

DEKRA Automobil GmbH

DEKRA ROAD SAFETY REPORT 2016

Passenger Transportation

Accident Prevention Strategies
on Europe's Roads



Accidents:
Acute risk of
missing EU
targets for 2020

The human
factor:
Paying attention is the
best safety strategy

Vehicle
technology:
Saving lives through
technical safety





**ACCIDENTS
CAN BE
AVOIDED**

ON THE ROAD

AT WORK

AT HOME

**GLOBAL
PARTNER
FOR A
SAFE
WORLD**



DEKRA

On the safe side.



Tackling Challenges with Even More Focus

The number of road users killed or injured in the EU has been falling more or less continuously over a long period. Over the past two years, however, this positive downward trend seems to have stalled somewhat. Take Germany, for example: Here, the number of traffic fatalities in 2014 increased on the previous year by 1.1% to 3,377. According to provisional figures for 2015, as recorded by the German Federal Statistical Office, the 3,475 traffic fatalities point to an almost 3% increase on the previous year. Things don't look much better in France, either: Here, 3,384 traffic fatalities were recorded in 2014 – a 3.5% increase on 2013. For 2015, the "Observatoire National Interministériel de la Sécurité Routière" is forecasting a 2.4% increase in the number of traffic fatalities to 3,464. In Italy, too, the number of traffic fatalities in 2015 is expected to be higher than in 2014.

Given the EU's strategic target of halving the number of traffic fatalities between 2010 and 2020, this is an alarming trend. Indeed, there's an acute risk that this target will be missed. In light of the successes already seen, it will undoubtedly become ever harder to maintain the greatest possible year-on-year percentage reductions. All the more reason, therefore, to urgently call upon all stakeholders to make every effort to reverse the trend and mirror the successes of previous years. This challenge applies as much to vehicle technology as it does to infrastructure, road construction, legislation, traffic monitoring, emergency services, road safety education and other preventive measures. The focus, however, must always be on people – after all, it is people who, as road users, will always be vulnerable to hazards. That said, people can also help themselves to avoid hazards through their own behavior and so make an extremely important contribution to road safety.

Through its various activities, DEKRA, too, is committed to road safety – for example, the regular vehicle inspections that we perform make an im-

portant and recognized contribution to enhancing road safety, as do the numerous accident research projects and crash tests that DEKRA conducts. And our accident analysts are regularly called upon to investigate the causes of road accidents at the scene. Furthermore, our experts are highly valued by national and international committees as competent partners in dialog. Not to forget the numerous publicity campaigns that DEKRA regularly initiates.



*Clemens Klinke, Member of the Board of Management
DEKRA SE, Head of Business Unit Automotive*

Likewise, we consider the annual DEKRA Road Safety Report – first published in 2008 – as yet another contribution to ensuring that the number of people killed or injured on the EU's roads, wherever possible, keeps falling. With this latest report, DEKRA is once again providing food for thought, recommendations and advice for politicians, traffic and infrastructure experts, manufacturers, scientific institutions and associations, as well as all road users.

Where in previous years we devoted our efforts to, among other things, pedestrians and cyclists, rural roads, urban mobility and milestones especially in the development of new vehicle technology and the resulting future potential, this time our focus is on passenger transportation. One of our key focuses is the car – after all, cars still account for by far the biggest proportion of our means of individual mobility. At the same time, car drivers constitute the road user group most frequently involved in accidents with casualties: In Germany in 2014, the figure was 63.5%. It is precisely here that we need to act. In the following, DEKRA will discuss in detail what it considers to be the central spheres of activity.

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The new web portal
www.dekra-roadsafety.com



Since 2008, DEKRA has been publishing the annual European Road Safety Report in printed form in several languages. Coinciding with the publication of the DEKRA Road Safety Report 2016, the new web portal www.dekra-roadsafety.com is also going online. In this portal, not only can you find more detailed information on the content of the printed report (e.g. in the form of moving images or interactive graphics) but it also covers a range of other topics and DEKRA activities concerning road safety. When reading the printed version on your tablet or smartphone, you can call up the web portal directly using the QR codes.

Scan the codes using an ordinary QR code reader and you will be taken directly to the corresponding content.

IMPRINT

DEKRA Road Safety Report 2016 – Passenger Transportation

Publisher:
DEKRA Automobil GmbH
Handwerkstraße 15
70565 Stuttgart
Tel. +49.711.78.61-0
Fax +49.711.78.61-22.40
www.dekra.com
April 2016

Responsible for the publisher:
Stephan Heigl
Concept/coordination/editing:
Wolfgang Sigloch
Editing: Matthias Gaul
Layout: Florence Frieser
Project manager: Alexander Fischer

Realization: ETMservices, a Business Unit of EuroTransportMedia
Verlags- und Veranstaltungs-GmbH
Handwerkstraße 15, 70565 Stuttgart
www.etmservices.de
Business unit head: Thomas Göttl
Managing director: Oliver Trost
Translation: EVS Translations GmbH

Picture credits: Continental: Seite 48; Antonio Avenoso: 12; Wout van Bommel: 44; Daimler: 6; Jacques Demarthon: 14; DEKRA: 30–35, 52; dpa: 45; Alexander Fischer: 20, 23, 36; Fotolia: 1; Jacqueline Galant: 28; Getty Images: 1; Imago: 1, 3, 5, 6 (2), 7, 10, 11, 13, 16, 18, 24, 29, 39, 43, 46, 55, 60, 61, 62, 64; Erik Jonnaert: 49; Chris Keulen: 58; Thomas Küppers: 3, 26, 28, 37, 41, 56; Grazyna Lendzion: 59; Oliver Lang: 40; Museum of Copenhagen: 8; Dusan Mladenovic: 60; Melanie Schulz: 11; Alfonso Suarez: 19; Jan Pauls: 27; Paul Alan Putnam: 55.



A Safe Road to Future Mobility

A recent McKinsey study shows that Germany is the world leader in mobility. Nowhere else in the world are goods and people transported more effectively than right here. This is the foundation of our prosperity and the basis for unlimited freedom through individual mobility.

All of this requires a high-performance infrastructure and safety on the roads, to which independent testing organizations make an essential contribution. They guarantee the safety of progress in mobility in Germany and help to ensure the smooth flow of traffic on our roads.

Our goal is a 40% reduction in the number of traffic fatalities by 2020. The figures prove that we are on the right track, with fewer accidents occurring despite greater mobility and more traffic. Overall, the number of accident fatalities since 2011 has already fallen by 16%. This is testament not least to the success of our road safety program and other measures such as accompanied driving at the age of 17.

We want to build on this positive trend by implementing safety measures on our roads, providing information and educational advertising and making the jump to Mobility 4.0. To achieve this, we will be increasing our investment in infrastructure in the second half of the road safety program to a record level of around €14 billion in 2018. We are also pursuing targeted strategies such as the campaign against heat blow-ups aimed specifically at

reducing risk situations. In addition, we are supporting the market penetration of innovations such as the turning assistant for trucks and the eCall system. Furthermore, on the A9 in Bavaria, we have launched the "Digitales Testfeld Autobahn" project, a collaboration with the automotive industry and digital economy aimed at promoting automated and networked driving and, in so doing, paving the way for a whole new quality of road safety. To encourage more conscientious mobility, we are also investing record sums in educational campaigns alerting people to the dangers of excessive speed, inattention at the wheel or the importance of wearing a helmet when riding a bicycle or motorcycle.

Road safety is a joint task for politicians, road safety organizations and society as a whole. Through close collaboration, we can successfully build on the trend toward greater mobility and fewer accidents. DEKRA and its Road Safety Report are key fellow travelers on this journey.

Safe driving!



Alexander Dobrindt (MdB), German Federal Minister of Transport and Digital Infrastructure



Safely into the Future

The majority of traffic can still be found on our roads, a fact driven by not only globalization of the manufacturing economy but also increasing mobility in both our professional and private lives. But mobility has its price – traffic jams, exhaust emissions, noise and accidents with material damage and sometimes serious – even fatal – injury. This is why an integral approach is so urgently required for making road traffic better and safer. Automated driving and Mobility 4.0 can help to lay important foundations for this.

Whether by car, motorcycle, moped, pedelec, bicycle, public transport – buses, trains and airplanes – or on foot, “passenger transportation” is nothing more than a general term referring to the conveyance of persons from A to B, encompassing the technical, technological, organizational and economic conditions of the mobility of people and of the people themselves.

For decades, cars have accounted for by far the highest amount of passenger kilometers traveled by any mode of transport. This is shown by, among other things, the most recent figures published by the Statistical Office of the European Union (Eurostat) from 2012 (Figure 1). During the year in question, passenger cars accounted for 83.3% of all inland passenger transport in the EU-28; bus-

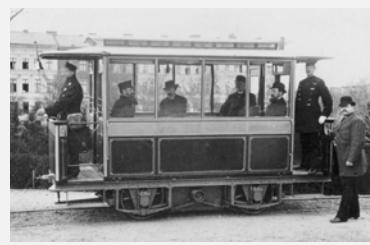
Milestones in passenger transportation

1662 The world's first horse-drawn omnibuses ("carrosses à cinq sols") enter service in Paris, although they are taken out of service again after just a few years.

1839 The first horse-drawn streetcar enters service in Europe between Montbrison and Montrond in France.

1863 The world's first underground railway opens in London.

1881 The world's first electric streetcar enters service in Berlin.



1886 The German inventor Carl Benz files the "Benz Patent-Motorwagen Number 1", heralding the age of the modern internal combustion automobile.

es, coaches and trolley buses 9.2%; and trains 7.4%. Between 2002 and 2012, car usage increased significantly in many states that joined the EU in 2004 and 2007 – in Bulgaria, for example, car usage rose by more than 30%. In contrast, the relative importance of the car as a mode of inland passenger transport fell in eight of the old EU-15 member states. Between 2002 and 2012, this trend was most clearly observed in Italy (minus 5.3%), Luxembourg (minus 3.3%) and the United Kingdom (minus 2.8%). But in the three biggest EU member states – Germany, Spain and France – the relative importance of the car also fell, even if only marginally by an average of around 1.5%.

MAJORITY OF JOURNEYS MADE BY CAR

A person's choice of transport depends on a number of factors – for example, on the purpose of the journey, age and personal finances. According to the statistical compendium "Transport in Figures 2014/15", which is compiled by the German Institute for Economic Research and published by the Federal Ministry of Transport and Digital Infrastructure (BMVI), more than 1.13 trillion passenger kilometers were covered in Germany in 2012. Of these, 915 billion were by motorized individual transport – and here, above all, by car. Recreational and vacation trips accounted for around 40% of these journeys (see also Figures 2 to 4). As the 2008 "Mobility in Germany" survey revealed, an "average person" takes 3.4 trips every day, covering a total of 39 kilometers, and with the average single trip covering almost 12 kilometers. Around 88% of all business trips and 70% of all journeys to work are taken by car or some form of motorized two-wheeler. Big differences can be observed in a person's choice of transport depending on whether they live in an urban area or in the country: Motorized individual transport has for years accounted for almost

1 Importance of selected forms of transport

In all EU member states, passenger cars account for by far the biggest proportion of inland passenger transport.

	2002			2012		
	Cars	Buses*	Trains	Cars	Buses*	Trains
EU-28	83.6	9.6	6.8	83.3	9.2	7.4
Austria ³⁾	79.4	10.9	9.7	78.5	10.0	11.5
Belgium ²⁾	82.3	11.4	6.3	80.4	12.4	7.1
Bulgaria	61.2	33.4	5.4	80.1	16.9	3.0
Croatia	82.2	13.3	4.5	85.8	10.7	3.5
Cyprus	77.4	22.6	–	81.3	18.7	–
Czech Republic ²⁾	79.1	18.7	7.5	74.8	16.8	8.4
Denmark	79.1	11.7	9.2	80.2	9.7	10.1
Estonia	71.7	26.5	1.8	83.6	14.6	1.8
Finland	84.1	11.1	4.8	84.9	9.8	5.3
France	86.4	5.0	8.7	85.1	5.4	9.5
Germany	86.2	6.7	7.1	85.4	5.7	9.0
Greece	75.1	23.0	1.9	81.6	17.7	0.7
Hungary ²⁾	61.1	25.0	13.9	67.7	22.2	10.1
Ireland	81.0	15.6	3.5	82.8	14.4	2.8
Italy	83.3	11.1	5.6	78.9	15.0	6.1
Latvia	76.6	18.6	4.8	76.9	18.3	4.8
Lithuania	82.0	15.4	2.5	91.0	8.2	0.8
Luxembourg	85.7	10.5	3.9	83.0	12.4	4.6
Malta	79.4	20.6	–	82.5	17.5	–
Netherlands	86.4	4.3	9.3	88.2	3.0	8.8
Poland ⁴⁾	77.0	13.5	9.5	84.6	10.7	4.8
Portugal ⁴⁾	84.9	10.9	4.3	89.3	6.6	4.1
Romania ⁴⁾	75.8	12.3	11.9	82.2	12.9	4.9
Slovakia	66.8	26.0	7.2	77.8	15.1	7.1
Slovenia	83.9	13.2	3.0	86.7	11.1	2.3
Spain	82.5	12.3	5.2	80.7	13.7	5.6
Sweden ²⁾	84.0	8.2	7.8	84.3	6.7	9.1
United Kingdom ⁴⁾	88.4	6.4	5.2	86.0	5.8	8.2
Iceland	88.6	11.4	–	88.5	11.5	–
Norway	89.0	6.9	4.1	89.7	5.6	4.7
Switzerland	80.1	5.1	14.8	77.7	5.1	17.2
FYR Macedonia	81.3	16.7	1.9	77.8	20.7	1.5
Turkey ²⁾	49.0	47.8	3.1	61.6	36.6	1.7

¹⁾Transit buses, coaches and trolley buses. ²⁾Not including motorized two-wheelers. ³⁾Passenger cars: break in series.

