Currently, however, only three per cent of street lighting is replaced each year. Action needs to be taken in this regard. The situation is probably similar in other EU Member States. The booklet states: “Because road traffic is increasing good lighting has become increasingly important, both for motorists and for cyclists and pedestrians. All traffic areas must have light levels sufficient to allow constantly changing situations or black spots to be seen from a sufficiently long distance in moving and stationary traffic and to allow the more vulnerable road users to be protected. The lights should mark the course of the road and serve to orient and guide the traffic.” An analysis of accidents that occurred in darkness also shows that the distance between the street lights should not be too large. The frequent alternation between lit and unlit stretches of road reduces the visibility of pedestrians, as the eye has to

Cycle routes and other special regulations

The establishment of cycle routes has been allowed in Germany since the entry into force of the 24th amendment of the StVO on 1st October 1997. Under the StVO a cycle route is for use by cycles only. According to Section 41 StVO these routes are indicated by the sign 244 (beginning) and 244a (end). Vehicle drivers other than cyclists may only use these routes if an additional sign permits it. In addition, all vehicles may only travel at moderate speed and cyclists may cycle next to each other.

The 46th amendment of the StVO, which entered into force on 1st September 2009, introduced an innovation to increase the road safety of cyclists. Since then a speed limit of 30 km/h has been in force on cycle routes for all vehicles, including for cyclists. Vehicle drivers must reduce their speed even further if necessary.

However, a common problem is the general lack of acceptance on the part of motorists of cyclists on the road. In addition, motorists often do not comply with the speed limit on cycle routes because it is not explicitly marked. In towns and city centres, too, one-way streets are often released for cyclists against the direction of traffic. This can, however, pose a potential risk of accident for both vehicular and bicycle traffic, because many motorists are not familiar with the relevant signage or the small additional sign is simply overlooked. Conflicts are bound to occur especially if the ban on driving on the right-hand side of the road and driving at an appropriate speed are not complied with.

constantly adapt to the changing light conditions and has to look from bright areas into dark areas.

OPTIMISING URBAN CYCLE PATHS

The safe expansion of the network of cycle paths and the maintenance of existing cycle paths are fundamental aspects of reducing the risk of accident for cyclists, especially in town and city centres. Although the network of cycle paths is in fact being expanded, the paths do not provide the desired protection for users everywhere. In urban areas in particular, where there is seldom enough room for a separate cycle path between the houses, cyclists often have to share the road with heavy traffic – separated only by a marking stripe painted on the ground which, as it gets older, is worn away until it is hardly recognisable. As on roads without cycle lanes, all two-wheeled vehicles run the risk of being struck by motor vehicles, especially by heavy goods vehicles, and of being forced off the road or even being run over when a vehicle turns right. Where cyclists have their own lanes, the main problem is the poor dividing line between the cycle lane and the roadway and poor marking at exits.

If cycle paths are in a poor condition, cyclists generally switch to the road despite the higher risk. Although, in Germany for example, cyclists have to use a cycle path if it is marked as such (traffic sign 237, 240 or 241), the cycle paths must run alongside roads, and they must be easy and reasonable to use. The Road Traffic Act stipulates that a cycle path has to meet numerous structural requirements for the obligation to use them to kick in. A cycle path must be wide enough and the line must be clear and continuous. At crossroads, the route must be safe and the path must be designed in accordance with the latest standards of construction and be maintained.

Experience shows that cycle paths frequently do not meet these criteria. Where urban cycle paths exist, many are too narrow, and trees and lamp posts present obstacles or lead cyclists out of the field of vision of motorists. At the 47th German Traffic Court Conference 2009 in Goslar towns, cities and municipalities were urged to abide even more strongly by the principle 'see and be seen' when planning, constructing and maintaining cycle paths. At junctions and access roads in particular, fields of vision at entry and exit roads must be kept free in both directions. Safety zones to parked vehicles must be sufficiently wide. There is substantial need for optimisation where cycle paths are concerned. If cycle paths are in good condition they will be used and they will make an important contribution to greater traffic safety.

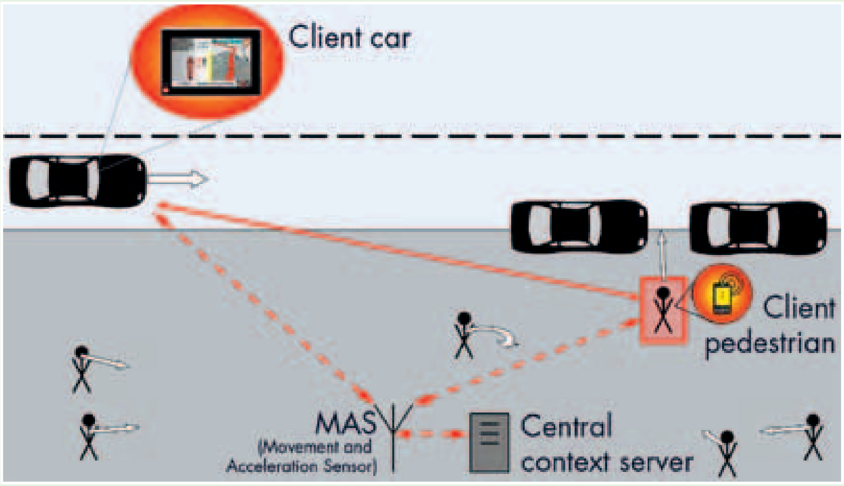
Cyclists are also urged in this context to use cycle paths wherever they exist. It is telling how, despite the existence of well maintained cycle paths, with great self-confidence 'sports' cyclists increasingly prefer to share the road with faster moving traffic and to weave in and out of stationary and slow-moving traffic at great risk to themselves. They are either unaware of the increased risk of accident or simply choose to ignore it – until they eventually 'draw the short straw'.

Mobile phone technology to prevent accidents

The EU has set itself the goal of making road traffic safer. Help may in the future come in the form of new mobile phone technology, which scientists from the Department of Electrical Engineering and Computer Science at the University of Kassel are developing, inter alia, in the context of the VENUS project funded by the State of Hesse. Accidents can be prevented if the pedestrian's position, context and profile data are transmitted to other road users using the mobile phone carried by the pedestrian. The so-called intelligent context filter uses these data to identify people within a radius of up to 70 metres and can, with just a few calculations, reliably assess whether a collision is imminent. The movement and acceleration sensors (MAS) integrated into the mobile phone measure the pedestrian's movement and reaction dynamics. They deliver between 20 and 50 values a second and are therefore able to detect changes in the progression of movement at lightning speed. This enables motorists and pedestrians to be warned quickly. The sensor data are transmitted by WLAN or UMTS, a mobile phone standard characterised by high transmission rates.

This can take place via the car's navigation system or via an alarm tone in the pedestrian's mobile phone. Installing an automatic brake function in the vehicle is also conceivable.

Automobile systems for the detection of other road users already exist, but they mostly consist of video sensors and light or thermal imaging cameras installed in the vehicle, which have the disadvantage that direct, unrestricted 'visual contact' is usually necessary. However, in city traffic there are often situations in which pedestrians step onto the road between parked cars. The existing systems do not detect the pedestrians quickly enough. The use of context and profile data may be one approach to solving this problem.



Reducing the risk of accident even more efficiently

To increase the safety of pedestrians and cyclists it is necessary to focus on several areas. As a high percentage of fatal accidents occur at night greater emphasis must be placed on adequate lighting and visibility. The light systems on cycles and cars in particular play a central role, as does the clothing worn by pedestrians and cyclists. Further improvements in the frontal protection of cars and the lateral protection of heavy goods vehicles should not be forgotten. Finally, electronic driver assistance systems, which are increasingly used in cars and heavy goods vehicles as elements of active safety, offer potential for preventing accidents that should not be underestimated.

23, 32, 39, 43 per cent: these figures are not an extract from a randomly ascending sequence but the proportion of road users killed in road accidents at night in 2009 in Italy, Germany, Spain and France respectively. In view of the fact that, in Germany for example, night journeys account for just 20 per cent of the total distance travelled, while in France it is just 10 per cent, these figures unmistakably point to an increased potential for preventing fatal accidents through, for example, better illumination of the road and the surrounding area. Improvements in stationary road illumination and vehicle headlights, among other things, are conceivable.

On the basis of the figures for 2009 (Figure 39), in towns and cities in Germany 436 pedestrians lost their lives, 201 (= 46 per cent) in road traffic accidents in darkness. Of the 259 cyclists killed in accidents in urban areas, 38 (= 15 per cent) lost their lives in road traffic accidents in darkness. If the lighting and visibility conditions had been better, these figures would without doubt have been lower, especially for pedestrians. This would have been the case not only in 2009, but equally in previous years, in which the proportion of pedestrians and cyclists killed in urban areas in road traffic accidents in darkness remained relatively constant.

Outside built-up areas, too, the proportion of fatalities of road traffic accidents in darkness remained relatively constant and was very similar to that of road traffic accidents in urban areas. This is quite remarkable since, outside built-up areas, there is generally no road lighting on main roads, national roads and country roads. This means that the ability of road users to see at night is guaranteed exclusively by the vehicle's headlights and also by the tail lights and stop lights of any preceding vehicles and side lights. Therefore, in Germany, in 2009, 108 pedestrians and 39 cyclists killed outside built-up areas may have been able to benefit from the possibilities offered by improved lighting technology in relation to vehicle headlights.

INADEQUATE RISK AWARENESS

It is clear therefore that, especially at night, adequate lighting and visibility play a crucial role in reducing the risk of accident. As numerous studies have shown, the risk of pedestrians and cyclists being involved in an accident at night is two to three times higher than during the day. Following road traffic accidents in darkness involving pedestrians, according to an investigation by the Federal Highway Research Institute (BASt) nine out of ten motorists say that they did not see the pedestrian. Despite this fact, most pedestrians (58 per cent) wear dark clothes, while only 42 per cent of pedestrians where bright or reflective clothing. Among children, bright and

Dipped headlights: The people are standing 10, 15 and 25 metres away.

Dipped headlights: Both people are 25 metres away from the vehicle. Light-coloured jackets and reflectors improve visibility.

39

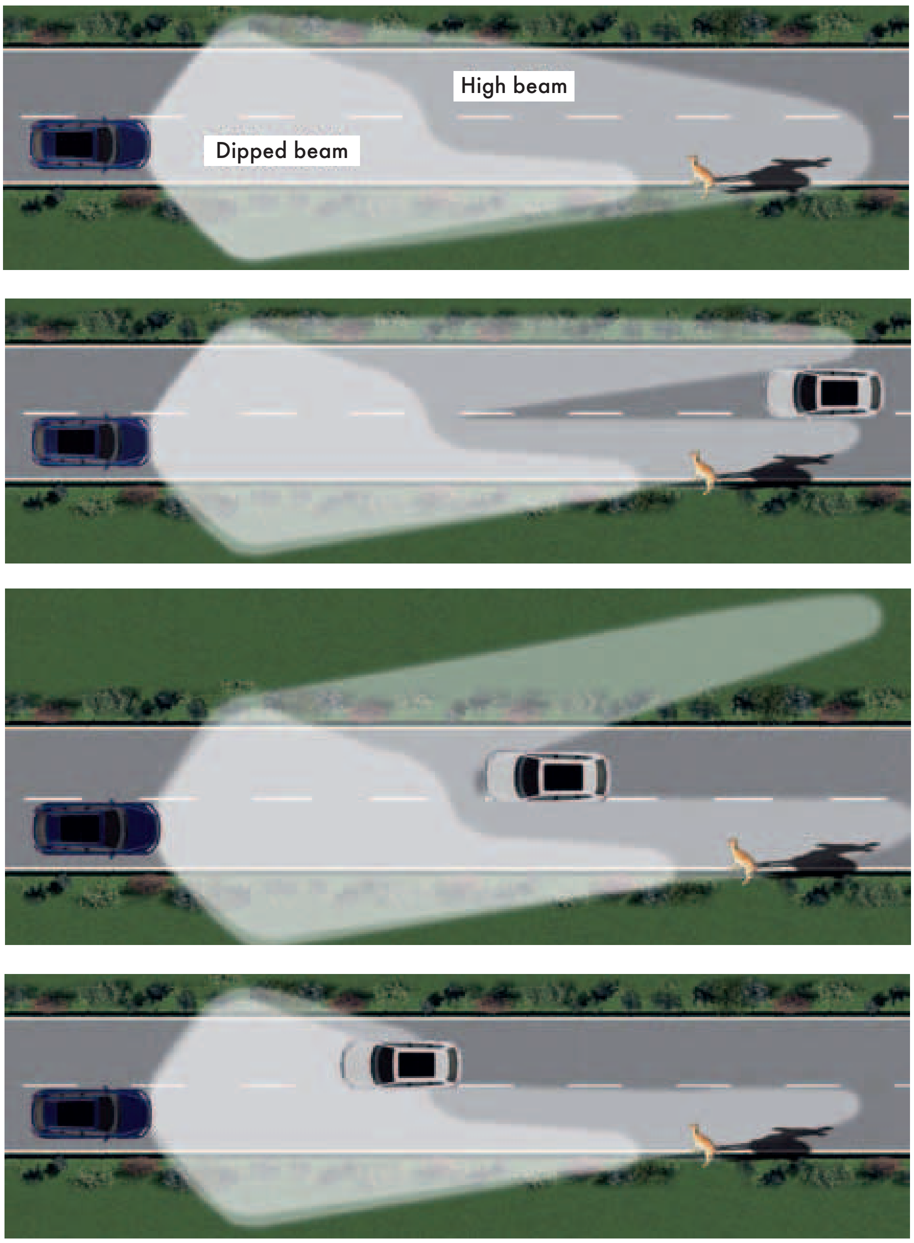
Proportion of road accident fatalities in 2009 by type of road use and light conditions

Source: Federal Agency for Statistics

reflective clothing is still most frequently encountered.

Darkly dressed pedestrians are difficult for motorists to see because human vision considerably diminishes in the dark. Even those with perfect vision during the day have much worse vision in the dark. That is why the risk for a pedestrian being hit and injured by a motorist is much greater at night than in daylight.

That a large number of road users in Germany have not learned the appropriate lessons from these findings is shown in a representative survey carried out in 2010, which employers' liability insurance associations and statutory accident insurance funds commissioned as part of their 'Fight the Risk!' prevention campaign. According to the survey, the respondents thought that it was risky for a pedestrian not to wear high-contrast or even reflective clothing. Yet only 13 per cent said that they consciously wore reflective clothing or bands, or carried reflective bags in poor visibility conditions. And only half made sure that they only crossed roads at well-lit spots. On the other hand, the cyclists surveyed said that they paid much closer attention to ensuring that the lights worked and that reflectors had been fitted. However, one in six said that they cycled without lights and reflectors. Among younger respondents this figure was even higher.



In headlight systems with vertical cut-off, the high beam shines past a vehicle whose driver could be dazzled.

Source: Volkswagen AG

MODERN LIGHTING TECHNOLOGY AND DRIVER ASSISTANCE SYSTEMS

In principle, better lighting conditions can help reduce the risk of accident at night. In towns and cities, dipped headlights and stationary street lighting generally illuminate the relevant traffic area. Outside urban areas, vehicle headlights are generally the only adequate light sources available at night, but on roads with high traffic density dipped headlights are mostly used so as not to dazzle other road users. On road sections outside urban areas where high beams could occasionally be used, drivers frequently do not use them because they find it annoying to constantly turn the high beams off and on.

However, the dipped-beam inclination can be nothing more than a compromise between the driver's ability to see and not dazzling other road users. The recognition of more distant objects, animals or people on or close to the road is significantly reduced with dipped beams compared to high beams. The recognition distance depends on a number of factors, such as the size of the person or the object, contrast with the surroundings or the degree of reflection of the clothes and the surface. A study carried out by L-LAB, a research laboratory for automotive lighting technology and mechatronics operated by the University of Paderborn and the systems supplier Hella showed that, under dipped headlight conditions, people dressed in light-coloured clothing could be made out as a source of danger at a distance of over 100 metres. Under the same conditions, however, objects that were harder to make out and people dressed in dark-coloured clothing as well as dummies of hare and deer could only be seen at a distance of between 50 and 60 metres. Under high beam conditions the recognition distance for all persons, dummies or animals and objects was more than 140 metres.

At a speed of 100 km/h, a reaction time of 0.8 seconds and a mean deceleration of 7.5 m/s^2 (dry road), the stopping distance is approximately 74 metres. If, at the same speed, the reaction time is 1.2 seconds and the mean deceleration is 6.5 m/s^2, the stopping distance increases by approximately 93 metres. Anyone driving along a country road at a speed of 100 km/h without their high beams switched on is unable to stop in good time, or to avoid an obstacle, despite slamming on the brakes, in comparable dangerous situations at recognition distances of 50 to 60 metres.

Source: BMW AG

Passive infrared night vision system

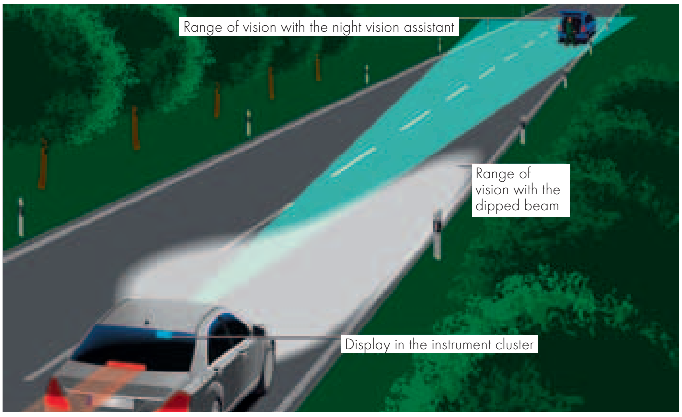
Image taken with a far infrared camera with additional automatic person recognition displayed on the central display unit.

Headlight systems with high-beam assistants, which switch automatically from dipped beam to high beam when the road ahead is clear outside urban areas, may improve the situation. If the assistance system recognises other road users in front of the vehicle who could be dazzled, or that the vehicle is travelling along a road in an urban area, it switches back to dipped beam. High-beam assistants have been available in Germany since 2005 – initially in luxury cars – as an optional extra.

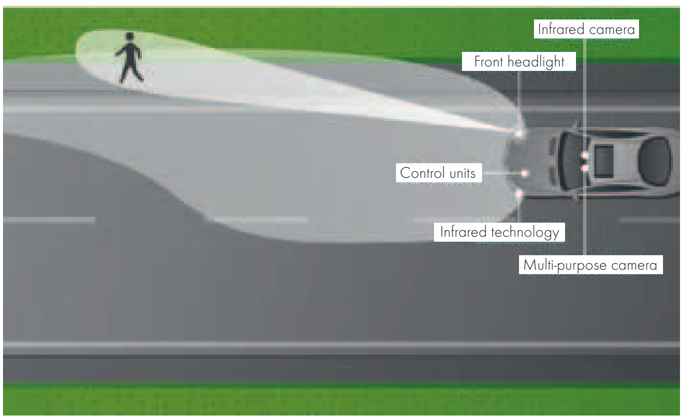
Vehicles are currently coming onto the market in which the assistance system constantly adapts the luminous distribution of the headlamp to traffic conditions via an adaptive cut-off. When the road is clear, the range of the headlights is regulated upwards as far as the high beam. If the system detects that other road users may be dazzled it regulates the range of the headlights downwards again, if necessary down to the level of the normal dipped beam. In another version, when the high beam is switched on, the lighting assistance system, by means of an adaptive vertical cut-off, masks the areas in the luminous distribution of the headlamp in which it has recognised other road users who could be dazzled

Active infrared night vision system

Image taken with a near infrared camera displayed on the central display unit.



Comparison of the range of the dipped beam and the range of the night vision assistant.



Source: Daimler AG

With the spotlight function the night vision assistant automatically illuminates people identified as being in danger several times for a short time.

by the high beam. Once the road users have passed, the high beam switches back on (see the graphical representation on Page 44). Such modern lighting assistance systems have been made possible through the installation of video cameras behind the windscreen, which constantly record the traffic area in front of the vehicle and analyse it using image processing software for pattern recognition and distance measurement. The headlights are then controlled in accordance with specified programs taking into account the particular situation and need. The driver still has the option of overriding the assistance system by manually switching back to dipped beam, adjusted to driving on normal urban roads or in traffic-calmed areas, as appropriate.

SOPHISTICATED INFRARED CAMERA SYSTEMS

In addition, there are also night vision systems, which have been available in Germany since 2005 as an optional extra in certain luxury cars. These systems work with light in the infrared region. As passive systems, far infrared systems use the long-wave infrared thermal radiation emitted by every living creature and object with a surface temperature greater than absolute zero. The name far infrared (FIR) is derived from the longer spectral distance to the visible light. This infrared light cannot penetrate the windscreen of a vehicle and so infrared cameras cannot be installed inside the vehicle; instead they are located behind an opening in the radiator grill for example.

The infrared images taken by the infrared camera are shown on a display inside the vehicle or also as a virtual image on a head-up display in front of the windscreen. A typical far infrared image resembles a black-and-white image in which warmer objects are lighter then colder objects and the colder surroundings. Through filtering and electronic post-processing with pattern recognition and the tracking of recognised patterns, with the latest FIR night vision systems it is possible to generate a clearly-defined monochromatic image showing only the main features, in which possible sources of danger, such as pedestrians or cyclists, are bright and depicted in pin-sharp definition, as well as being additionally marked.