³⁾The railway in Liechtenstein is owned and operated by the Austrian ÖBB and is included in its statistics.

⁴⁾Buses: break in series.

Data source: Eurostat



1895 First regular service in Germany with a fuel-driven bus between Siegen and Netphen.

1900 The Paris Métro opens during the World's Fair.

1902 The German inventor Otto Schulze develops the eddy-current tachometer for road vehicles and has it patented in Berlin. Automobile manufacturers install speedometers as standard from 1910.

1907 In Offenbach, Germany, segregated cycle facilities are constructed along the "Offenbacher Alleenring". It is the oldest existing cycle path in Germany.

1912 The first electric traffic signal with red and green lights is installed in Salt Lake City, Utah.

50% of all traffic in urban areas; in rural areas, however, this figure is more than 60%. In urban areas, public transport networks are often much better developed and are used for around 15% of all trips, three times more than in rural regions, where only 5% of trips are made by public transport.

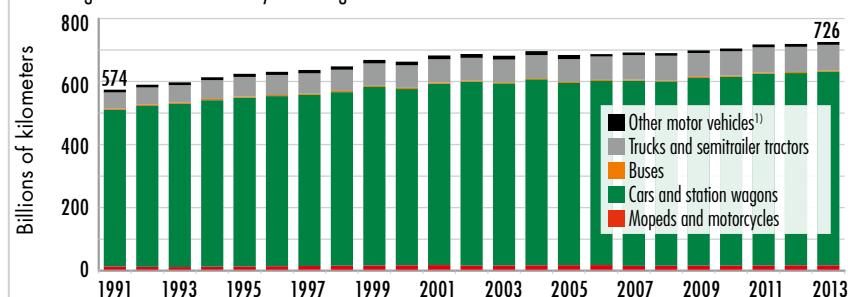
ROLE OF MOTORIZED PASSENGER TRANSPORTATION CONTINUES TO GROW

Numerous studies published over the past few years have focused on the traffic trends of the fu-

ture. At a detailed level, the individual studies and underlying assumptions contain significant differences, for example in terms of trends in transportation, technical progress as well as the social and economic framework. But one thing they all largely agree upon is that the role of motorized passenger transportation will continue to grow, if not quite as quickly as in the past. The latest Shell Passenger Car Scenario 2014, for example, expects the proportion of motorized individual transport in the overall share of land-based modes of transport to remain at the current level in the future, as well.

2 Total distance traveled by vehicle type

Passenger cars account for by far the greatest distances traveled.

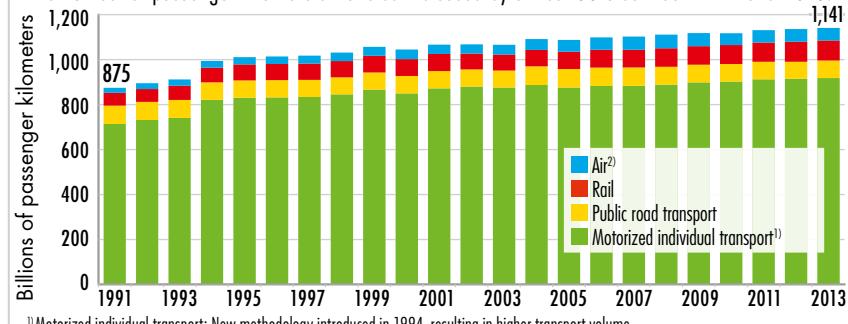


¹⁾ Conventional tractors with semitrailers and special-purpose vehicles not designed for conveying loads; as of 2006, vehicles with a specific function (e.g. motor homes, ambulances) are counted as passenger cars.

Data source: BMVI (Federal Ministry of Transport and Digital Infrastructure)

3 Proportion of people-carrying modes of transport

The number of passenger kilometers traveled increased by almost 30% between 1991 and 2013.



¹⁾ Motorized individual transport: New methodology introduced in 1994, resulting in higher transport volume.

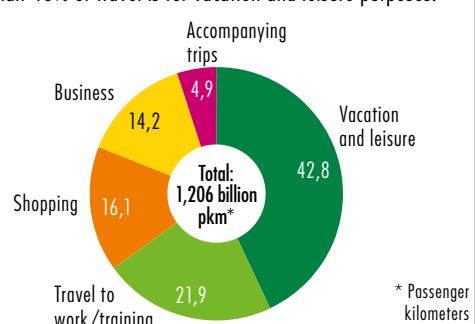
²⁾ Air traffic: New survey method introduced in 2010.



Data source: BMVI

4 Purposes of travel in 2012

More than 40% of travel is for vacation and leisure purposes.



Data source: BMVI

1921 Engineers working for the Radio Air Service at the McCook aviation experimentation station in Dayton, Ohio, unveil to the public the first driverless, radio-controlled car.



1933 Europe's first pedestrian light is installed in Copenhagen, Denmark. Pedestrian lights do not appear in Germany until 1937 (Berlin).

1937 The Berlin-based manufacturer Gaubschat unveils a passenger road train with corridor connection.

In other EU member states such as Italy, the use of motorized passenger transportation is also likely to increase. A study published in Rome in May 2015 by the social research institute Censis (Centro Studi Investimenti Sociali) and the association of car rental companies ANIASA (Associazione Nazionale Industria dell'Autonoleggio e Servizi Automobilistici) came to the conclusion that the number of people using cars will increase by almost 10% between 2010 and 2030.

MORE TRAFFIC FATALITIES IN 2015

Given that road haulage transport, too, is set to increase significantly – according to the BMVI, by 39% between 2010 and 2013 in Germany alone – the high volume of traffic will continue to constitute a major challenge particularly with regard to road safety. That much is clear when you look at the accident statistics for Germany in 2015. According to preliminary figures released by the Federal Statistical Office of Germany, the total number of accidents in which people were either injured or killed was 305,900 – a 1.1% increase on 2014. For the second time in succession, the number of traffic fatalities has also increased, this time to 3,475 – a 2.9% increase on 2014, when 3,377 traffic fatalities were recorded.

As the current figures for January to November 2015 show, the trends in the number of traffic fatalities in the various road user groups in Germany varied considerably. As the Federal Statistical Office of Germany reports, more car occupants (+ 61), more riders and passengers of officially licensed motorcycles (+ 41) and more pedestrians (+ 27) died compared with the first eleven months of the previous year. In contrast, fewer people died on insurance-licensed motorcycles (- 21) and on bicycles, including pedelecs (- 26).

1938 In May, the US magazine "Popular Science" publishes the first ever report on automated traffic of the future. It presents a vision of a world in which all cars follow electric cables that are buried beneath the pavements of superhighways and emit electromagnetic impulses that control the speed and direction of travel.

1951 The general inspection is introduced for motor vehicles in Germany. The general inspection is designed to ensure that the number of vehicles on the road with technical safety defects is kept to a minimum.

1952 Kässbohrer Fahrzeugwerke unveils the first modern articulated bus with a wide corridor between the front and rear carriage.

1954 A medical-psychological assessment (MPA) is introduced in Germany to assess a person's fitness for driving.

Violeta Bulc

European Commissioner for Transport



Harmonization of technical standards and promotion of new technologies

While road safety is a real European success story, we are still losing 70 lives on our roads every day. This is hard to accept, and there are a lot of things we can do to prevent road crashes or in some cases at least to limit their consequences.

The European road safety policy is inspired by the 'safe system' approach. This includes infrastructure design, such as "forgiving roads", as much as the safety of vehicles.

As far as the safety of vehicles is concerned, harmonising technical standards at European level has a great impact on road safety. We are working now on the implementation of the recent roadworthiness legislation, introducing tougher rules on vehicle testing in order to

prevent crashes linked to technical failure.

Promoting the use of new technologies, which can compensate errors and distraction or prevent offences, is also a priority. We encourage car manufacturers to commit to their deployment by working on the definition of standards and certification procedures. The most cost-effective safety systems should be adopted as standard vehicle equipment. The reviewed general safety regulation for type-approval will be an efficient legal instrument in setting the mandatory safety equipment for vehicles registered within the EU.

Road safety is indeed our common business and, together, we can do better!

This overall negative trend can be seen elsewhere, too, not just in Germany. The initial preliminary figures from France do not look promising, either. For 2015, the "Observatoire National Interministériel de la Sécurité Routière" (ONISR) forecasts a 2.4% rise in the number of traffic fatalities to 3,464 – with 2014 already seeing a 3.5% rise. The primary cause of 25% of fatal accidents was found to be excessive speed, with alcohol and drugs playing a role in another 25%. And, mirroring trends in Germany, 2015 saw significantly more people die in France as occupants of cars (+ 8%).



In 2015, German police recorded around 2.5 million accidents. The number of accidents resulting in physical injury rose by 1.1% compared with 2014 to 305,900.

AUTOMATED DRIVING OFFERS REAL POTENTIAL FOR PREVENTING ACCIDENTS

Against this background, the top priority must be to exploit every opportunity available to bring about a further reduction in the number of road accidents and casualties. Modern vehicles equipped with ever more advanced assistance systems and functions are already playing an important role. Accident researchers at the Allianz Center for Technology (AZT) have established, for example, that the number of accident-critical situations could be reduced by 32 to 82% if adaptive cruise control (ACC) and forward collision warning (FCW) were activated in 51% of cars on highways. On rural roads and in urban areas, too, such systems could help to cut the number of accidents by an impressive 32 to 45%. Mobility 4.0 key technologies play an important complementary role here, too. Thanks to intelligent infrastructure and the networking of vehicles to facilitate communication either between cars (car-to-car) or from cars to centralized and decentralized systems (car-to-in-

frastructure), these technologies can also help to further reduce the number of accident-critical situations and, in turn, the number of serious accidents resulting in death and serious injury.

Already today, some vehicles are semi-automated and networked. In the future, the number of vehicles featuring automated driving and networking functions will increase significantly. For road traffic, a number of digital “test fields” are currently being set up in Germany. One of these is a stretch of A9 Autobahn in Bavaria (“Autobahn 4.0”), on which partial and highly automated driving – and, looking ahead, even fully automatic driving from time to time – is to be trialled.

Important discussions and a diverse range of research projects are currently taking place in the field of automated driving. Journalists are reporting almost every day on “autonomous vehicles.” Depending on one’s existing knowledge, however, the terms are often blithely confused, leading to unrealistic expectations among consumers. Experts are now calling for the term “autonomous” (i.e. self-determined, self-reliant, independent) to be dropped in reference to ongoing vehicle automation.

DIFFERENT LEVELS OF AUTOMATED DRIVING

For a more effective classification of past, current and future developments, the companies that collaborate within the framework of the German Association of the Automotive Industry have developed a six-level system. This classification describes which tasks the vehicle assumes with its assistance systems and which are executed by the driver and/or what requirements are placed on the driver.

Level 0 describes permanent driving without actively intervening assistance systems. Here, the

1961 The inspection tag is introduced in Germany as verification that a vehicle has passed its general inspection.

1966 On February 1, the German TV broadcaster ARD starts broadcasting the series “Der 7. Sinn” [The 7th Sense]. Once a week, in a prime-time slot just before the main news, aspects relating to road safety, rules of conduct and tips for car drivers and adult road users are presented in a vividly presented. The last episode, for the time being, is broadcast in December 2005.