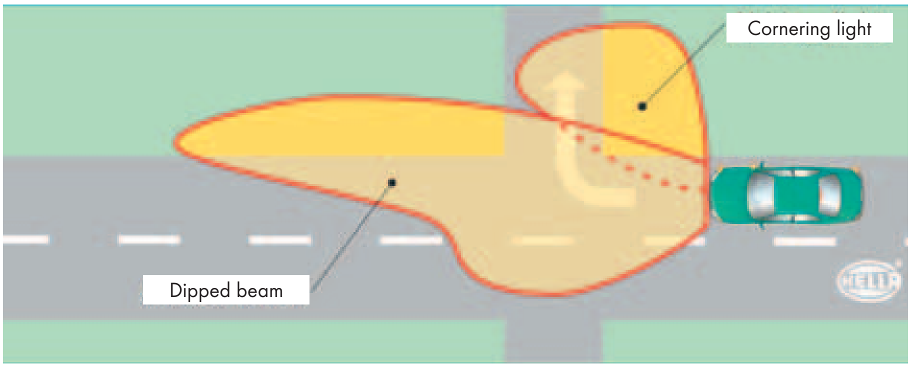
Near infrared (NIR) systems are so-called active systems. They emit infrared light through the vehicle's headlights with a wavelength that is close to the spectrum of light that is visible to humans. If this infrared light is reflected by persons, animals or objects, it can penetrate the windscreen and be captured and electronically analysed by a camera installed inside the vehicle. A typical near infrared image is also monochromatic. The persons, animals or objects illuminated by the infrared light are shown as lighter than the dark surroundings. Because of the light/dark contrast, the NIR image is like the image taken with a conventional black-and-white video camera. Here, too, it is possible to show the image either on a display inside the vehicle or as a virtual image on a head-up display in front of the windscreen. Like the FIR system, the NIR system also works with filtering, pattern recognition, the tracking of recognised patterns and marking, which means that the driver can be warned in good time of possible dangers. The range of NIR systems is up to 150 metres.

EVER MORE EFFICIENT LIGHTING TECHNOLOGY

The latest development in this area is the so-called spotlight function, which has been available since 2011. If the assistance system spots, for example, a pedestrian at the verge of the road through the camera, the pedestrian is specifically illuminated several times for a short time. The driver spots the pedestrian sooner and, if necessary, has more time to react accordingly. But the pedestrian is also warned by the brief light impulses and is then able, for his part, to help defuse the situation.

Together with the additional variable luminous distribution of the headlight when the driver turns off or negotiates a bend, the latest developments in the area of automotive lighting technology once again offer broader opportunities

Effect of the static cornering light

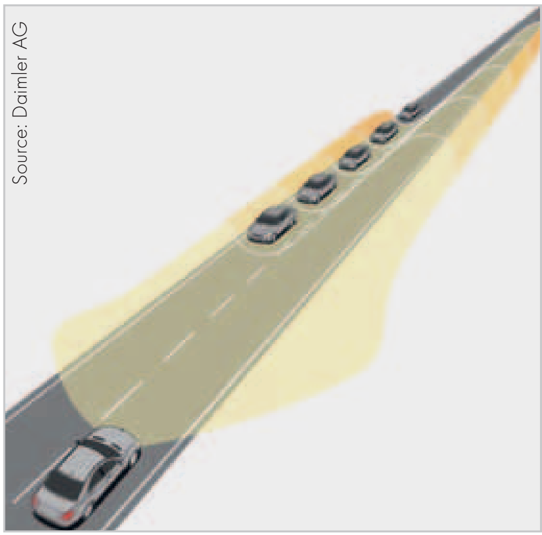


Switching on of the static cornering light when turning right.

Illuminated field of vision with static cornering light when turning left.

Illuminated field of vision when turning with conventional dipped beam.

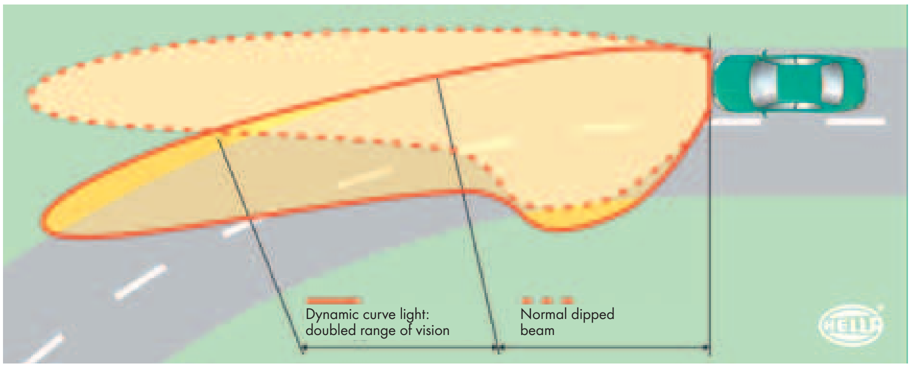
Sources: Hella KGaA Hueck and Co., Daimler AG



Source: Daimler AG

High-beam assistant with adaptive cut-off.

Effect of the dynamic cornering light



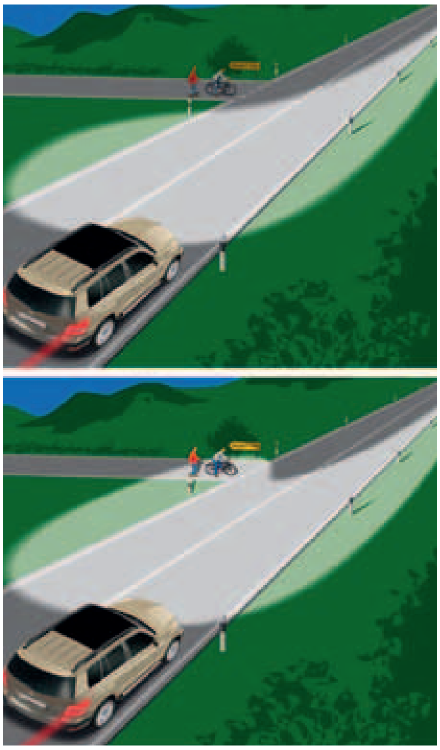
Increasing the range of vision by means of a dynamic cornering light on a left bend.

Illuminated field of vision with dynamic cornering light on a left bend.

Illuminated field of vision with conventional dipped beam on a left bend.

Sources: Hella KGaA Hueck and Co., Daimler AG

Intelligent Light System



Country light: Better illumination of the left verge of the road

Source: Daimler AG

for reducing the special danger to which pedestrians and cycles are exposed on the roads at night.

In recent years, the much improved vehicle lighting technology has helped to significantly reduce the number of road users killed in accidents in darkness. While, in 1991, of the 11,300 road fatalities in Germany, 43 per cent were killed as a result of accidents in darkness, in 2009 this proportion was 'just' 32 per cent (of 4,152 road fatalities) and therefore fell by 11 per cent in 18 years.

At the start of the 1990s the Xenon headlight was introduced in volume production cars, initially for the dipped beam. In 2000 the first vehicles with bi-xenon headlights, in which the dipped beam and the high beam are generated within the same gas discharge lamp, came onto the market. In the past few years the percentage of vehicles fitted with xenon light has risen almost continuously (Figure 40). In 2008, 34 per cent of new cars purchased were fitted with xenon light. Of the total number of cars on the road, 14 per cent are fitted with xenon headlights.

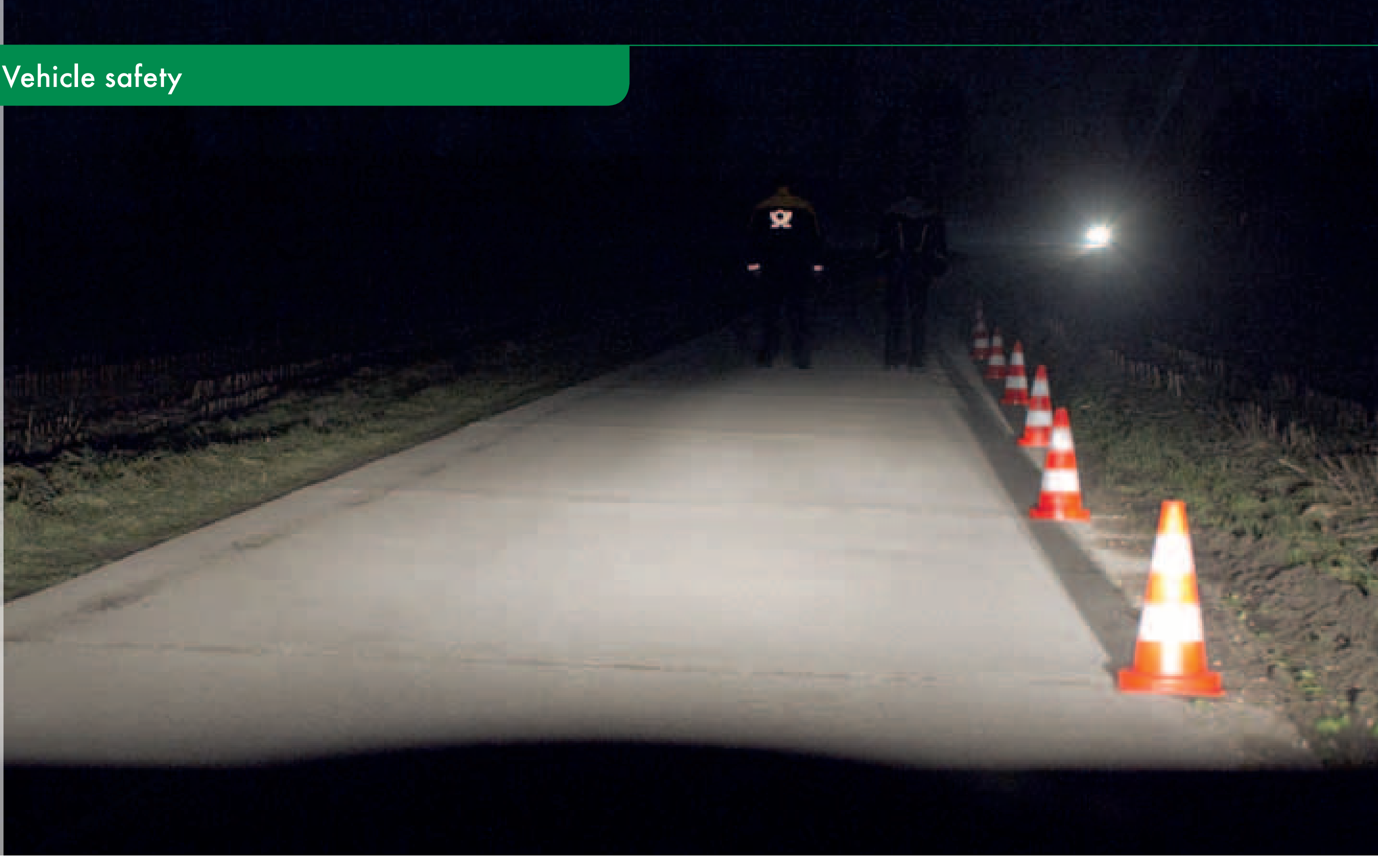
Even today xenon headlights are being offered as an optional extra in most vehicles, while halogen headlights are still standard equipment. It is clear that many buyers are put off by the additional cost of xenon headlights and are not aware of the gains in safety and comfort when driving at night. The light yield of xenon headlights is approximately 50 per cent higher than that of halogen headlights. What is more, xenon light sources have a much longer service life. Nevertheless, they are more expensive to replace. As xenon headlights must be fitted with automatic headlight range adjustment to prevent dazzling under different load conditions, this always guarantees the correct setting of the cut-off of the headlights.

LEDS AS A LIGHT SOURCE

The latest developments of vehicle headlights use light-emitting diodes (LEDs) as a light source. In Germany, the first vehicles with full-LED headlights came on the market in 2007. Compared to halogen and xenon light, white LEDs generate light with a larger proportion of blue. This leads to improved perception by the human eye at twilight and in the dark. The light emitted by LEDs is much closer to natural daylight than xenon light is, which drivers find more pleasant. They therefore drive in a more relaxed way and do not tire as quickly. As modern high-performance LEDs also have advantages in terms of light yield, by consuming less power they can help to save energy in the field of vehicle lighting technology. This increases the range of electrical vehicles. Another advantage is the long service life of LEDs, which is approximately 15 years. This is approximately equivalent to the operating life of a car. Against this background, in the coming years, more and

40 Proportion of cars in Germany fitted with xenon headlights by new cars and total vehicle ownership

Facts	2002	2003	2004	2005	2006	2007	2008	2009
Automobile ownership	6 %	8 %	9 %	13 %	14 %	13 %	14 %	14 %
New cars	17 %	25 %	25 %	25 %	28 %	30 %	34 %	22 %
Source: DAT annual reports 2003 to 2010								



Two people at a distance of 25 metres with and without reflectors. The second person, on the right, can hardly be seen.

How important reflectors are only becomes apparent in darkness.

41

Currently prescribed equipment for safer 'all-round lighting'

Source: ADFC

more cars are expected to come on the market with developed, high performance lighting technology. The era of the incandescent lamp, which has fulfilled all vehicle lighting functions for more than a decade, is coming to an end. This will also further increase the safety of vulnerable road users.

LIGHT SYSTEMS ON CYCLES

Well functioning lights are especially important for cyclists in the dark months of the year, not only to see well when cycling but also to be seen well at all times. But even in the lighter months of the year, cyclists should always ensure that they can see well and that they are clearly visible to other road users. In relation to lighting, Section 17 of the German Road Traffic Act (StVO) provides, among other things, that the prescribed lights must be used at twilight, in darkness, or if visibility conditions otherwise make it necessary, and that they must not be covered or dirty.

If a cyclist cycles in the darkness without lights he is in principle liable in the event of an accident. On the other hand, the regulation also stipulates that a vehicle driver who collides with a cyclist cycling without lights will face a charge of strict liability. This should be reason enough, especially for recreational motorists, to set a particularly good example in the use of the prescribed lights, since almost all of them have experienced the shock of a 'bicycle guerrilla' suddenly appearing from nowhere and almost landing on the hood.

Section 67 of the German Road Traffic Act describes the lights prescribed for cycles (Figure 41). Cycles must be fitted with a dynamo to operate the headlight and the tail lights.

ADAPTING THE REGULATIONS

The German Bicycle Industry Association (ZIV) is working to ensure that road bikes intended for use on public roads are equipped with a dynamo to provide a continuously available and reliable source of energy for the lights. However, the ZIV is also campaigning for racing bicycles weighing up to 11 kilograms and other sports bikes such as mountain bicycles weighing up to 13 kg (off-road competition bikes) to be allowed to be ridden with battery-supported authorised lighting. In addition. battery-operated lights should continue to be allowed, in addition to the dynamo.

The regulation should be adapted for bicycles with an auxiliary electric motor (cycles with pedal assistance or so-called pedelecs). To make these special cycles, which have enjoyed increasing popularity in recent years, even more attractive as a health-promoting, environmentally and socially responsible form of transport, especially to the older generation, the following should apply. Because of technological developments in the area of electric motors and accumulators (rechargeable batteries), cycles with pedal assistance (pedelecs) do not need a type-approved dynamo if the accumulator used by these electric cycles makes it possible to guarantee continuity of supply to the lights for at least two hours, even after the auxiliary electric motor has shut down because of the load. It must also be guaranteed that the electric motor can be used as a dynamo to supply the light with power, if the energy provided by the battery is not sufficient.

Unlike cycles without pedal assistance, because of its greater weight a pedelac cannot be expected to travel for a long distance or over a long period of time with muscle power after the auxiliary electric motor has shut down because of the load.

VISION OF THE FUTURE FULLY-FLEDGED FITTING OF CYCLES WITH HIGHLY EFFECTIVE LIGHT SYSTEMS

Significant progress has been made in recent years in the development of permanently available power sources (generators) for example in the form of the now common, highly efficient hub dynamos. These hub dynamos have a step resist-

Look into the future

Visions for efficient bicycle lighting

All bicycles (irrespective of use)

P a s s i v e light systems

Future (minimum) equipment regulations for n e w bicycles

O b l i g a t o r y p a s s i v e l i g h t s y s t e m s

➡ **white reflector,** facing forward
➡ **red large reflector 'Z',** facing backward
➡ **yellow pedal reflectors,** facing forward and backward
➡ **retro-reflective devices on the front and rear wheel,** facing both sides, optional
 ➡ **yellow spoke reflectors,** mounted at an angle of 180°
 oder
 ➡ **retro-reflective white strips on the tyres or spokes,** connected in a circle
 or
 ➡ **retro-reflective white spokes or cap sleeves**

P a s s i v e light systems must be type approved and be p e r m a n e n t l y f i x e d on a l l cycles to the extent prescribed.

Bicycles for normal use

A c t i v e light systems

➡ additional mounting of a removable battery / accumulator-powered lights is permissible

Future equipment regulations for n e w bicycles

O b l i g a t o r y a c t i v e l i g h t s y s t e m s

➡ (hub) dynamo,
➡ Headlight and tail lights, which have a parking light function

O p t i o n a l a c t i v e l i g h t s y s t e m s

➡ Headlight with daytime running light function + automatic twilight switch
➡ Brake lights
➡ Direction indicators
➡ (side-marker lamps)

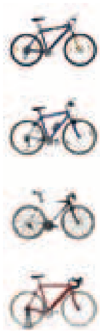
All optional active light systems must also be type approved.
➡ Technical requirements as stipulated by the German Vehicle Parts Regulation (FZV) must be drawn up for this (unless type-approved systems are used for mopeds).

Bicycles for sporting use*

*Road competition bikes ≤ 11 kg and off-road competition bikes ≤ 13 kg

A c t i v e light systems

Future equipment regulations for n e w bicycles



O b l i g a t o r y a c t i v e l i g h t s y s t e m s

In the future, instead of a generator t h e s e bicycles may have
➡ **Batteries or accumulators** which can be assembled with
➡ **Headlight and tail lights,**
 - which automatically have a parking light function and
 - may be removable.

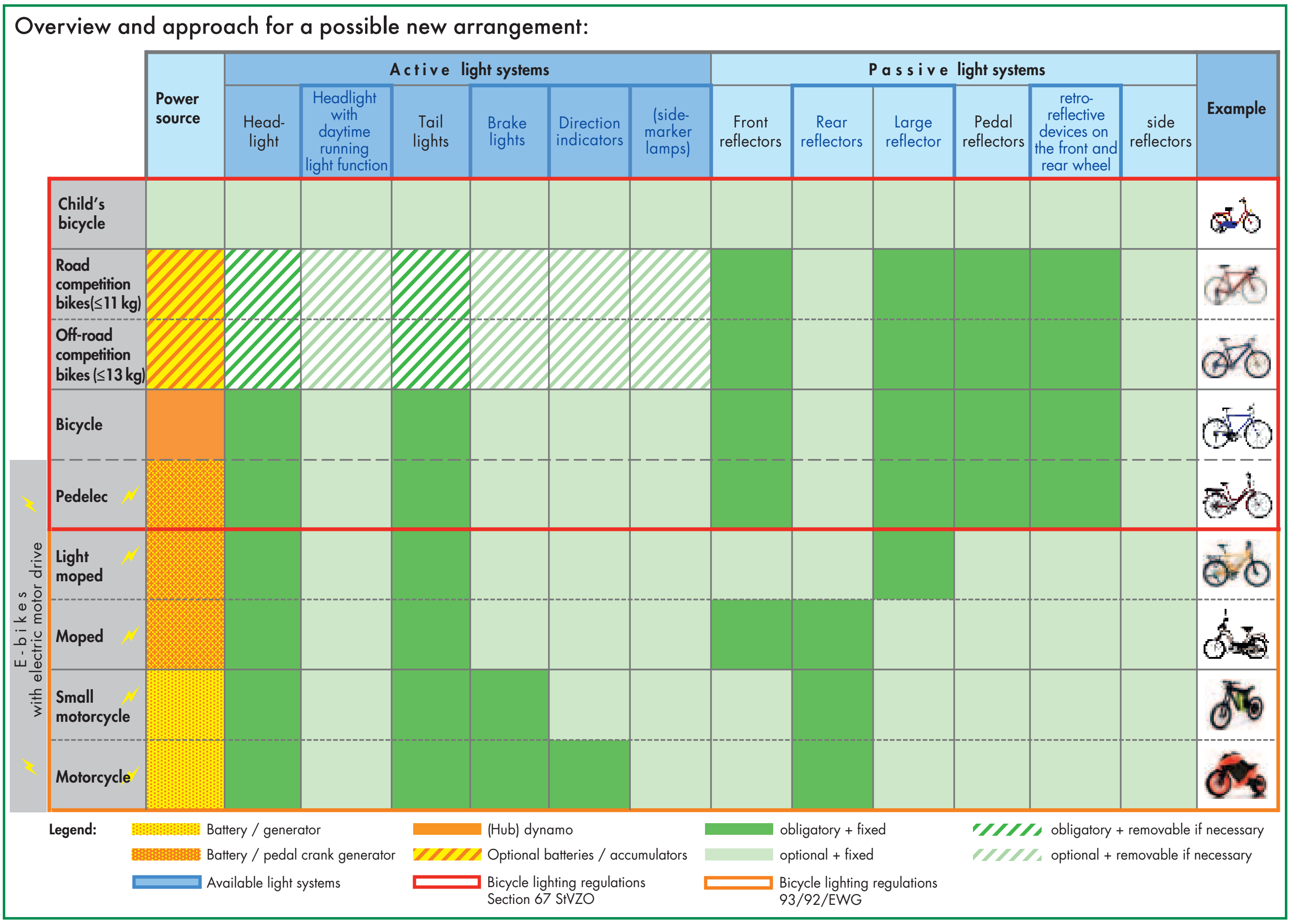
O p t i o n a l a c t i v e l i g h t s y s t e m s

➡ Headlight with daytime running light function + automatic twilight switch
➡ Brake lights*
➡ Direction indicators*
➡ (side-marker lamps*)

*depending on their technical feasibility

While the bicycle is being used d u r i n g t h e d a y any light systems that have been removed m u s t a l w a y s b e c a r r i e d a n d b e o p e r a t i o n a l.