1968 In London, the Victoria Line enters service as the world's first fully automatic, computer-controlled underground railway line.

1968 The US Department of Transportation (DOT) launches a program for the development of experimental safety vehicles and, via its subordinate National Highway Traffic Safety Administration (NHTSA), initiates the international “Technical Conference on Experimental Safety Vehicles” (today, “Enhanced Safety of Vehicles” (ESV)). The conference continues to take place every two years at different venues all over the world.

driver assumes full responsibility for driving the vehicle, whether straight ahead or to the left or right. At level 1, the driver is supported by active systems that drive the vehicle straight ahead or steer it to the left or right. If adaptive cruise control regulates the speed and distance from the vehicle ahead, for example, the driver remains responsible for steering. However, the driver must be able to intervene in straight-ahead driving in critical situations in order to execute, for example, emergency braking. Conversely, active park assist can help to steer the car during parking, with the driver only having to operate the gas and brake pedal.

Level 2 describes partially automated driving, whereby the driver, in an appropriate situation, hands over full control of straight-ahead driving and steering to the vehicle and its assistance systems. However, the driver remains fully responsible for the vehicle. This means that they have to monitor the entire system at all times and intervene immediately if required by the situation, for example at low speeds on the highway when the traffic jam vehicle following function is active (highway traffic jam assist) or during semi-automated parking with a system that controls not only the steering but also the drive and braking.

For the highly automated level 3, a system is required that assumes responsibility for straight-ahead driving and steering and independently recognizes its functional limits at which the required environmental and other conditions are no longer ensured. It then prompts the driver to take control. The driver does not have to monitor the system constantly and can even devote their attention to other, more demanding secondary tasks. This is why it is important that the system prompts the driver to take over the controls with sufficient advance warning, giving them enough time to safely take over the driving task.

1970 The "European Enhanced Vehicle-Safety Committee" (EEVC), which focuses on preregulatory research, is founded as a European counterpart to the US ESV program. The EEVC developed, for example, the testing and inspection procedure for occupant protection in front and side collisions and the component tests for pedestrian protection.



1974 On January 1, three-point safety belts become mandatory in the Federal Republic of Germany on the front seats of newly registered cars. The installation of safety belts on the rear seats of newly registered cars does not become mandatory until May 1, 1979. On August 1, 1984, fines are introduced for not wearing safety belts.

1975 In Japan, Konuske Matsushita, the founder of Panasonic, unveils an e-bike.

Melanie Schultz van Haegen-Maas Geesteranus

Minister of Infrastructure and the Environment of the Netherlands



Promotion of intelligent mobility solutions

Innovations in the field of mobility – even if they seem so promising – often have a hard time winning recognition. "If I had asked people what they wanted, they would have said faster horses," Henry Ford once said. Fortunately, Ford followed his entrepreneurial insight and paved the way for journeys faster and longer than anyone had ever dreamed of before.

Today, more than a century later, cars are much more comfortable, efficient and safer. Fundamentally, however, car driving has changed little over time. The engine is still the beating heart of any vehicle. But even that, too, is changing. I am confident that software will one day replace the central role of the engine. This development will bring numerous benefits for society as a whole – for example, by reducing traffic jams, improving the quality of life and enhancing road safety. In a sense, you'll be able to create a whole new car with a simple software update.

I consider it my job to promote the development of intelligent mobility solutions, which is why I

have called for a change in Dutch law to allow manufacturers to perform comprehensive testing of their self-driving cars on public roads. We are collaborating with the industry according to the "learning by doing" principle. In this way, I am seeking to create a productive environment in which innovations are promoted.

Furthermore, it should be possible to cross national borders with an intelligent, self-driving car without the system needing to be reprogrammed to take account of technical or legal differences. For this reason, I am engaged in an ongoing dialog with the industry and my European ministerial colleagues. We are currently bound by international law from the era of Henry Ford, which states that "[e]very driver shall at all times be able to control his vehicle or to guide his animals." It's clearly time for this to be revised.

If we asked car owners in Europe today what they wanted, perhaps not everyone would respond with "a more intelligent car." But I am confident that self-driving cars will offer us unprecedented benefits.

Assisted, partially and highly automated driving at levels 1 to 3 has not only already been technically achieved, but is undergoing constant refinement and enhancement toward the fully automatic level 4. Due to the "Vienna Convention on Road Traffic" from 1968, however, the legal framework conditions do not (yet) allow even highly automated driving (level 3) under normal traffic conditions. Article 8 stipulates the following: "Every moving vehicle or combination of ve-

hicles shall have a driver." Article 13 goes further: "Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all maneuvers required of him." Driverless cars are, therefore, legally forbidden. In March 2016, an internationally recognized revision of the text was published to take future account of highly and fully automated vehicles (levels 3 and 4). According to this, systems

Antonio Avenoso

Executive Director of the European Transport Safety Council (ETSC)



Has Intelligent Speed Assistance's time finally come?

For years, speed has been recognised as one of the three main contributing factors to deaths on our roads. And for more than a decade, ETSC has been advocating the benefits of Intelligent Speed Assistance (ISA), a driver assistance system that a 2014 Norwegian study found to be the 'most effective' in saving lives. We are optimistic that 2016 could prove to be a turning point in wide adoption of the technology.

ISA uses a speed sign-recognition video camera and/or GPS-linked speed limit data to advise drivers of the current speed limit – and the most advanced systems can automatically limit the speed of the vehicle as needed (though the driver is still able to override the system). The first vehicles with this kind of ISA system factory fitted started appearing on the market this year – helped in part by Euro NCAP's decision to reward extra points for vehicles that include ISA.

The technology has also been boosted by the increasing use of hardware on vehicles such as GPS, front facing cameras and manual speed limiting systems which, effectively, can just be reprogrammed to add intelligent speed assistance as an option.

This year, the European Commission is expected to propose the next set of mandatory vehicle safety standards for the European market, and there are promising signs that ISA will be included. A report for the Commission by consultants TRL earlier this year found ISA to be 'feasible in terms of the technology required', already available on the market and offering a positive benefit-cost ratio.

The importance of the adoption of the technology cannot be underestimated. ISA is expected to reduce collisions by 30% and deaths by 20%. But waiting for the technology to trickle down from

premium cars to the mass market, would take years longer than a regulatory approach.

ISA has been trialled in many member states, and while drivers take a short time to adjust to the technology, the majority appreciated it. One obvious benefit, as Ford has pointed out in a recent marketing campaign, is that it helps drivers avoid speeding tickets.

While much of the hype in the media these days is concerned with autonomous vehicles, ETSC believes that policy-makers should not focus their regulatory eyes too far in the future. Semi-automated systems already available and approved for use have the potential to save many lives today. They should make sure that ISA, together with other proven technology such as Intelligent Speed Belt Reminders and Automated Emergency Braking, are fitted as standard as soon as possible.

1980s General Motors equips a number of its models destined for the US market with a black-and-white head-up display, which allows drivers to see what speed they are driving at without having to take their eyes off the road.

1982 With his study of the "Gelhard-E-Bike", Egon Gelhard lays the foundations for the pedelec principle.

1992 The "Contrôle Technique" – equivalent to the general inspection in Germany – becomes mandatory for all newly registered vehicles in France.

1995 Robert Bosch GmbH and Mercedes-Benz introduce the electronic stability program (ESP), a brake-based driver assistance system.

1995 "Vision Zero" is applied for the first time to road traffic in Sweden (target: zero traffic fatalities and zero serious injuries).

VISION ZERO.
NOBODY DIES. EVERYONE ARRIVES.

that influence the driving of a vehicle are permissible provided that they comply with the relevant internationally applicable legal regulations or they can be deactivated or overridden by the driver.

Finally, level 5 means that the driverless vehicle can travel from start to finish – even over very long distances – on all road types, in all speed ranges and under all environmental conditions. Only then can a vehicle be described as truly autonomous. Everyone in the car would simply be passengers. This is equivalent to the “Google car”, which received a huge amount of media attention and was originally designed without a steering wheel or pedals (Figures 5 and 6).

CHANGING THE LEGAL FRAMEWORK CONDITIONS

The fact is that highly and fully automated driving open up major potential for further reducing the number of accidents and, in particular, the number of killed or injured road users. Volvo, for example, is pursuing its vision of zero deaths or serious injuries in a new Volvo from 2020. And according to a forecast made by accident researchers at Daimler, by 2070 the number of accidents with casualties in which car drivers are mainly responsible could fall to almost zero. Even if these predictions might not turn into reality completely, they would entail further important steps toward “Vision Zero” – i.e. zero traffic fatalities and serious injuries. Of course, the legal framework conditions urgently need revising if this vision is to be realized. In addition to the aforementioned “Vienna Convention on Road Traffic”, further concrete amendments in traffic law need to be made, for example concerning the national and international provisions regarding the rights and obligations of road users as well as regulations regarding the registration of motor vehicles.

5 Levels of automated driving

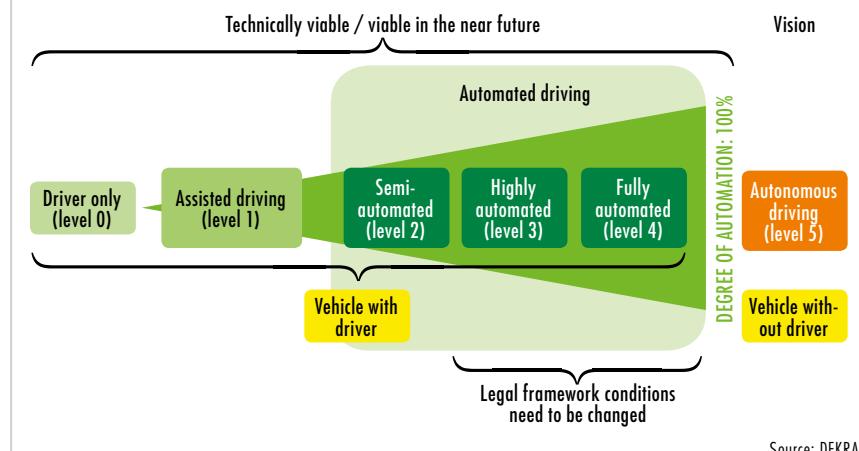
Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	100%
Driver only	Assisted	Semi-automated	Highly automated	Fully automated	Driverless	Degree of automation
Driver has to execute all longitudinal and transverse control maneuvers.	Driver has to execute longitudinal or transverse control maneuvers.	Driver has to constantly monitor the system.	Driver no longer has to constantly monitor the system.	No driver required in a specific case.	No driver required from start to finish.	
			Driver must be able to potentially take over the controls.			
No active intervention system.	System takes over a different function.	System has to execute longitudinal and transverse control maneuvers in a specific case*.	System has to execute longitudinal and transverse control maneuvers in a specific case*. It recognizes system limits and prompts the driver to take over the controls with sufficient advance warning.	System can handle all situations automatically in a specific case*.	The system assumes responsibility for all driving tasks on all road types, in all speed ranges and under all environmental conditions.	0%

*Cases here refers to road types, speed ranges and environmental conditions.

Source: VDA (German Association of the Automotive Industry)

6 Classification of vehicle automation

Technically speaking, automated driving up to level 4 is already feasible, but the legal framework conditions urgently need to be changed accordingly.



Source: DEKRA

1998 In Paris, the new driverless Métro line 14 opens.

1999 On October 1, it becomes mandatory for all newly registered coaches to be fitted with safety belts. Where safety belts are prescribed, it is also mandatory to wear them. The wearing of safety belts in coaches and long-distance buses becomes mandatory at EU level in May 2006.

2000 BMW launches the C1, the first and so far only two-wheeler in the world that protects the rider in an accident by means of a surrounding structure (aluminum space-frame design) and safety belt. The C1 can, therefore, also be ridden without a helmet.



Emmanuel Barbe

Interministerial Delegate for Road Safety

**Public transport in France must remain safe**

In France and in the rest of Europe, public transport counts among the safest forms of transport. This is the case not only for rail and air traffic but also for public road transport, with coaches involved in just 0.3% of all accidents with casualties in 2014 and urban buses in just 1.22%. The fact that it is not the occupants who are most at risk in an accident is hardly reassuring, however. While six people died in coaches and three people in urban buses in 2014, almost five times as many people (27) were killed in accidents involving coaches and seven times as many (21) in accidents involving urban buses. Regrettably, most of these victims were pedestrians.

Despite the tragic accident that occurred in October 2015 in Puisseguin (Gironde), in which 43 people were killed in the most appalling of circumstances, there is still no need to directly question the safety of this mode of transport. Even if the accident was triggered by a dramatic chain of events, it is still impossible to tell whether the findings of the ongoing investigation will lead to new recommendations regarding the safety of coaches. The government will be keeping a close eye on this.