42 Two-wheeled vehicles of all types require equipment with highly effective active and passive light systems because of their narrow silhouette and the little protection they afford their riders.



ance which is no longer noticeable. This means that they can provide so much continuous energy during the day that – in combination with the highly efficient yet, at the same time, low-consumption LED technology for light sources – the use of other lights with a signal function is, in principle, possible in the future.

This vision (Figure 42) is, of course, to be seen against the background of the current trend in the bicycle industry. Not only is the bicycle becoming increasingly popular, but the so-called e-bikes will also play an increasingly important role in the future. While the faster e-bikes, which are often hardly distinguishable from the 'bicycle-born' pedelecs from a purely visual point of view, must be fitted with light systems in accordance with the relevant EU regulations for two-, three- and light four-wheeled vehicles, continuing to equip pedelacs and the large number of conventional cycles (namely without pedal assistance) with 'lower-quality' light systems would mean that they remain less safe.

Last but not least, it is already becoming apparent that, with the availability of a permanent power source, not only can all the permanently fixed active light systems that are important for safety be reliably and sufficiently supplied with power, but mobile phones, music players and navigation devices can also be permanently operated during the cycle ride.

ADDITIONAL SAFETY THROUGH PASSIVE ELEMENTS

Although significant progress has been made in the area of active light systems, the special importance of passive light systems, especially for lateral identification, must also be stressed. Equipped with yellow retro-reflectors on the wheels, white reflective strips on the tyres or white retro-reflective spokes or spoke clips in combination with retro-reflectors facing forward and backward (including on the pedals), a cyclist, especially in cross traffic, is clearly and unambiguously identified as a vulnerable road user.

Not compulsory but very much to be recommended are additional retro-reflective elements and (flashing) lights on the cyclist's clothing. Reflectors on bicycle bags increase the visibility of the cycle in road traffic even further.

In particular, parents should pay attention to their children's bicycles. Unlike so-called children's or play bicycles, which must not be used on public roads or cycle lanes because they do not have the necessary safety equipment, road cycles fully equipped in accordance with the StVZO are available on the market even for the youngest cyclists. Such equipment includes a permanently fitted modern light system – preferably with a hub dynamo and parking light function. Care should also be taken to ensure that baskets or bags do not cover the cycle's light elements. Last but not least, cyclists can significantly improve their visibility during the day as well with a modern light system with parking light function – in the future for visibility forwards and rearwards – as well as by means of a special daytime running light.

Construction and equipment regulations for cycles

There are now EU framework Directives and specific Directives for almost all categories of vehicles and their trailers establishing the requirements imposed on the construction and equipping of these vehicles. The testing of new vehicle types is based on this legislation. Type-approval is granted to manufacturers on the basis of proof that the extensive body of legislation has been complied with. This is the condition for the series production and the subsequent sale or marketing of the vehicle.

This is not the case as regards cycles, for which no such type-approval procedure exists. However, EU Directive 2001/95/EC on general product safety imposes a general obligation to guarantee a high level of consumer protection, imposing in particular a general obligation on economic operators to market only safe products.

Proof that the relevant product safety requirements have been met is currently provided essentially by independent (self-) certification recognised by the competent authorities. This procedure also establishes all relevant norms and safety standards on the basis of which the individual car components must be manufactured and tested.

While previous cycle standards were widely ridiculed in trade and industry because the minimum requirements they laid down were much too low and a quality cycle, at that time, often did more than the standard required, the initial current standards of the European standardisation body CEN have now been implemented. With the publication of these standards, they now represent the state of the art in science and technology pursuant to EU Directive 2001/95/EC and must therefore be taken into account throughout Europe, regardless of whether these standards have been transposed into national law. In many countries the standards run alongside laws and regulations and are therefore not directly binding. In Germany, for example, in Part 3 of the StVZO (Other road vehicles), paragraphs 64 (Steering device), 64a (Audible warning), 65 (brakes) and 67 (Light systems) are authoritative for cycles.

The current outcome of the work of the standardisation committee CEN TC 333 Cycles is a compromise on which everyone was able to reach agreement. While the "safety requirements and test methods" deal with the load-bearing parts, the problem of the sharp outer edges, for example, was not taken into consideration. The sensitive issue of lighting, where the very major differences throughout Europe are well known, was also overlooked.

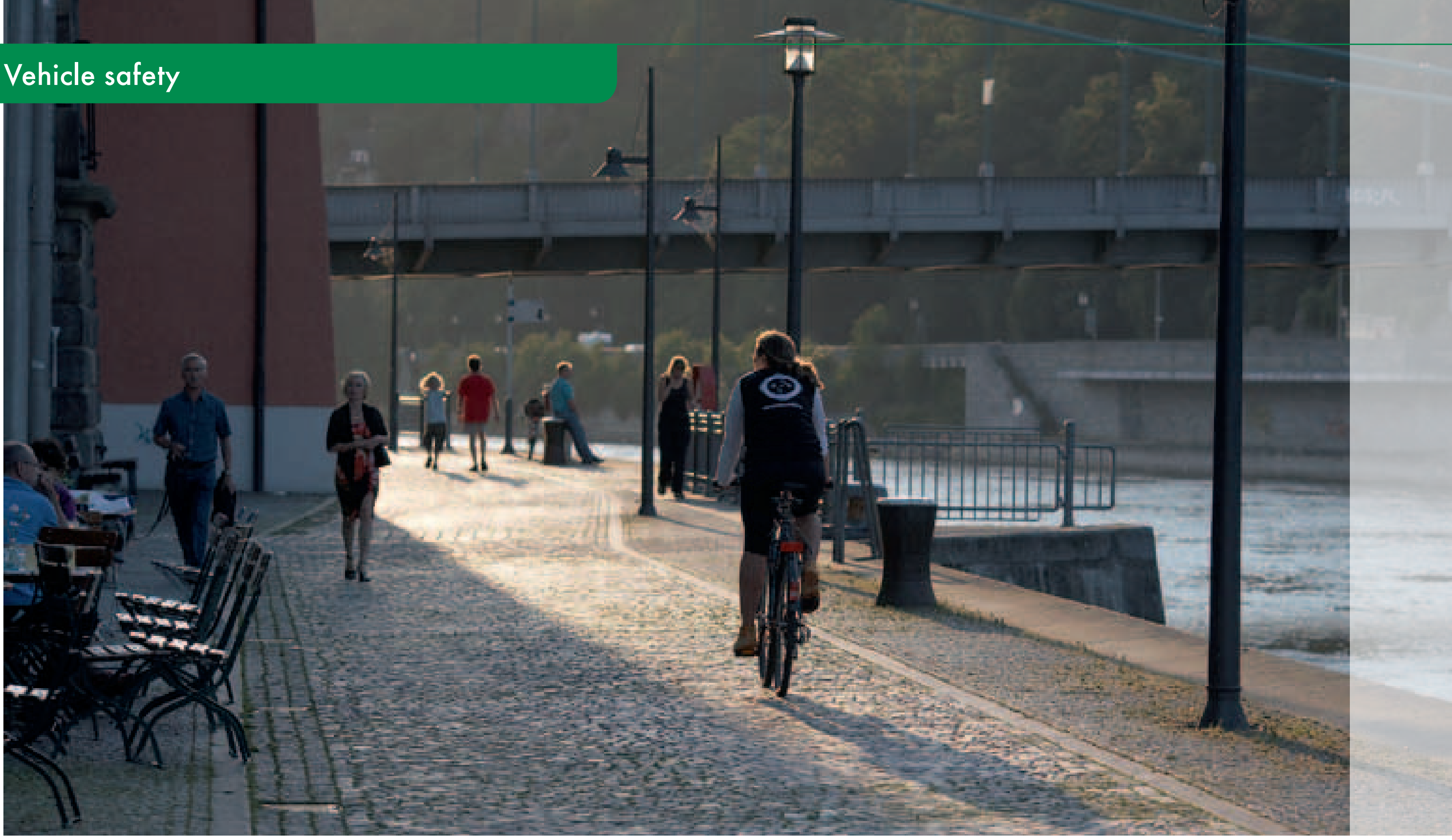
The same is true of the testing of the braking effect: in southern Europe measuring cycles are carried out at the roadside, while in Germany machine tests are the norm. As a result, both forms of testing were included in the standard with more or less the same requirements. The tests cover not only the maximum braking effect in dry conditions but also in wet conditions. Special tests are carried out to trace the reduction in braking power, which is called fading, especially in the sensitive drum and disc brakes.

The conformity of products with the CEN standards and proof of conformity is a step towards the completion of the European internal market. In the past there were trade barriers preventing, for example, a container with bicycles being unloaded in a country because the tests as set out in the relevant national standard had not been carried out in the laboratory accredited for the procedure.

The following relevant standards are to be applied (selection):

DIN EN 1078	2006-03	Helmets for cyclists and for users of skateboards and roller skates
DIN EN 14344	2004-11	Child use and care articles – Child seats for cycles – Safety requirements and test methods
DIN EN 14764	2006-03	City and trekking bicycles – Safety requirements and test methods
DIN EN 14765	2006-09	Bicycles for young children – Safety requirements and test methods
DIN EN 14766	2006-09	Mountain-bicycles – Safety requirements and test methods
DIN EN 14781	2006-03	Racing bicycles – Safety requirements and test methods
DIN EN 15194	2005-05	Cycles – Electrically power assisted cycles – EPAC bicycle
E DIN EN 15918	Draft	Cycles – Bicycle trailers – Safety requirements and test methods
ISO 4210		Cycles – Safety requirements for bicycles
ISO 6742-1		Cycles – Lighting and retro-reflective devices; Photometric and physical requirements – Part 1: Lighting equipment
ISO 6742-2		Cycles - Lighting and retro-reflective devices – Photometric and physical requirements – Part 2: Retro-reflective devices
ISO 8098		Cycles – Safety requirements for bicycles for young children

With the CE marking the manufacturer confirms the conformity of the product with the relevant EU Directives and compliance with the basic requirements established therein.



The cycle's safety condition should also be checked thoroughly on a regular basis. In this regard, DEKRA also makes an important contribution with its bicycle safety check in the sense intended by the European Road Safety Charter, DEKRA being one of its first signatories. In this context, once a year the bicycles of primary school children in at least 200 schools nationwide are checked free of charge. The children receive a cycle pass and a test badge, which certify that their bicycle is safe.

PROGRESSIVE BRAKING POWER

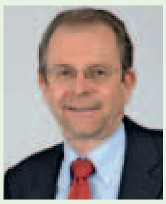
As well as lighting, the brakes also play a crucial role in ensuring that cyclists are safe. Section 65 of the StVZO stipulates that cyclists must have two independent, easy-to-use brakes to reduce speed. However, for two-wheeled vehicles, which include mopeds, the relevant EU directives impose stricter requirements, especially with regard to the effectiveness of the brakes. However, modern road traffic, in which cyclists participate on equal terms, requires cyclists to have deceleration devices that are effective under all conditions. This is taken into account by the latest individual European standards for safety requirements and test procedures for specific classes of cycles.