Following the accident near Beaune in 1982, in which 53 people – including 44 children – were killed, the safety of public transport was declared a top priority. A whole raft of provisions were enacted: Mandatory wearing of safety belts for all coach occupants; reduction of the maximum blood alcohol content of drivers (0.2 g/l of blood); initial

and advanced driver training; and, since September 1, 2015, the across-the-board introduction of an alcohol immobilizer. Consequently, since 2010, the number of fatal accidents on public transport has fallen by 6%.

Unfortunately, this statistic is not necessarily all it seems. Since the number of traffic fatalities in France in 2014 increased, Bernard Cazeneuve – the Minister of the Interior – presented an emergency plan containing 26 measures aimed at improving road safety. On October 2, 2015, Prime Minister Manuel Valls convened the ministers most strongly involved in this matter to draw up a highly ambitious interministerial catalog of measures for improving road safety. The 22 main measures – in conjunction with the 33 accompanying measures – reflect the government's intention to identify and leverage every ounce of potential for avoiding fatal accidents.

In this, the ambitious continuation of the strategy of conducting radar speed checks plays a central role. Outsourcing the use of mobile radar vans to approved companies, the installation of dummy speed cameras, the possible use of drones, not to mention the imminent use of speed radar traps that can also identify coaches are all key milestones toward reducing speeding on our roads and make an important contribution to road safety.

Of particular note is measure 21, which allows freight carriers to check whether the driver's licenses held by their employees are valid. This measure, which

address a long-standing and justified demand on the part of freight carriers, is without doubt an important step toward addressing the obvious fact that driver's licenses – unlike other forms of ID – occupy a unique position and should be available not only to law enforcers.

Despite the impressive successes that have been achieved, road safety remains a high-priority task because the unacceptably high number of traffic fatalities in France – 3,464 in 2015 – does not even begin to reflect the number of road traffic incidents that saw 26,143 people hospitalized in 2015.

2001 The first color head-up display is installed in the Chevrolet Corvette.

2003 BMW becomes the first European manufacturer to introduce the head-up display, installing it in the 5 and 6 Series.

2003 On November 17, the European Parliament and Council of the European Union enact Directive 2003/102/EC for the protection of pedestrians and other vulnerable road users. This stipulates that the front ends of cars must undergo a series of component crash tests to verify that certain biomechanical limits are not exceeded. The impactors used during testing represent the parts of a pedestrian's body that are most at risk of injury (head, pelvis and leg). Since October 2005, newly certified vehicle types are required to undergo testing in this way.

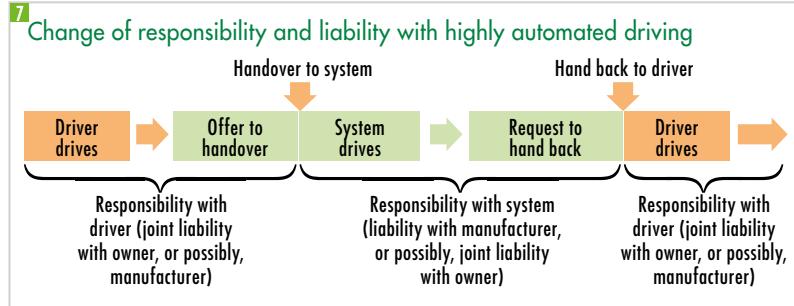
2007 The DARPA Urban Challenge – an international competition for unmanned vehicles in an urban environment – takes place in the USA.

2008 Germany's first fully automatic, driverless underground railway travels through Nuremberg.

2011 In the "Road Safety Guidelines 2011–2020", the European Commission formulates its goal to halve the number of traffic fatalities between 2010 and 2020.

Even in conjunction with the introduction of highly automated vehicle functions (level 3), liability issues have to be clarified (Figure 7). Responsibility for driving traditionally lies with the driver of the vehicle, although the vehicle owner is co-liable in the event of an accident within the scope of their responsibility – for example regarding the technical condition of the vehicle or the surrender of the vehicle to the driver. The manufacturer, too, may also be liable if a product defect caused or contributed to the accident.

Overall, it is highly likely that, already by the end of the second decade of this century, numerous car manufacturers will be offering cars featuring functions enabling partially automated driving (level 2) on highways or for parking – and not just in the luxury segment. By that time, associated systems will probably be sufficiently technically advanced to enable highly automated driving



(level 3). Whether this will be possible for normal drivers on public roads, however, seems less likely as things currently stand. Among other things, level 3 driving would have to be allowed within the framework of applicable, further amended legislation and of the associated subordinate regulations and implementing regulations, including clarification of liability.

The facts at a glance

- Cars account for by far the highest amount of passenger kilometers traveled by any mode of transport.
- Motorized individual transport has for years accounted for almost 50% of all traffic in urban areas; in rural areas, however, this figure is more than 60%.
- The use of motorized passenger transportation in Germany and other EU states is set to increase by around 10% between 2010 and 2030.
- The number of traffic fatalities in several EU states rose again in 2015.
- Modern vehicles equipped with assistance systems and functions are making an important contribution to further reducing the number of road accidents and victims.
- Highly and fully automated driving will require numerous amendments to the existing legal framework conditions.

2014 From November 1, all new road vehicles – including everything from cars to heavy buses and trucks and their trailers – in the EU must be equipped with electronic vehicle stability control (EVSC), generally known as ESP or ESC. This requirement has already been in place for newly type-approved vehicles since November 1, 2011. This equipment requirement is based on EU regulation no. 661/2009.

2015 From July 1, technical testing organizations in Germany are required to use a main inspection adapter during general inspections on cars. This is used for inspecting electronic vehicle components and is designed for the increasingly complex technology installed in cars.

2015 In September, a section of the A9 highway in Germany becomes a designated “test track” for automated and networked driving.

2015 From November 1, in the EU, newly registered heavy-duty trucks (more than 3.5 t gross weight rating) and buses with more than eight seats (not including the driver's seat) must be equipped with an advanced emergency braking system (AEBS) and a lane departure warning system (LDWS). This requirement has already been in place for newly type-approved vehicles since November 1, 2013 and is also based on EU regulation no. 661/2009.



Acute Risk of Missing Eu Targets for 2020

When it comes to road accidents with casualties, car occupants account for the highest number of fatalities and injuries. In Germany alone in 2014, almost 50% of all people killed on the roads were occupants of a car; among those suffering minor and serious injuries, this figure was more than 55%. Furthermore, almost two thirds of all people involved in accidents with casualties were car drivers. And things don't look much different EU-wide, which is due no doubt to cars' sheer dominance on the roads – more than half of all journeys are made by car. However, the figures also show that, in terms of mobility behavior, this vehicle category and its users still offer the biggest potential for initiating a distinctive downturn in the number of road accident victims. At the same time, the number of vulnerable road users such as riders of two-wheeled vehicles and pedestrians is also increasing, which means that even more attention must be devoted to these road user groups in the future. Demographic change also ultimately gives rise to additional challenges.

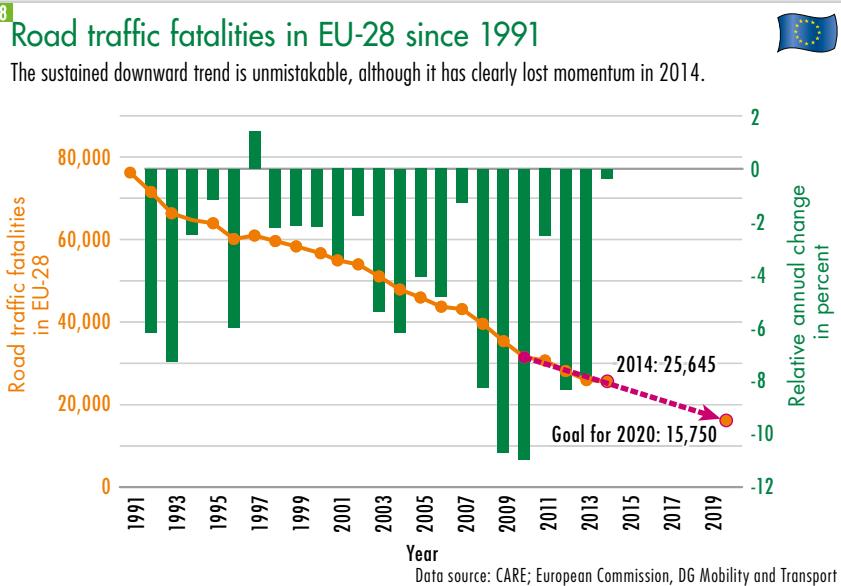
The judgment of Violeta Bulc, the EU Commissioner for Transport, at a press conference last year in Brussels could hardly have been more sobering when she stated that, in her view, 2014 was a re-

ally bad year for road safety, particularly in terms of the unfavorable development compared with 2013. Although the number of traffic fatalities fell by 1.2% to around 25,700, this percentage decline was a long way from the fall needed to achieve the European Commission's strategic goal of halving the number of traffic fatalities between 2010 and 2020. In figures, this would mean that the number of traffic fatalities on Europe's roads would have to be less than 16,000 in 2020. This would be just about possible with a percentage decline of around 7.8%, as was the case from 2012 to 2013 (Figure 8).

8

Road traffic fatalities in EU-28 since 1991

The sustained downward trend is unmistakable, although it has clearly lost momentum in 2014.

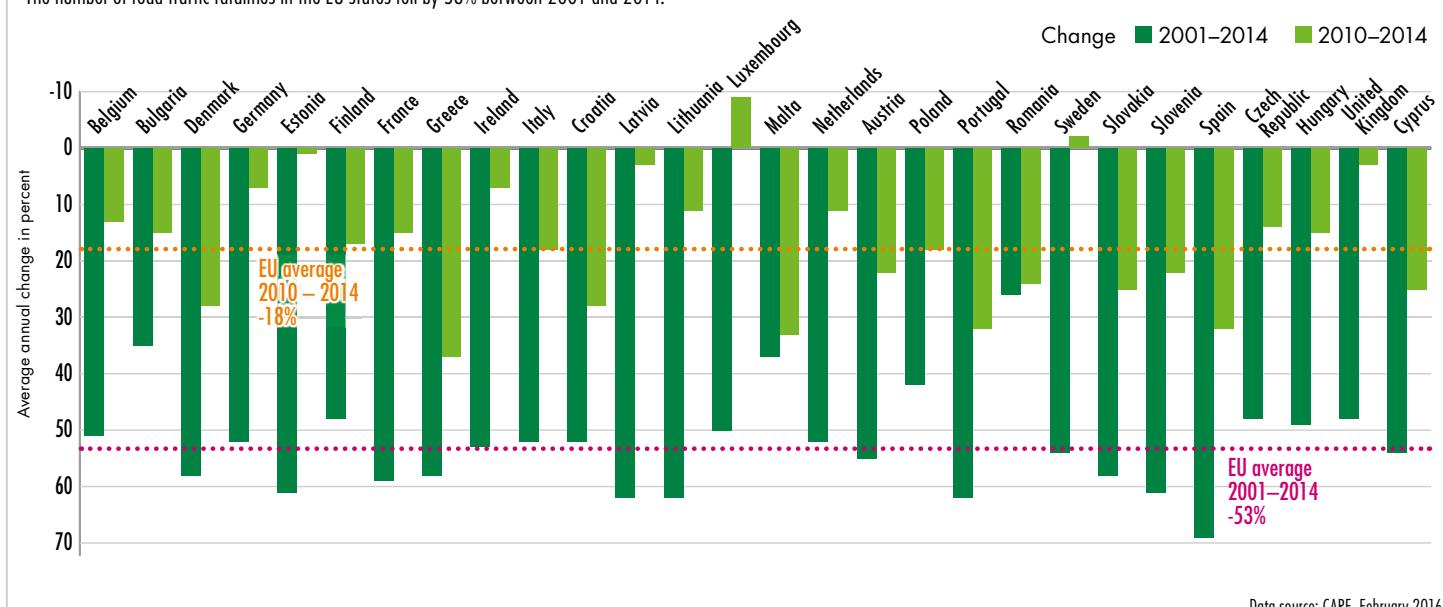


The Commissioner noted that the EU member states above all must be responsible for everyday road safety, for example by enforcing traffic regulations, launching public information campaigns and expanding and maintaining infrastructure. The EU bears some responsibility, too: Through legal provisions and recommendations concerning, for example,

9

Fatalities in the EU member states

The number of road traffic fatalities in the EU states fell by 53% between 2001 and 2014.



minimum requirements regarding the registration of new vehicle types, technical vehicle monitoring and the harmonization of technical standards, it can play a role in improving the safety of Europe's roads.

BIG GAP BETWEEN POORER AND RICHER COUNTRIES

Broken down by member state, the statistics published by the EU Commission show that big differences still exist when it comes to the number of fatal accidents. The average number of traffic fatalities in the EU in 2014 was around 51 per million inhabitants. With around 30 per one million inhabitants, the Netherlands, Sweden and the United Kingdom still have the fewest traffic fatalities. In four countries, 2014 saw more than 90

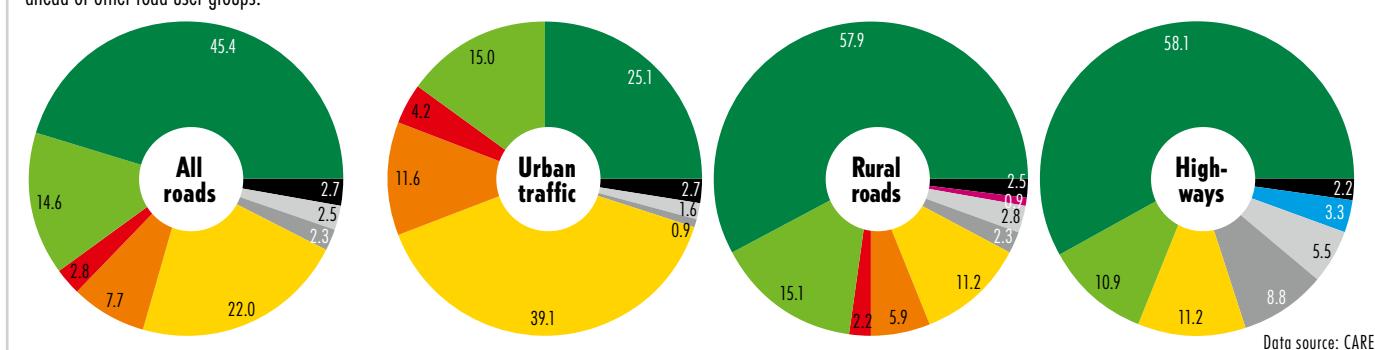
traffic fatalities per million inhabitants: Bulgaria, Latvia, Lithuania and Romania. The most dangerous roads in the EU are in Latvia, where 106 traffic fatalities per million inhabitants occurred in 2014. In Germany, the number of traffic fatalities per million inhabitants increased from 41 in 2013 to 42 in 2014.

According to the European Commission, some member states – particularly Greece, Malta, Portugal and Spain – have enjoyed an above-average improvement in road safety over the years. Denmark, Croatia, Austria, Romania, Slovakia and Cyprus have also seen an above-average decline in the number of traffic fatalities between 2010 and 2014 (Figure 9). In all states, nearly half of all road users involved in accidents were in cars (Figure 10).

10

Traffic fatalities in the EU by road user group and location

Across the EU, car occupants account for the highest number of traffic fatalities – on rural roads and highways, in particular, the figure is almost 60%. In urban areas, pedestrians account for nearly 40% of fatalities, significantly ahead of other road user groups.



Accidents



■ *Urban areas in particular have a diverse range of road user groups, linked to a correspondingly high risk of accidents.*

If one compares road safety in Europe with other parts of the world, it quickly becomes clear that the gap particularly between poor and rich regions is very big. As shown in the “Global Status Report on Road Safety 2015” published by the World Health Organization (WHO), there are 93 traffic deaths for every 1 million inhabitants in Europe; in Africa, this figure rises to 266. In the USA, the figure is 106; and in China, 188 (see also Figure 11). According to the WHO, the greatest successes are achieved by those countries that implement strict traffic rules and that have made roads and vehicles safer. For example, safety belts are a statutory requirement for all car passengers in 105 countries. 47 countries impose speed limits of 50 km/h or lower in residential areas. 34 countries place

a limit on the maximum blood alcohol content, while motorcycle helmets are compulsory in 44 countries. Regardless of this, however, the number of traffic fatalities worldwide remains high and, since 2007, has stagnated at around 1.25 million. And injuries sustained during road accidents remain the most common cause of death among 15- to 29-year-olds. According to the WHO, more than 300,000 young people worldwide were killed in road accidents in 2012.

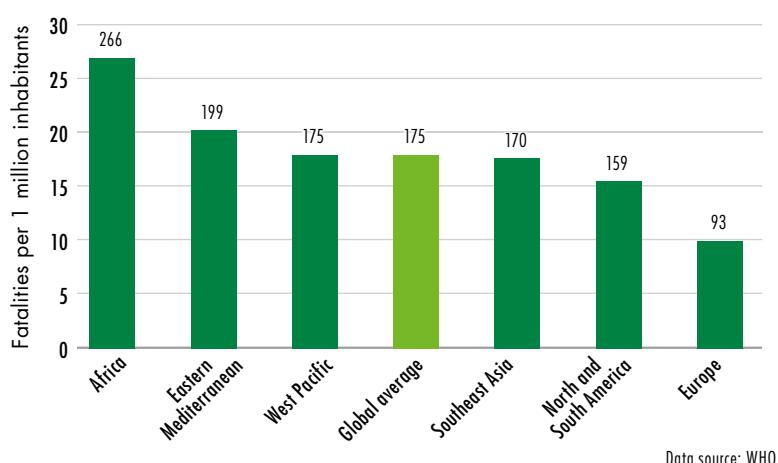
MORE DEATHS IN GERMANY IN 2014 AND 2015 THAN IN PREVIOUS YEARS

If one looks at the statistics for Germany over the past few years, the trend looks fundamentally positive. This is the gist, too, of the mid-term review, presented by Federal Minister of Transport and Digital Infrastructure Alexander Dobrindt, of the “Road Safety Program 2011–2020.” While 4,009 people died on German roads in 2011, by 2014 this figure had fallen by around 16% to 3,377. In relation to 2010, during which 3,648 people died, the decline is just 7%.

In the minister’s view, however, Germany is still well on course to achieve the goal, specified in the 2011 road safety program, of improving road safety and reducing the number of traffic fatalities by 2020 by 40%. But it must not be forgotten that, according to figures released by the Federal Statistical Office of Germany, the number of traffic fatalities in Germany in 2014 had increased by 1.1% compared with 2013. The number of people sustaining minor and serious injuries also increased

11 Traffic fatalities worldwide in 2013

Europe features very low on the ranking compared with other parts of the world.



by 3.8% and 5.7% respectively. And, according to preliminary figures released by the Federal Statistical Office of Germany, 2015 saw 3,475 traffic fatalities nationwide, equivalent to a 2.9% increase on 2014.

As in most EU member states, most fatalities in Germany continue to occur on rural roads. Even so, however, the number of fatalities on rural roads fell by 17% between 2011 and 2014. The decline since 2000 is as much as 58%. Almost 30% of fatalities occur on roads within built-up areas. Between 2011 and 2014, the number of such fatalities fell by 12%. That the risk of accidents on rural roads is much higher than on other roads is also confirmed by the ratio of persons killed to accidents with casualties: While 2014 saw five deaths in 1,000 accidents with casualties in urban areas, the corresponding figure for highways was 20 and for rural roads as high as 27 (see also Figures 12 and 13).

As the Federal Statistical Office of Germany also reports, in Germany in 2014 almost all road user groups recorded more fatalities than in the previous year. The biggest increase was among fatally injured users of insurance-licensed motorcycles (87 deaths = + 19.2%), followed by cyclists (396 deaths, + 11.9%) and users of officially licensed motorcycles (587 deaths = + 3.3%). In contrast, the number of pedestrians killed (523 deaths = - 6.1%) and occupants of trucks (143 deaths = - 3.4%) fell. If one looks at these trends by road user group over the past five years, it is clear that huge advances have been made for car occupants. When it comes to cyclists, motorcyclists and pedestrians,

Raimundo García Cuesta

President of the AEA (Asociación Española de Accidentología Vial)

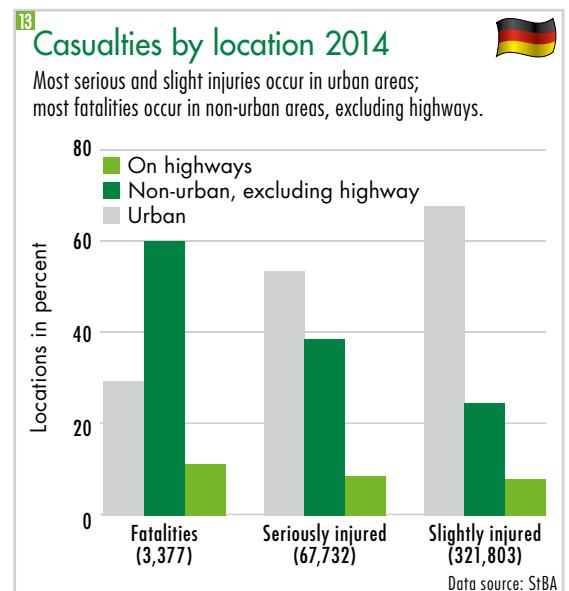
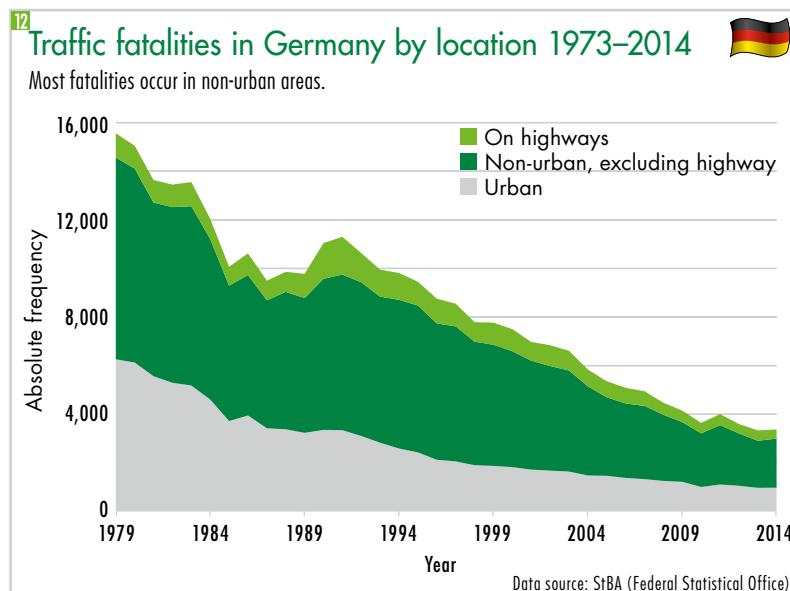


Introduction of a quality system in road safety management

The general road safety situation in Spain has improved dramatically over the past few years, with Spain now one of the countries that has experienced a significant reduction in the number of traffic fatalities. This success can be attributed not only to decisive action on the part of legislators but also the participation of society as a whole. Indeed, with 650 signatories, Spain's level of participation in the European Road Safety Charter is without doubt among the highest in Europe. This gives an insight into the level of social commitment when it comes to matters of joint responsibility.

But changing times and the challenges imposed by European politicians – of which the Spanish road safety strategy is a direct product – mean that advances have to be

made and new solutions found for old problems. With this in mind, and in a world of continuous improvements in infrastructure and the technical development of ITS (intelligent transport systems), it is important to focus attention on the human factor without ignoring measures that have already proved effective. The smartest thing would be to use social commitment as a foundation. In this way, resources are optimized, synergies are supported and greater success rates are achieved. The drive to introduce a quality system in road safety management with the aim of instilling a real culture of road safety, which must be accompanied by training and awareness-raising measures, seems to be one of the most effective means of achieving this target.



THE RISK OF DYING IN A CAR ACCIDENT HAS FALLEN BY MORE THAN 70% SINCE 1995

however, the trend has stagnated somewhat, which is why these road user groups will continue to represent a key focus for politicians in efforts to improve road safety.

SIMILAR TRENDS IN FRANCE, ITALY AND SPAIN

Looking beyond Germany, a similar trend can be observed in, among other countries, France. Here, too, the total number of traffic fatalities is falling – by 15.2% to 3,384 between 2010 and 2014 – although in 2014 around 3.5% more road users died than in 2013. Likewise, statistics published by the “Observatoire National Interministériel de la Sécurité Routière” (ONISR) show an almost 4% increase

in the number of minor injuries and 2.6% more serious injuries. As far as traffic fatalities are concerned, the biggest increases were seen among pedestrians (+ 7.3%), cyclists (+ 8.2%), moped riders (+ 3.8%) and car drivers (+ 3.0%) (see also Table 14).