The most important of these is progressive braking power, which enables cyclist and cycle to slow down or stop in good time depending on the situation under all conditions. With today's rim brake, disk brake or drum brake systems, there is, of course, a risk that, if the brakes are not applied progressively, the cycle will decelerate too quickly and, in extreme cases, reach the locking limit and risk somersaulting. This risk is much higher than the opposite case of too little deceleration – previously often experienced with backpedal brakes and hub brakes, or front-wheel brakes, in which the brake block pressed against the tyre.

Nowadays, of course, bicycle brakes must also reliably allow smooth deceleration in wet conditions. Even if, when cycling in damp conditions, an initial stronger introduction of braking force may be necessary due to the design of the system, following a phase of dry braking, full brake power must not kick in abruptly, as this could cause the brakes to lock and the cycle to slide away.

VEHICLE-MOUNTED PEDESTRIAN AND CYCLIST PROTECTION

As far as the safety of pedestrians and cyclists on the road is concerned, the



Siegfried Neuberger, Managing Director of the German Two-Wheeler Industry Association (Zweirad-Industrie-Verband e.V. – ZIV)

"While the car industry is struggling as a result of the development of electric vehicles ready for series-production, electric bicycles have long been present in the street scene. Cycles with the so-called integrated tailwind are providing the necessary impetus, even when the wind comes from the front. In the mountains, bicycles with an electric motor make pedalling easy. So-called pedelecs make cycling more attractive, thus making a significant contribution to environmentally-friendly mobility. They remove the suffering of cycling from the passion of cycling: mountains are no longer intimidating, the headwind loses its force and so the daily journey to work – without any effort – becomes a pleasure. And it is economical as well: over a distance of 50 kilometres an e-bike consumes hardly more electricity than a two-minute hot shower. To ensure that all two-wheeled vehicles are also safe on the road, the German Two-Wheeler Industry Association (ZIV) is pushing for the further development of regulations and standards. With the "Pro Fahrrad – Rad fahren bewegt" initiative we want to raise the profile of the bicycle – with or without an electric motor – and promote its use."

The laws of physics

In accordance with the laws of physics, the potential for reducing the risk of a pedestrian being killed or injured in an impact against the front of a car is, in principle, limited. The mass ratio between a pedestrian and a car is 1:20. At a collision speed of 40 km/h with a car weighing 1,600 kilograms, under the simplifying assumption of a full-plastic impact, within a fraction of a second a pedestrian weighing 80 kilograms is accelerated to a speed of approximately 38 km/h during the impact, while the car loses approximately 2 km/h in speed. This shows that a passenger car can never really be made 'pedestrian-friendly' through passive safety measures alone.

construction of the vehicle, or rather, the safety equipment of the vehicle plays a fundamental role. This is especially true of passenger cars, as the other party most frequently involved in accidents both in urban areas and in non-urban areas. The German In-Depth Accident Study (GIDAS) initiated in July 1999 by the Federal Highway Research Institute (BASt) and the German Association for Research in Automobile Technology (FAT) provides an important framework for improving vehicle and road safety.

Every year, approximately 2,000 accidents involving personal injury in the area of Dresden and Hanover are recorded in the context of GIDAS. At the place where the accident occurred, the survey team records all the relevant information on vehicle equipment and damage, injuries to the persons involved, the rescue chain, as well as the conditions at the scene of the accident. Then, each of the persons involved is interviewed and detailed measurements are taken of the scene of the accident and the available accident traces. In addition to recording the relevant information at the scene of the accident, the survey team also records all subsequently available information in close cooperation with the police, hospitals and rescue services.

Each documented accident is reconstructed in a simulation program. The entire course of the accident is documented, beginning with the events leading up to the accident and the reaction of the persons involved, the collision, right through to when the vehicles come to a standstill. Characteristic parameters such as braking deceleration, approach and collision velocities as well as angle changes are ascertained. In GIDAS the scope of documentation amounts to up to 3,000 coded parameters per accident. Complementing the official statistics, the numerous collisions between cars and pedestrians investigated by GIDAS showed that the front of the car was the most predominant impact part, at 65 per cent, followed by the side of the car, at 28 per cent. Collisions between a pedestrian and the rear of a car, for example when the car is reversing, at 5 per cent, are relative rare. The most serious injuries resulted from an impact with the front bumper, an impact with the windscreen and windscreen frame, and the post-collision impact of the pedestrian with the road.

INTEGRATED VEHICLE SAFETY

With regard to the further improvement of vehicle safety in the case of an accident involving a car and a pedestrian, an impact with the front of the car in particular offers the greatest potential. To mobilise this potential, consideration should be given both to measures in the area of active vehicle safety for the prevention of accidents and to measures in the area of passive vehicle safety for the reduction of the consequences of accidents.

An example of measures to improve active safety is the so-called brake assistant. In the event of an emergency braking procedure, which this driver assistance system recognises on the basis of the characteristics of the braking procedure initiated by the driver, the build-up time of the deceleration is minimised and the applied brake pressure is maximised. For the average driver, significant shortening of the braking distance is therefore possible in recognised emergency situations. As a result, collisions can be avoided in an actual accident situation. If a collision cannot be completely avoided, at least the collision velocity is reduced. This can make a valuable contribution to reducing the severity of the accident. From a holistic perspective, the brake assistant has an impact in the area of passive and active safety and is therefore an example of an element of integrated vehicle safety.

An example of measures that have an impact solely in the area of passive safety are changes to the front of the vehicle

The development of the front of the vehicle using the VW Golf as an example

Golf I (1974 –1983)

Golf II (1983 –1991)

Golf III (1991 –1997)

Golf IV (1997–2003)

Golf V (2003 –2008)

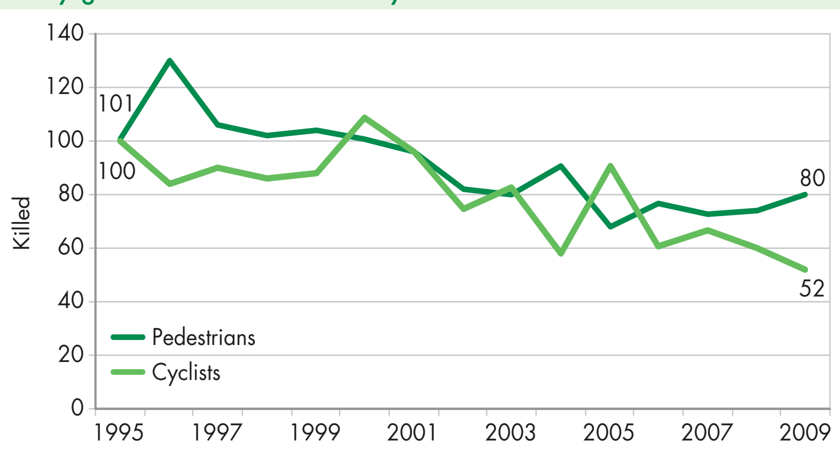
Golf VI (2008 – today)

The new mirror systems improve the indirect field of vision of the heavy goods vehicle driver.

in compliance with Directive 2003/102/EC of the European Parliament and of the Council relating to the protection of pedestrians and other vulnerable road users before and in the event of a collision with a motor vehicle, which came into force on 1st October 2005. The Directive sets out the basic requirements in the form of tests and limit values for the Community type-approval of motor vehicles with regard to pedestrian protection. These measures are intended to reduce the risk of pedestrians sustaining injuries in a frontal impact with a car with an impact velocity of 40 km/h to such an extent that the pedestrian has a realistic chance of survival. These measures have potential benefits especially in the case of accidents occurring in urban areas. The fact that, in the past few years, the protection of car occupants has improved while pedestrians and cyclists have remained largely unprotected and that there was thus a need for action on the part of the legislator was put forward, among other things, as an argument for the introduction of these tests. As pedestrians and cyclists do not have a 'crumple zone', it was vital to define and test appropriate impact-energy absorbing 'soft' zones in the external area of the front of the vehicle. The tests carried out are component tests with a variety of test specimens representing the head of a child, the head of an adult as well as a person's hip and leg.

43

Pedestrians and cyclists killed in urban areas in accidents involving heavy goods vehicles in Germany



Source: Federal Agency for Statistics

ELECTRONIC ASSISTANCE SYSTEMS ARE INCREASING

In recent years, the manufacturers' main objective in terms improving the front of vehicles has been to make the possible contact zones flexible and as smooth as possible. In this sense, measures to improve the aerodynamics of vehicles have had positive effects. Mirrors that snap off, plastic bumpers with foam inlays, recessed windscreen wiper arms, as well as a change to the front design have demonstrably changed the consequences of the injuries sustained by impacting pedestrians for the better. In addition, in the event of a collision with a pedestrian, pop-up bonnets and windscreen airbags provide additional deformation space and opportunities for energy to be absorbed in the event of head impacts. However, the opportunities for further measures to improve the external safety of cars are very limited, due to the limited availability of deformation paths to absorb energy. Nonetheless, considerable load reductions for impacting pedestrians were achieved through the use of deformation possibilities in the range of a few centimetres, for example at the front and rear edge of the bonnet and on the wheel arch. The hypothesis that changes to the front area have also contributed to reducing the consequences of accidents in the case of collisions with pedestrians is technically feasible and consistent with the historical trend in the numbers of pedestrians seriously injured or killed in road traffic accidents. Future measures integrated into new vehicles for reducing the severity of injuries must take into account, above all,

the problem of impact on the road. Finally, an analysis carried out on the basis of the GIDAS database showed that an impact on the road caused more head and hip injuries than an impact against the windscreen.

Measures in the area of passive safety alone, which are integrated into vehicles, therefore, only provide limited protection. It is possible to significantly reduce the numbers of pedestrians and cyclists killed or seriously injured on the road even further, especially through accident prevention measures, including the more widespread installation of assistance systems in passenger cars and heavy goods vehicles. Examples of this are the night vision systems already presented in detail in this section, automatic emergency braking systems, the turning assistant for heavy goods vehicles, which monitors the dangerous blind spot in front of and next to the vehicle for pedestrians and cyclists and warns the driver accordingly, or cameras and radar sensors installed in the vehicle, which focus on pedestrians and cyclists in particular.

The side protection device is intended to prevent the cyclist or pedestrian from sliding under the vehicle.

The HGV – a powerful opponent

Accidents involving heavy goods vehicles occur very frequently due to limited vision in connection with a very large blind spot. This applies in particular when HGVs turn right, which is one of the most dangerous situations in road traffic, especially for pedestrians and cyclists (Figure 43). Not only do children incorrectly assess the field of vision of the HGV driver, but pedestrians and cyclists often end up in the blind spot when they stop at a crossroads directly alongside the HGV, where they are difficult or impossible to see by the HGV driver. If the HGV then turns right, there is a high risk that they will be run over. The risk is just as great in cases where a vulnerable road user travelling straight on wants to drive past an HGV on the right in the belief that the driver can see him and confident of his own priority.

The EU reacted and prescribed the obligatory introduction of new safety devices especially for HGVs, including a mirror to reduce the blind spot and to improve the indirect field of vision (Directive 2003/97/EC). The new mirror systems are now able to seamlessly show a two-metre wide strip in front of and alongside the HGV. In this way, the number of dead and injured will fall significantly. The Directive has applied to new HGVs since 26th January 2007. In addition, under Directive 2007/38/EC all HGVs over 3.5 tonnes initially registered after 1st January 2000 had to be retrofitted by 31th March 2009.

A project investigating the risks posed to pedestrians and cyclists at crossroads by right-turning HGVs, which was awarded to DEKRA Unfallforschung by the Federal Highways Research Institute, also provides orientation for further action to increase the safety of pedestrians and cyclists on the road during a collision with a heavy goods vehicle. The analysis of 90 accidents showed that, in the majority of cases (57 per cent), the initial contact was made in the area of the right front edge of the HGV. An initial contact in the area of the side protection is only of minor importance (7 per cent). Half of the vulnerable road users ended up in front of the right front wheel or in its immediate vicinity under the HGV. More than half (62 per cent) were run over. Construction site and municipal vehicles were most often involved (46 per cent of cases) in the accidents investigated. In the case of construction site vehicles, the major cause was the larger frame height, which made it even harder for the driver to see.

The safety concept developed as part of the project includes measures such as the lowered lower edges of the windscreen and side windows and additional camera monitor systems, as well as the turning assistant and mirrors for reducing the blind spot, which are now prescribed by law. An acoustic alarm in the HGV, which is activated when the vehicle turns rights, would also be very helpful in informing vulnerable users. Another option is the use of the vehicle's side-marker lamps as an additional direction indicator when turning. Another proposal is to make design changes to HGVs, such as an additional window in the lower door region. To attain new, innovative solutions to the problem of the side protection of HGVs, changing Directive 89/297/EEC to a performance requirement is recommended.

Being run over is a problem in the case of collisions between HGVs and pedestrians. As part of the EU APROSYS project an optimised design for the front of the vehicle was developed, which redirects pedestrians and cyclists as well to the side of the HGV in the event of a collision. The vulnerable road user falls onto the ground next to the path of travel of the vehicle and is not run over. The accident is not prevented, but, in all likelihood, being run over is. This design can, in principle, be transferred to buses and trams. With the new tramway models, the existing covering to the clutch would only have to be optimised accordingly.

Potential for improvement not yet fully exploited

Despite the fact that the number of pedestrians and cyclists killed on the roads has been falling throughout Europe for years there is still a need for action in many areas. The European Road Safety Policy Orientations 2011–2020 point to the new goal: once again reducing by half the number of deaths on Europe's roads. All road users are called upon, through their behaviour, greater risk awareness and compliance with regulations and safety standards, to help attain this goal. Countless improvements in infrastructure are also desirable.

The previous section of this road traffic safety report clearly showed that the number of pedestrians and cyclists involved in road traffic accidents can be reduced even further by a whole series of measures. Although much has already been achieved, efforts should be aimed at preventing accidents from happening in the first place. Even when, for example, passenger cars, as the most common other party, travel comparatively slowly, extremely serious injuries are possible if there is a collision. Pedestrians and cyclists have no chance against the mass and speed of motor vehicles. The possibilities of reducing the potential danger caused by the front of a passenger car in a collision with a pedestrian are essentially limited. Very little can be done to prevent the subsequent impact against the road or kerb, which is often even more serious. Prevention is therefore the top priority.

RETRO-REFLECTIVE ELEMENTS FOR EARLY DETECTION

Numerous studies have shown that the risk of pedestrians and cyclists being involved in a road accident is especially high at twilight and in darkness, when they are spotted too late. To reduce this risk, it is highly recommended that vulnerable road users wear contrasting clothing, with reflecting elements, if possible. Retro-reflective elements in particular increase the distance at which vulnerable road users are visible many times over.

Responsible cyclists ensure that their cycle is fitted with all prescribed active and passive light systems. Active light systems preferably have a parking light function and are permanently and reliably powered by means of a hub dynamo with no appreciable step resistance. In conjunction with modern LED light sources, which produce a lot of light with very little energy, the optional installation of 'fully-fledged' light systems, with daytime running lights, brake lights and direction indicators, which are prescribed or permissible for (small) motorcycles, will, in the future, become possible for cycles. We should not have too long to wait for the adaptation of requirements to technical progress.

Retro-reflective elements on clothing and cycle can also save the lives of children under 15 and the elderly. As pedestrians and cyclists both these age groups are particularly at risk: children under 15 because, among other things, their risk awareness is as yet underdeveloped; the elderly because, from the age of 65 the risk of injury increases significantly. It these people are difficult to see and are spotted too late, the risk of accident also increases. In this connection, the elderly and the disabled are urged to fit their walking frames and walking aids, plus wheelchairs where relevant, with retro-reflective strips.

THE INTERPLAY OF DRIVER ASSISTANCE SYSTEMS

Car manufacturers also contribute to improving light and visibility conditions with headlight and recognition systems, which have become more efficient over the years, especially in non-urban areas. These include high-beam assistants, which switch automatically from low beam to high beam and back again when the road ahead is clear, and assistance systems that constantly adapt the luminous distribution of the headlamp to traffic conditions via an adaptive cut. There are also night vision systems, which work with light in the infrared region and generate a sharp image on a display or even directly in front of the windscreen, in which possible sources of danger, such as pedestrians or cyclists, are bright and depicted in pin-sharp definition, as well as being additionally marked.

It is desirable that such systems are offered as standard equipment and that vehicles are fitted with headlight systems with maximum light yield, which, at the same time, dip reliably for oncoming (vulnerable / non-motorised) road users. It is also desirable to implement further electronic assistance systems in cars and heavy goods vehicles even more strongly on the market. An example is the emergency brake assistant, which, in the event of an emergency braking procedure, minimises the build-up time of the deceleration is minimised and maximises the applied brake pressure. The significant shortening of the braking distance is therefore possible. As a result, collisions can be avoided or the collision velocity can be reduced. In addition to modern mirror and camera systems, the HGV turning assistant, which monitors the blind sport in front of and alongside the vehicle and warns the driver accordingly, makes a valuable contribution to greater road safety.

DEVELOPING AND MAINTAINING ROAD INFRASTRUCTURE

In addition to vehicle-specific safety elements, road infrastructure also plays a critical role in increasing road safety for pedestrians and cyclists. As most accidents between pedestrians and vehicles occur when their paths cross, crossings must be safe and pedestrians must be able to use them without having to make major detours. The duration of the green, flashing green and amber phases must be sufficiently long for the road to be cleared and, in addition, it must ensured, especially at heavily used crossings, that the crossing can be recognised as such by motorists in good time both during the day and at night, either through appropriate signage or road markings. It is just as important that the crossing is adequately lit. Road marking must be well maintained so that they are clearly visible in all weather both day and night.

For people with reduced mobility, the partially sighted and the elderly, crossing a road safely is often a major problem. In light of the demographic trend, not only in Germany but elsewhere, this group of persons is likely to experience rapid growth. Although the so-called zero-drop of the kerb to the level of the road surface at crossing points is probably the best solution for people with reduced mobility, wheelchair users, users of walker frames and for people pushing prams, the blind and visually impaired can no longer feel the edge of the pavement. It is therefore important that zero-drops are consistently constructed in a way that ensures that the blind and visually impaired are not put at risk.

There is also a problem as regards pedestrian crossings, or zebra crossings. Within the EU there are different regulations governing their use. In the United Kingdom, for example, unlike in Germany, Austria and France, vehicles do not have to stop before a pedestrian has set foot on the road. In a united Europe, it would be desirable for all traffic signs to have the same meaning.

It should also be born in mind that, in towns and cities, the bus and the tram are an important alternative to motorised private transport. The distance between home or the workplace and the nearest stop can in many cases be covered easily by bicycle. To promote this combination it is important that there is a sufficient number of suitable parking spaces for bicycles at stops. Good protection against theft and vandalism must therefore be guaranteed. Additional protection from the weather makes this option even more attractive.

Given the rise in bicycle traffic, it is also necessary to expand the network of cycle paths, especially in town and city centres. In addition, it is just as important to maintain existing cycle paths. If cycle paths are in bad condition, cyclists generally move onto the roads, despite the increased risk. A good level of maintenance is, in principle, essential for all road infrastructure installations. As far as Germany is concerned, central government, the Länder and local authorities must play their part. Road safety cannot be a question of money.

DEKRA's demands in brief

- More consideration on the roads
- Greater use of cycle helmets
- Wearing of contrasting clothing, with retro-reflective elements if possible
- Optimisation of road structure in terms of development and maintenance
- To have all cycles fitted with the prescribed active and passive light systems
- Regular bicycle safety checks
- Retro-reflective elements on walking frames, walking aids and wheelchairs
- Even stringer market implementation of electronic (light) assistance systems in car and heavy goods vehicles
- European-wide standardisation of traffic rules and regulations

25 000 LIVES TO SAVE
European Road Safety Charter

CYCLE HELMET PROTECTS AGAINST INJURIES

Cyclists must wear a helmet in a number of EU Member States: for example in Italy (children under 14), Spain (in non-urban areas), in the Czech Republic (cyclists under 18), in Sweden (children under 15) and in Finland. The German Society for Trauma Surgery is pushing for, among other things, a statutory obligation for cyclists to wear a helmet. In its opinion, around 90 per cent of all cerebrocranial injuries and up to 65 per cent of facial injuries could be prevented in this way.

The discussion should be continued dispassionately with a view to arriving at as uniform a regulation as possible. In view of the possible severity of the injuries following a collision with a car, and also in the event of a solo accident, cyclists are urged to wear a helmet that, as a minimum, complies with the current ECE standard. As a reminder, according to the Federal Highway Research Institute, in Germany the proportion of adult cyclists who wear a helmet is around 10 per cent.

MORE CONSIDERATION ON THE ROADS

All the measures and equipment recommendations that have been mentioned contribute to further increasing the road safety of pedestrians and cyclists. However, more considerate and responsible behaviour among road users is no less important. Such behaviour must be encouraged early on, for example when children are being trained in road safety, and as part of the driving test. Traffic rules and regulations are meant to be complied with by motorists, HGV drivers and motorcyclists as well as by pedestrians and cyclists. As Federal Minister for Transport, Building and Urban Affairs Dr Peter Ramsauer said in his preface to this report: “All road users should make it a point of honour to meet the requirements of Section 1 of the German Road Traffic Act. Courtesy is a legal and, above all, social obligation!”

Any questions?