Two further statistics should also give pause for thought: More than 750 people – so almost a quarter of all traffic fatalities – died in accidents in cars driven by someone who had held a driver’s license for less than two years. And more than 10% of car occupants killed were not wearing a safety belt. The ONISR also points out another alarming trend: Pedestrians and cyclists are the only two road user groups not to be included in the positive overall trend observed since 2010. The number of pedestrians killed increased by 4% and the number of cyclists killed increased by 7%.

In its latest statistics, the ONISR has also put a figure on the economic cost of all the road accidents that occurred in France in 2014: €37.5 billion, or around 1.5% of the gross domestic product. Fatalities account for €10.7 billion, serious injuries €10.5 billion and minor injuries €700 million. On top of this are €300 million for material damage caused by accidents with casualties and €15.3 million material costs for accidents without casualties.

Fatalities by road user group in 2014 in France

At around 50%, passenger car occupants accounted for the highest number of traffic fatalities in 2014 in France.



Type of road user group	Fatalities 2014	Percentage
Pedestrians	499	14.7%
Cyclists	159	4.7%
Mopeds	165	4.9%
Motorcycles	625	18.5%
Cars	1,663	49.1%
Light commercial vehicles	143	4.2%
Heavy commercial vehicles	56	1.7%
Public transport	9	0.3%
Small cars and three-wheelers	24	0.7%
Other	41	1.2%
Total	3,384	100%

Data source: ONISR (L’Observatoire national interministériel de la sécurité routière)

■ Like here in Croatia, some countries have put up large signs telling drivers to stop before they drive the wrong way onto the highway.

Wrong-way driving on the highway



Italy, too, has seen a positive trend over the past number of years (Figure 15). According to figures released by the “Istituto Nazionale di Statistica” (Istat) between 2001 and 2014, the number of traffic fatalities fell from 7,096 to 3,381 – a decline of around 52%. The majority of those killed on the roads in 2014 were car occupants (1,491), followed by motorcyclists (704), pedestrians (578) and cyclists (273).

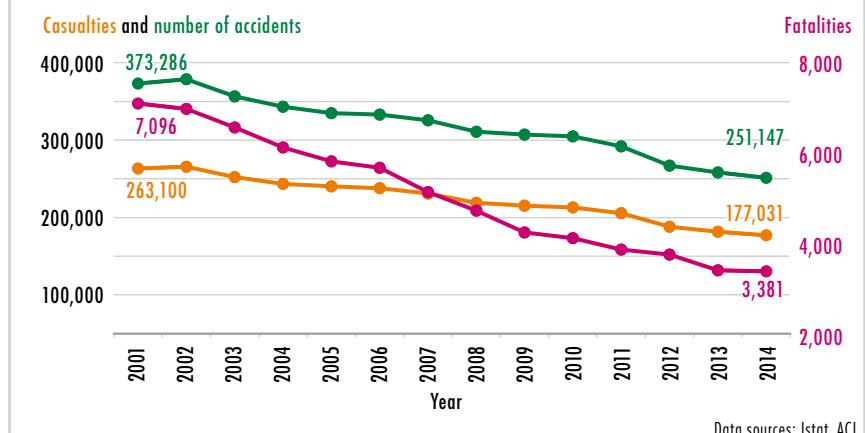
In Spain, the number of traffic fatalities in 2014 – 1,688 – was roughly the same as in 2013; in terms of road user groups, the statistical ranking mirrors that in Italy and France. The same also applies to accident locations (Table 16). While any increases and decreases remained at a comparatively low level among most road user groups, a significant increase in the number of fatalities – from 52 to 100 – was observed among van occupants.

COMPARISON OF RISKS AMONG DIFFERENT ROAD USER GROUPS

If one now compares the different road user groups in terms of passenger transportation, it quickly becomes clear that the risk of being killed in a road accident is still many times higher in a car than it is on public transport. The main reasons for this, according to a 2011 study published

15 Positive trend in Italy

In Italy, the number of people injured in accidents on the roads fell significantly between 2001 and 2014. The number of fatalities has more than halved.



Data sources: Istat, ACI

16 Comparison by location of fatalities in 2014

While by far the most road traffic fatalities in 2014 in Germany, France and Spain occurred on rural roads, in Italy almost as many fatalities occurred in urban areas as on rural roads.

Location	Germany	France	Italy	Spain
Urban	983 (29%)	992 (29%)	1,505 (45%)	441 (26%)
Rural road	2,019 (60%)	2,150 (64%)	1,589 (47%)	1,182 (70%)
Highway	375 (11%)	242 (7%)	287 (8%)	65 (4%)
Total	3,377 (100%)	3,384 (100%)	3,381 (100%)	1,688 (100%)

Data sources: StBA (Federal Statistical Office), ONISR, Istat, DGT

According to a survey conducted by the University of Wuppertal on behalf of the German Federal Highway Research Institute, around 1,800 reports of wrong-way drivers are received by radio traffic services every year in Germany. On the basis of extrapolations of the actual number of accidents caused by wrong-way drivers, it can be assumed that every year between 75 and 80 of these accidents occur on highways. Half of these involve casualties, and around one sixth involve fatalities. In general, accidents caused by wrong-way drivers have comparatively serious consequences.

Most wrong-way drives (at least 32%) begin at highway ramps. The second most common cause of wrong-way drives is when a driver turns

around on a free stretch of road (at least 15%). Highway interchanges and service stations figure more rarely as contributors to wrong-way drives.

Reports of wrong-way drivers are most commonly received at periods of low traffic (at night) and especially on weekends. For example, around twice as many wrong-way drivers are reported on Saturdays, Sundays and public holidays than on working days. The peak period is late Saturday night / early Sunday morning, when reports of wrong-way drivers are almost three times higher than the average number of reports on a working day.

According to the study, around one third of wrong-way drivers causing accidents are aged 65 years or more.

What is not clear, however, is whether older people are really more likely to be wrong-way drivers than people in other age groups. Older people tend to drive in the wrong direction during the day, young people at night. Older people are more likely to simply lose their bearings, while young people are more likely to be under the influence of alcohol. In relation to the number of accidents caused by wrong-way drivers, the number of alcohol-related accidents is 14%, so around ten times higher compared with all highway accidents.

It is unlikely that wrong-way drives will ever be completely prevented, particularly if there is intent on the part of the driver – for example, if they deliberately drive down the wrong highway ramp or turn around

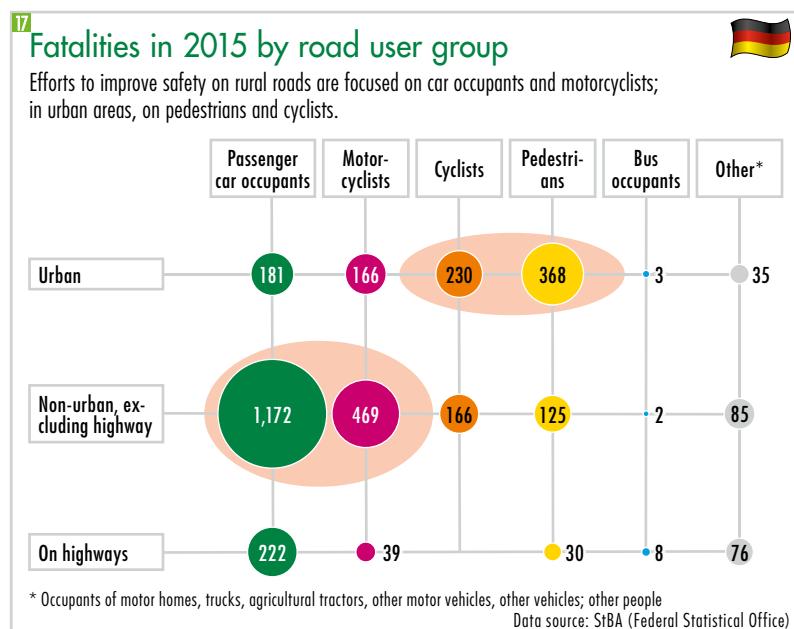
on multi-lane carriageways. Nevertheless, the hazards associated with inadvertent wrong-way drives can be mitigated through suitable measures designed to assist drivers in (intuitively) regaining their bearings early on. Such measures should be taken into account in the planning of future road construction projects and regular reviews and checks. Infrastructural measures – for example, regarding the signposting, road signs and/or markings – can also assist road users in ensuring that they do not drive the wrong way along highways and other roads. Along certain sections of the highway, some EU states have already erected huge signs alerting drivers to the risk of driving onto the wrong side of the highway.

by the Federal Statistical Office of Germany comparing the risks associated with different forms of transport, are likely to be the more comprehensive safety precautions on public transport and the reduced likelihood of human error.

A comparison of the absolute figures for the individual road user groups shows that, over the course of any given year, most traffic fatalities are occupants of cars. If one looks at the number of fatalities broken down by location (urban, non-

urban excluding highway, highway), significant differences can be observed (Figure 17). That said, the accident figures for the other forms of transport are much lower (Table 18).

A simple comparison of the absolute figures for the number of people involved in accidents is not enough, however, for drawing a conclusion regarding the accident risk associated with different forms of transport. This is possible only when one looks at the ratio of accidents and casualties to a common base number (e.g. frequency of use). Possible variables for measuring vehicle use include the number of vehicles on the roads, the number of hours spent in a vehicle, the number of persons conveyed in a vehicle or the distances covered in a vehicle.



Many experts consider “passenger kilometers” to be the most useful reference figure for relativizing the occurrence of accidents in different forms of transport because the combination of “kilometers driven” and “number of persons conveyed” contained in the “passenger kilometers” figure compensates for any distortion that would arise if only one of these variables were used.

In 2011, the Federal Statistical Office of Germany calculated the average number of persons injured or killed per billion passenger kilometers from 2005 to 2009 for five different forms of trans-

18 Comparison of accidents with casualties



Year	Pedestrians	Road user group								
		Riders (riders and passengers) of			Occupants (driver and passengers) of				All road user groups*	
		Bicycles (incl. pedelecs)	Motorcycles		Cars	Buses	Trucks	Streetcars		
FATALITIES AND INJURED										
2010	30,139	65,573	17,247	26,969	213,396	5,580	11,539	888	374,818	
2011	32,162	76,750	18,679	30,680	217,238	5,736	10,754	763	396,374	
2012	31,830	74,776	17,344	27,947	216,068	5,671	10,194	846	387,978	
2013	31,364	71,420	15,231	27,336	212,581	5,821	9,952	837	377,481	
2014	31,161	78,296	15,952	30,930	216,962	5,779	9,596	989	392,912	
FATALITIES										
2010	476	381	74	635	1,840	32	162	0	3,648	
2011	614	399	70	708	1,986	10	174	0	4,009	
2012	520	406	93	586	1,791	3	154	0	3,600	
2013	557	354	73	568	1,588	11	148	0	3,339	
2014	523	396	87	587	1,575	13	143	2	3,377	

* Pedestrians / persons on bicycles and motorcycles / occupants of cars, buses, trucks and streetcars / drivers of agricultural tractors and other vehicles/other people

Data source: StBA (Federal Statistical Office), 2015



port: car, bus, train, streetcar and airplane. The order was the same both in terms of number of people injured and number of people killed. By far the most dangerous was the car (276 injured and 2.9 killed per billion passenger kilometers), followed by bus (74 / 0.17), train (42 / 0.16) and streetcar (2.7 / 0.04). The safest mode of transport was the airplane, with 0.3 injured and virtually zero fatalities per billion passenger kilometers.

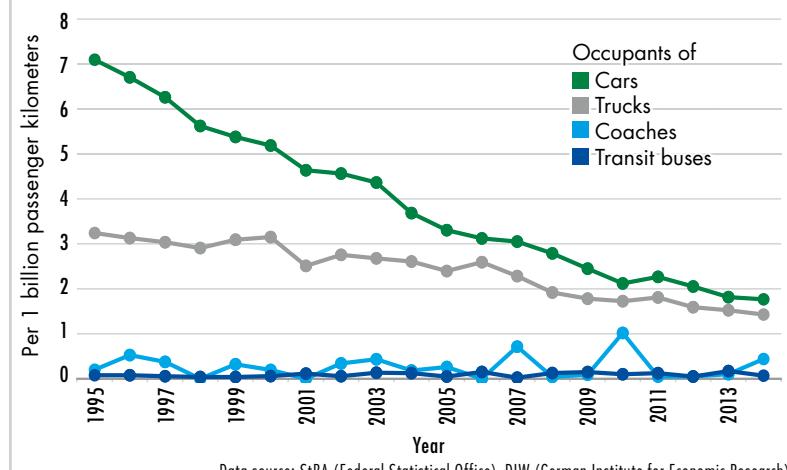
Regardless of this, the risk of being killed in a car accident in Germany since 1995 has decreased significantly and over a sustained period by more than 70% – from around seven fatalities per billion passenger kilometers to around two (Figure 19). As such, the occupants of cars are today almost as safe on the roads as the occupants of often much heavier trucks. Nonetheless, in terms of passenger kilometers, the risk of being killed in a car accident remains much higher than on public transport.