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References

AAAM, The Abbreviated Injury Scale: 1990 Revision, Association for the Advancement of Automotive Medicine, Des Plaines, Illinois, 1990.

Alterssurvey, 2002.

Ashton, S.J., Mackay, G., Murray, Some Characteristics of the Population Who Suffer Trauma as Pedestrians When Hit by Cars and Some Resulting Implications. IRCOBI

Conference Gothenburg, Sweden, 5.–7. September 1979, Proceedings Seite 39–48.

Berg, A., Mattern, R., Pedestrian Head Impact on the Windscreen of Compact Cars. A New Test Rig and First Results. IRCOBI Conference, Montpellier, Frankreich, 2000.

Berg, A., Egelhaaf, M., Ebner, H., Estimation of Benefits Resulting from Impactor-Testing for Pedestrian Protection. Proceedings of the 18th International Technical Conference on the Enhanced Safety of Vehicles, Nagoya, Japan, 2003.

Berg, A., Egelhaaf, M., Benefit Potential of Different Approaches to Pedestrian Protection. FISITA World Automotive Congress, Barcelona, 23.–27. Mai 2004, Proceedings Paper No. F2004V106.

Berg, A., Rücker, P, König, J., Schwalbe, G., Falltests zur Untersuchung der Belastungen von Dummys beim Aufprall auf den Boden. 34. Kongress der Deutschen Gesellschaft für Verkehrsmedizin, Heidelberg, 15.–17. März 2007.

Brackemayer, U., Erhöhung der Verkehrssicherheit aus Sicht eines Verkehrsteilnehmers.

Polizei Verkehr und Technik PVT 2007, Heft 4, S. 124–127.

Brenken, G., Der Weg zum Sicherheitsautomobil. ATZ Automobiltechnische Zeitschrift 73 (1971) Nr. 5, Mai 1971, S. 170–178.

Brilon, W., Bondzio, W., Mini-Kreisverkehr – Eine runde Sache. Rubin 2000, Heft 1, S. 39–43.

Bundesanstalt Statistik Österreich, Straßenverkehrsunfälle Österreich 2009, Wien 2010.

Bürkle, H., Scheerer, J., Bakker, J., Binder, S., Sicherheit für Fußgänger – Fokus auf die vorgeschlagene Testmethode. 1. Dresdner Tagung „Verkehrssicherheit Interdisziplinär" Dresden, 2003.

CARE EU Road Accident Database 2008.

Cuerden, R., Richards, D., Hill, J., Pedestrians and their Survivability at Different Impact Speeds. 20th International Technical Conference on the Enhanced Safety of Vehicles (ESV) Proceedings, Lyon, 18.–21. Juni 2007, paper Number 07-0440.

Deffenbacher, J. L., Lynch, R. S., Oetting, E. R. & Swaim, R. C., The driving anger expression inventory: A measure of how people express their anger on the road. Behavior Research and Therapy, 40, Seite 717–737, 2002.

DEKRA, AXA Winterthur, Zu Fuß, auf dem Sattel, hinterm Steuer – wie gefährlich ist der Stadtverkehr?, Broschüre zu den Crashtagen in Wildhaus, Juli 2010.

Dirección General de Tráfico, Las principales cifras de la siniestralidad vial Espana 2009, Madrid 2010.

Drecoll, H., Das Fahrrad als innerstädtisches Verkehrsmittel – Verkehrssicherheitsprobleme. Vortrag im Rahmen des 47. Deutschen Verkehrsgerichtstags 2009 in Goslar.

EEVC-WG 17, Report „Improved Tests Methods to Evaluate Pedestrian Protection Afforded by Passenger Cars", Dezember 1998.

European Commission, White Paper – European Transport Policy 2010: Time to decide, 2001.

Flade, A., Limbourg, M., Das Hineinwachsen in die motorisierte Gesellschaft. Institut für Wohnen und Umwelt, Darmstadt 1997.

Galovski, T., Blanchard, E. B., Road rage, A domain for psychological intervention? Aggression and Violent Behavior, 9, Seite 105–127, 2004.

Grösch, L., Hochgeschwander, J., Die experimentelle Simulation von Pkw-Fußgänger- und Pkw-Radfahrer-Kollisionen. Verkehrsunfall und Fahrzeugtechnik, November 1990, Heft 11, S. 307–312.

Hara, M., Ohta, M., Yamamoto, A., Yoshida, H., Development of the Brake Assist System. 16th International Technical Conference on the Enhanced Safety of Vehicles (ESV) Proceedings, Ontario, 31. Mai bis 4. Juni 1998, paper Number 98-S2-P-17.

Heckendorf, M., Pilotstudie zum Aufbau einer virtuellen Fußgängerunfall-Datenbank mit anschließender numerischer Simulation von realen Unfällen mit der Software PC-Crash und Untersuchung von Maßnahmen zur Erhöhung der Sicherheit. Unveröffentlichte Arbeit der DEKRA Unfallforschung, Stuttgart, 2003.

Howard, M., Thomas, A., Koch, W., Watson, J., Hardy, R., Validation and Application of a Finite Element Pedestrian Humanoid Model for Use in Pedestrian Accident Simulations. Proceedings IRCOBI Conference – Montpellier (France), September 2000, Seite 101–119.

IRTAD International Transport Forum, Road safety 2009, 2010.

Istituto Nazionale di Statistica, Incidenti stradali 2009. Rom, November 2010.

Jonah, B. A., Age differences in risky driving. Health Education Research, 5, Seite 139–149, 1990.

Kallina, I., Pedestrian Protection: Looking for Potentials. IRCOBI Conference München, 18.–20. September 2002, Proceedings.

Knowles, M. S., Holton, E. F., Swanson, R. A., Lebenslanges Lernen. Andragogik und Erwachsenen Lernen. München 2006.

Koch, W., Howard, M., Sferco, R., Ganzheitlicher Ansatz zur Verbesserung der Fußgänger-Pkw-Kollision. Tagung Innovativer Kfz- Insassen- und Partnerschutz, Berlin, 6. und 7. September 2001, VDI-Berichte Nr. 1637, S. 325–355.

Limbourg, M., Schroer, J., Radis, N., Krevet, H., Müssen erst Kinder verunglücken, damit Schulwege sicherer werden? Verkehrskonfliktforschung auf Schulwegen in der Stadt.

Essen. Sicher Leben (Hrsg.): Bericht über die 2. Tagung „Kindersicherheit: Was wirkt?" am 27. und 28. September 1996 in Essen, Wien, 1997, S. 227–241.

Limbourg, M., Ansätze zur Verbesserung der Mobilitätsbedingungen für ältere Menschen im Straßenverkehr. In: Frank, H., Kalwitzki, K., Risser, R., Spoerer, E. (Hrsg.): 65 plus – Mit Auto mobil? In Motion – Humanwissenschaftliche Beiträge zur Sicherheit und Ökologie des Verkehrs. Band II, AFN und INFAR, Köln 2005.

Mobilität in Deutschland 2008, Ergebnisbericht, Bonn und Berlin, Februar 2010.

Observatoire National Interministériel de Sécurité Routière, La sécurité routière en France 2009. Paris 2010.

Otte, D., Huefner, T., Relevance on Injury Causation of Vehicle Parts in Car to Pedestrian Impacts in Different Accident Configurations of the Traffic Scenario and Aspects of Accident Avoidance and Injury Prevention. 20th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Proceedings, Lyon, 18.–21. Juni 2007, paper Number 07-0176.

Risser, R., Ältere Verkehrsteilnehmer in der Zukunft. In: Ammann, A. (Hrsg.), Kurswechsel für das Alter. Böhlau Verlag, Wien 2000.

Schönebeck, S., Demographic Change and Changing Mobility – Evidence in the German National Accident Statistics. Vortrag anlässlich der 4. IRTAD-Konferenz in Seoul, Korea, 2009.

Schubert, W., Mattern, R., Criteria for the evaluation of future assessment models of physical and mental fitness of drivers. In: Nickel, W., R., Sardi, P. (Eds.), Fit to Drive – 1st International Traffic Expert Congress Berlin, 3.–5. Mai 2006, Tagungsband, S. 106–110, Kirschbaum Verlag, Bonn 2006.

Shell Pkw-Szenarien bis 2030, Fakten, Trends und Handlungsoptionen für nachhaltige Auto-Mobilität, Hamburg 2009.

Statistisches Bundesamt, Verkehrsunfälle – Unfallentwicklung im Straßenverkehr 2009. Wiesbaden, Juli 2010.Statistisches Bundesamt, Verkehrsunfälle – Kinderunfälle im Straßenverkehr 2009. Wiesbaden, September 2010.

Statistisches Bundesamt, Verkehrsunfälle – Zweiradunfälle im Straßenverkehr 2009. Wiesbaden, November 2010.

Statistisches Bundesamt, Verkehrsunfälle – Unfälle von Senioren im Straßenverkehr 2009. Wiesbaden, Oktober 2010.

Tingvall, C., The Zero Vision – A Road Transport System Free from Serious Health Losses. Tagungsband Transportation Traffic Safety and Health, First International Conference, Göteborg 1995.

Walter, E., Cavegn, M., Allenbach, R., Scaramuzza, G., Fahrradverkehr – Unfallgeschehen, Risikofaktoren und Prävention, Schweizerische Beratungsstelle für Unfallverhütung, Bern 2005.

Walter, E., Cavegn, M., Scaramuzza, G., Niemann, S., Allenbach, R., Fußverkehr – Unfallgeschehen, Risikofaktoren und Prävention, Schweizerische Beratungsstelle für Unfallverhütung, Bern 2007.

White Paper, European Transport Policy for 2010: Time to decide. Commission of the European Communities, Brüssel, September 2001.

Yao, J., Yang, J., Otte, D., Investigation of Brain Injuries by Reconstructions of Real World Adult Pedestrian Accidents. IRCOBI Conference Madrid, 20.–22. September 2006, Proceedings, S. 241–252.

Zedler, D., CEN-Normen für Fahrräder: „Lebensretter" der Branche, SAZbike 4/2006.

Zeidler, F., Biomechanik und passive Sicherheit – Aktueller Stand bei Mercedes-Benz. Verkehrsunfall und Fahrzeugtechnik, Juli/August 1986, Heft 7/8, S. 191–196.

Zschibuschka, F., Straßenraumgestaltung im Sinne der Seniorensicherheit. Vortrag bei der Tagung Mobilität im Alter: Lust oder Last?, Wien, Oktober 1999.

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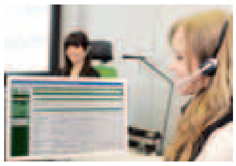
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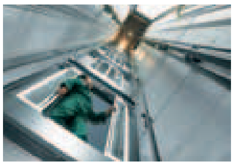
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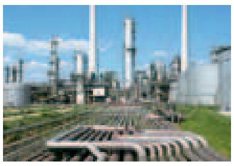
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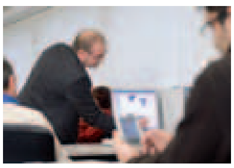
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