The statistical rankings are reflected EU-wide, too. However, there is one mode of transport that is much more dangerous than the car – and that's the motorcycle. Per billion passenger kilometers, an average of 53 bikers die on Europe's roads. In Germany alone, the risk of dying in an accident on an officially licensed motorcycle was, per billion passenger kilometers, 24 times higher than in a car (Figure 20). The risk statistics remain unchanged even if one takes the number of vehicles on the roads as the reference figure. Take Germany, for example: Per 100,000 vehicles, the Federal Statistical Office of Germany's statistics for 2014 state that four people died on insurance-licensed mopeds, 15 people died on officially licensed motorcycles and four people died in cars. These fig-



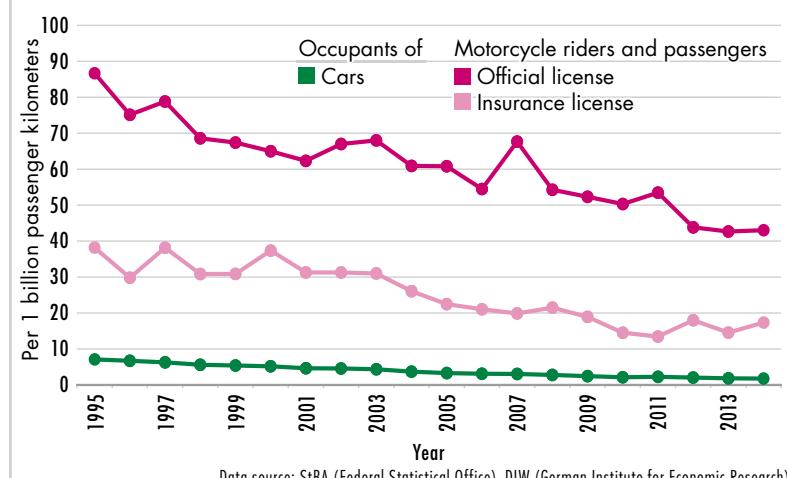
19 Occupant fatalities per billion passenger kilometers

Car occupants in particular have benefited from increased road safety over the past few decades.



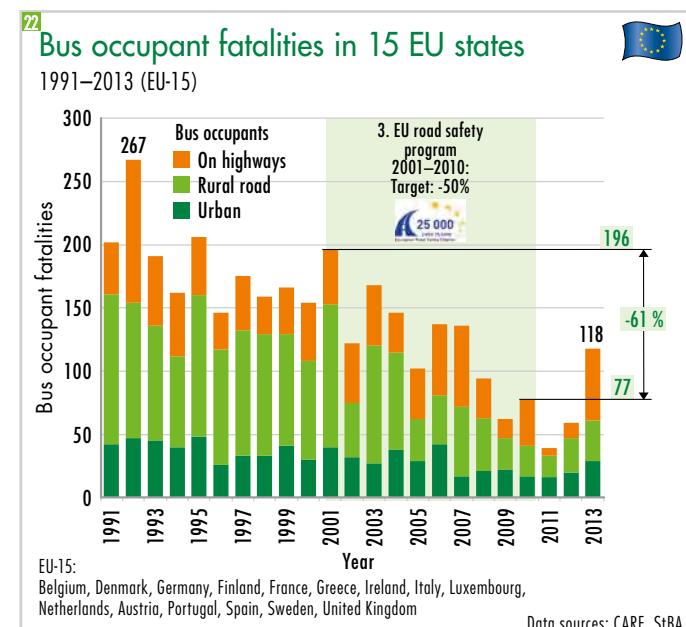
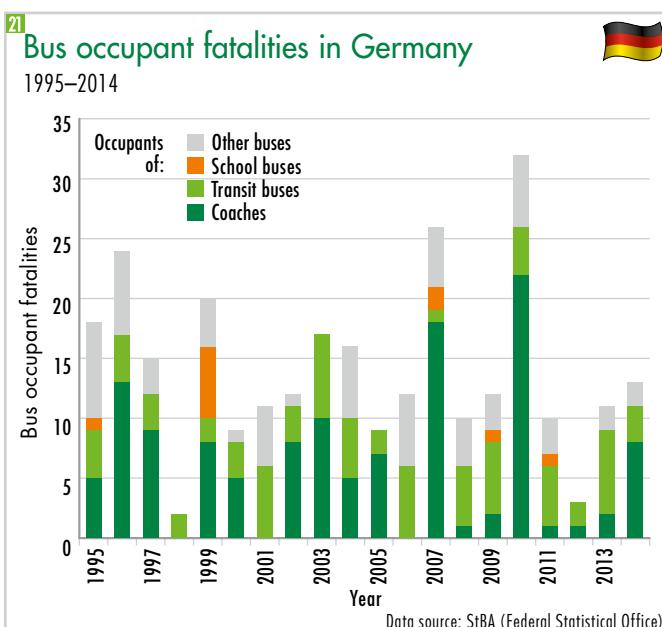
20 Occupant fatalities per billion passenger kilometers

The risk of fatality for motorcycle riders and passengers is much higher than for car occupants.





■ Bus accidents are comparatively rare, although they often have serious consequences



ures clearly show that, first, the risk of being injured on motorcycles is greater overall than in cars; and, second, the consequences of accidents for riders of officially licensed motorcycles are much more serious than for riders of insurance-licensed motorcycles and for occupants of cars. Regarding riders of officially licensed motorcycles, two factors are important: Despite protective gear, they are much more vulnerable than car occupants and also they travel at much higher speeds than than riders of insurance-licensed motorcycles.

BUS OCCUPANT FATALITIES IN GERMANY AND THE EU

Since 1995, the data published by the Federal Statistical Office of Germany have also included the number of bus occupants involved in road accidents in Germany, broken down according to the type of bus – coach, transit bus, school bus, trolley bus, other/unknown bus type (i.e. a bus type that the police officers at the scene of an accident cannot assign to any of the aforementioned types) (Figure 21). The figures are very low overall, but do contain significant fluctuations due to isolated, severe accidents. For example, an accident occurred in September 2010 in which a coach traveling on the highway collided with a bridge pier after being hit by a car. 13 bus occupants were killed, which represents 59% of all 22 bus occupants killed in 2010.



23 Cycling casualties by location, age and accident type

Special assessment of road accidents in 2014



Casualties		Urban				Non-urban				Urban and non-urban			
		Pedelec riders		Riders of bicycles without electric propulsion		Pedelec riders		Riders of bicycles without electric propulsion		Pedelec riders		Riders of bicycles without electric propulsion	
		Seriously injured	Killed	Seriously injured	Killed	Seriously injured	Killed	Seriously injured	Killed	Seriously injured	Killed	Seriously injured	Killed
Aged ...	≤ 17	8	–	1,672	9	–	–	237	17	8	0	1,909	26
	18–64	203	3	7,107	87	48	4	1,504	50	251	7	8,611	137
	65+	263	13	2,844	118	102	19	522	76	365	32	3,366	194
Total ¹⁾		474	16	11,632	214	150	23	2,266	143	624	39	13,898	357
Accident type													
Driving accident		133	4	2,333	34	55	1	691	29	188	5	3,024	63
Turning-off accident		61		1,685	36	14	–	181	11	75	0	1,866	47
Turning-into/crossing accident		125	4	3,990	81	41	20	522	56	166	24	4,512	137
Crossing-over accident		5	–	118	–	–	–	3	–	5	0	121	0
Accident in slow traffic		20	–	538	4	1	–	9	1	21	0	547	5
Accident in flowing traffic		53	4	1,103	13	23	2	461	32	76	6	1,564	45
Other accidents		77	4	1,865	46	16	–	399	14	93	4	2,264	60
Total		474	16	11,632	214	150	23	2,266	143	624	39	13,898	357

¹⁾ Including unknown age

Data source: StBA (Federal Statistical Office)

The statistics for 1998, 2001 and 2006 show that no bus occupants died as a result of an accident on German roads. For this road user group, "Vision Zero" had become a reality – temporarily at least. In some years, however, including 2007, 2010 and 2014, the number of coach passengers killed dominates the overall figures for bus occupant fatalities. Thankfully, in 15 individual years over the period under analysis, no deaths as a result of road accidents were recorded among occupants of school buses.

EU-wide, too, overall comparatively few bus occupants are killed in road accidents. On the basis of the long-term statistics published by CARE, historical trends for 15 countries can be ascertained, broken down according to location, from 1991 to 2013 (Figure 22). The relatively low overall figures reached their peak (267 fatalities) in 1992 and, from 2001 to 2010, fell by 61%, with the target of halving the number of fatalities – as specified in the third EU road safety program – being exceeded.

As can be seen, most bus occupants die in accidents that occur in non-urban areas. Typically, these are occupants of coaches and long-distance buses. While some years saw fatalities due to highway accidents dominate, other years saw more people involved in accidents on other, non-urban roads.

Bus accident statistics are consistently characterized by isolated, severe accidents in which it is generally coach occupants who suffer fatalities. For example, the increase to 118 accident-related fatalities in 2013 can be explained by an accident that occurred in southern Italy in June in which 38 people died because the vehicle plummeted down a 30-meter slope. Another tragic accident occurred in October 2015 near the city of Bordeaux in southwestern France, when 43 people were killed.

BICYCLE AND PEDELEC FATALITIES IN GERMANY

As already mentioned in this chapter, cyclists are especially vulnerable road users. In Germany in 2014, 396 cyclists were killed in road accidents, which is equivalent to 12% of all 3,377 traffic fatalities. Of all the cyclists killed, 39 (11%) were riding a pedelec (Table 23). The vast majority of cyclists killed were

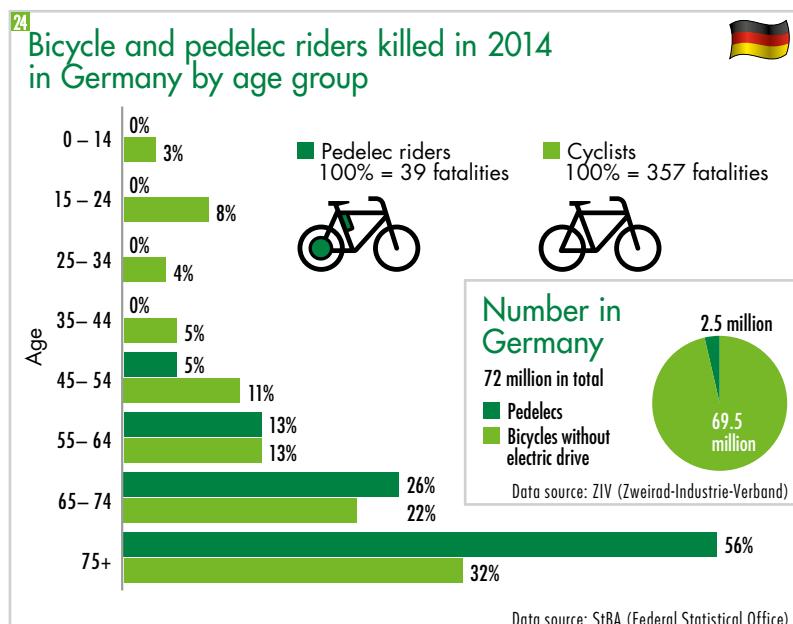


NEVER RIDE A PEDELEC WITHOUT WEARING A HELMET



Comparatively high speeds can quickly be reached on pedelecs, so a helmet is strongly advised. In Germany, helmets are mandatory on S-Pedelecs.

24 Bicycle and pedelec riders killed in 2014 in Germany by age group



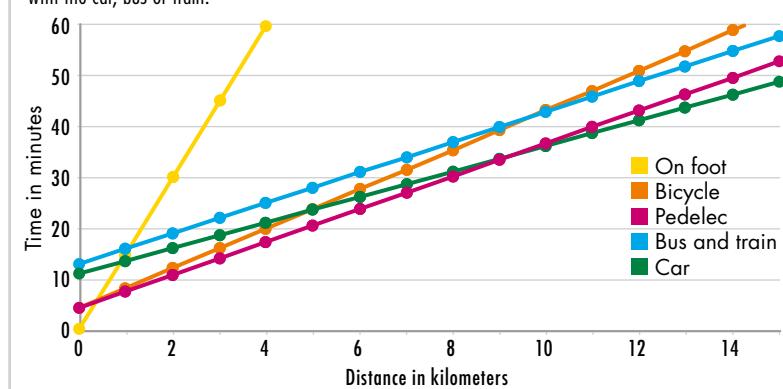
elderly riders, with more than half (54%) aged at least 65. Even more striking, at 82%, is the dominance of people aged 65+ among pedelec riders who were killed (Figure 24). Among people aged 44 and below, the statistics show not one single pedelec fatality, but 74 bicycle fatalities (21% of 357 fatalities).

IN VOGUE: PEDELECS

To avoid the stifling traffic jams that clog up our urban regions, an integrated road transport strategy comprising a mix of all modes of transport is necessary. In congested areas plagued by traffic jams, electric bicycles above all are an excellent alternative to cars because they are, on average, faster than cars in urban traffic (up to a distance of ten kilometers) and more eco-friendly at a local level (Figure 25). The number of pedelecs sold in the EU has been increasing for years. Internationally, too, electric bikes are becoming increasingly popular as a means of urban transportation (Figure 26).

25 Route comparison: from door to door in urban traffic*

Particularly over shorter distances, you can reach your destination more quickly on a pedelec than with the car, bus or train.



* Average speeds are specified for each mode of transport: On foot $\varnothing = 4 \text{ km/h}$, Bicycle $\varnothing = 15.3 \text{ km/h}$, Pedelec $\varnothing = 18.5 \text{ km/h}$, Bus and train $\varnothing = 20 \text{ km/h}$, Car $\varnothing = 24.1 \text{ km/h}$.

Source: UBA-Fachschätzung (July 2014)

But what exactly is a pedelec? A pedelec is a bicycle equipped with an electric motor that assists the rider with pedaling, which makes them much easier and more comfortable to ride than ordinary bicycles. The word "pedelec" is a coinage, made up from the words "pedal electric cycle." Unlike ordinary bicycles, pedelecs are additionally equipped with a battery, electric motor and control electronics.

A pedelec has to fulfill three conditions: Speed limit, continuous power limit and a support

drive for pedaling only. These criteria, which may also change from one country to another, result in different categories of pedelecs. In Germany, these are as follows:

- Pedelec25: Pedelecs that support speeds of up to 25 km/h are classified as bicycles according to the Road Traffic Act. The support drive must deliver a maximum continuous power of 250 W, which must only become active when the pedals are used. Speeds in excess of 25 km/h are possible and permitted, although in this case all the propulsive power must be generated by the rider themselves. A starting or pushing aid that propels the pedelec up to a speed of 6 km/h – even without pedaling – is permitted. A Pedelec25 can be ridden anywhere a conventional bicycle can be ridden.
- Pedelec45: Pedelecs that support speeds of up to 45 km/h (“S-Pedeles”) are a special type of pedelec and can be electrically propelled even at speeds in excess of 25 km/h. Electrical support cuts out at 45 km/h or with a continuous power of 500 W. S-Pedeles may also be ridden without any input from the rider (i.e. by purely electrical means) up to a speed of 20 km/h. It is important to note that S-Pedeles require an insurance license plate and a rear-view mirror because they are legally classified as mopeds. In urban areas, S-Pedeles may not be ridden on cycle paths unless this is explicitly permitted. Outside urban areas, they may be ridden on cycle paths unless this is explicitly forbidden.

RIDE SAFER – WEAR A HELMET

Unlike Pedelec45 riders, Pedelec25 riders are not required to wear a helmet. Nonetheless, studies have shown that pedelecs are generally ridden at higher speeds than conventional bicycles. Even untrained riders can, for example, quickly attain speeds of 25 km/h again after stopping at a stoplight. In addition, even pedelec riders who are not especially fit can ride at a steady 25 km/h; even uphill, speeds of 20 km/h and more are possible. The problem is that most road users perceive pedelecs as bicycles and, as such, as a generally low-speed mode of transport. Theoretically, therefore, the likelihood of pedelec riders finding themselves in critical traffic situations would seem higher. Since accidents at higher speeds result in more serious injuries, DEKRA explicitly recommends the wearing of a helmet.

Dr. Walter Eichendorf

President of the German Road Safety Council (DVR)



Cycling proficiency training for all

For children, riding a bike is the first step on the road toward independent mobility. But the high number of young cyclists aged between 10 and 15 involved in accidents clearly shows that they require special training in how to be safe road users if they later want to ride their bicycles out and about on their own. Cycling proficiency training with a cycling proficiency test when they finish elementary school is therefore a central measure of road safety initiatives at school.

With a view to realizing “Vision Zero”, all conceivable potential to enhance road safety must be leveraged – and this includes road safety education in schools. During cycling proficiency training, pupils learning under test conditions are for the first time confronted with the rules of the road.

When it comes to preparing and undertaking cycling proficiency training, schools depend on the assistance of parents and the police. This is particularly important

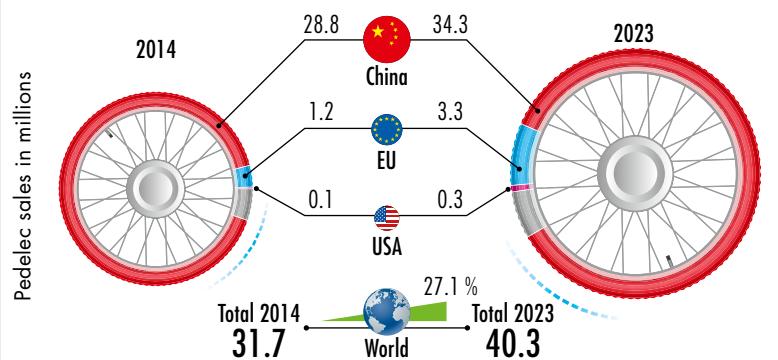
when pupils go for practice rides on real roads because this would be impossible without police supervision. Since many schools are already complaining about a lack of engagement from parents, the assistance of the police is all the more important – especially considering that many elementary-school-age children have never ridden, or even learned to ride, a bicycle.

The German Road Safety Council – together with its members – has therefore committed itself to ensuring that the police in all federal states remain a competent and important partner in road safety initiatives in schools. Because only with their support can cycling proficiency training followed by a cycling proficiency test remain something to which all children can have access. That said, schools also have to play their part by integrating issues relating to road safety work in teacher training programs.

26

Market forecasts for pedelecs (< 25 km/h)

31.7 million e-bikes were sold worldwide in 2014; according to an Allianz study, however, this figure is set to increase to more than 40 million per year by 2023.



Data source: Allianz, calculations based on market forecasts conducted by Navigant Research (2014)

Jacqueline Galant
Belgian Minister of Mobility



CHILDREN MUST BE BETTER PROTECTED

Viewed over the long term, data released by the Federal Statistical Office of Germany show that, thankfully, fewer and fewer children are losing their lives on the roads. While in the 1950s more than 1,000 child fatalities per year were recorded in Germany, this figure fell in the 1990s to less than 500 and was in 2014, for the fifth time, less than 100. In 2014, a total of 28,674 children were involved in accidents on Germany's roads – of these, 71 children died, 13 more than in the previous year. More than 10,765 children were involved in accidents as car passengers, with 26 of these losing their lives. One of the reasons is that they are not properly secured in the vehicle – whether because the person responsible for the child does not have enough time, is lazy or simply does not know how to properly use the securing system.

Particularly careless and negligent is anyone who puts their child on the front passenger's lap with no protection whatsoever. In a crash, the front passenger would be flung forward, resulting in acute danger to life for the child, even at low speeds, with severe crushing of vital organs. If a child is wearing very thick clothing, there is a risk that the restraint does not lie tightly enough across their body. In a critical situation, the child could strike the headliner, potentially resulting in serious injuries such as compression of the spine.

Also, one of the most common mistakes is when the child is not properly restrained in their seat or the seat is the wrong size. This is particularly hazardous in smaller vehicles in which the distance between the rear and front seat is relatively small. In a collision, the child could potentially suffer severe flexion injuries and overextension of the cervical spine, resulting in permanent nerve damage. If the child's head strikes the front seat, this could in the worst-case scenario result in a traumatic brain injury.

If the child turns around and out of the diagonal restraint in a crash, the entire restraint system is loose and then even the lap restraint will no longer be effective. If the child manages to turn around and out of the shoulder restraint even during normal driving, the shoulder restraint behind the child's back may be pulled tight by the retarder. In this case, only the lap restraint provides any security.

For this reason, the advice is simply to ensure that the seat is suitable for the weight, size and age of the child. Ideally, let your child test the seat first before

The e-bike – an attractive mode of transport

As part of my mandate, I am faced with three central challenges: To reduce the environmental impact of the transport sector; cut the cost of traffic jams; and improve road safety. The legislation on e-bikes is a good illustration of these three areas. We are currently seeing fundamental change in the world of e-bikes: Following technical improvements, the e-bike proved itself to be a real alternative – or complement – to conventional combustion engine motorcycles like scooters or lightweight motorcycles.

For the short distance between home and work or the nearest public transport stop, e-bikes are the perfect mode of transport: Not only are they ecofriendly, but they also place fewer demands on road infrastructure than cars (they take up less room on the roads; cause less road wear because they are light; etc.). In addition, the physical activity involved is good for your health.

In my role as minister, I now have to find an answer to the following question: What needs to be done for the e-bike to become an attractive mode of transport and, at the same time, for the

safety of all riders to be ensured? My first job is to amend the provisions in Belgium, and in doing so ensure that future e-bike models are also taken into account. And future technical developments, which come to pass ever more rapidly on this market, also have to be accommodated.

The word "e-bike" is currently still just an umbrella term for a range of models that could be comparable to conventional bicycles, mopeds and motorcycles in terms of power and speed, which is why the current draft law prescribes a minimum age of 16 years, at least theoretical knowledge of the rules of the road and the mandatory wearing of a helmet (bicycle or motorcycle helmet). These minimum requirements apply to vehicles with a speed of between 25 km/h and 45 km/h and motor power of between 1 kW and 4 kW (for higher-power vehicles, the specifications for motorcycles apply). By way of compromise, e-bikes may be ridden on all paths otherwise exclusively reserved for pedestrians, cyclists and horse riders. Mopeds are currently not allowed to be ridden along such paths.



you buy. Since more and more cars are equipped with the standardized Isofix child safety seat attachments, it is advisable to use a compatible child seat compliant with ECE 44-03 or ECE 44-04.

STILL TOO MANY SEVERE INJURIES

A major challenge is – and remains – the task of reducing the number of people severely injured in road accidents, specifically the number of those suffering life-changing injuries. No EU-wide definition has been formulated to describe such injuries. Official statistics in Germany, for example, label the severely injured as those who require in-patient hospital treatment (for at least 24 hours) immediately following the accident. In 2014, 67,732 people required such treatment. But only a fraction of those suffered life-changing injuries.

Some EU states started recording data on the number of severely injured people back in 2014. However, the abbreviated description “serious road injuries” can lead to misunderstandings – what is in fact meant is “serious injuries with lifelong consequences.” The agreed definition is based on an internationally medical scale commonly used by experts – Abbreviated Injury Scale (AIS) – for classifying the severity of injuries. Life-changing injuries have a severity score of AIS 3+ (without death). Often, however, the relevant data from hospitals is not available for compiling national statistics. In such cases, comparable data can be ascertained on the basis of existing data – for example, from data recorded by the police at the scene of an accident, in-depth accident studies such as those conducted in Germany (GIDAS) and injury data from nationwide trauma registers – by government-authorized institutions using a specially developed statistical process.

In the opinion of many road safety experts and institutions like the European Transport Safety Council (ETSC), the EU Commission and member states must intensify their efforts to bring about a significant reduction in the number of people sustaining life-changing injuries in road accidents. As a goal for 2020, the ETSC recommends in its “9th Road Safety Performance Index Report” a 35% reduction on 2014. For the measures to be effective, however, the total number of severely injured road users must be broken down according to individual road user group.



■ *Child seats lead to a noticeable reduction in the number of children killed in road accidents. More than half of the countries in the world have introduced the mandatory use of child seats. The belts must ensure that even slumped, sleeping children are reliably secured.*

The facts at a glance

- Within the EU, big differences in the number of fatal accidents still exist between the member states.
- Worldwide, the number of traffic fatalities since 2007 has stagnated at around 1.25 million.
- The slight decline of 1.2% in the number of traffic fatalities in the EU from 2013 to 2014 makes it a huge challenge to achieve the aim of halving this number between 2010 and 2020.
- In 2014, more people died in road accidents in Germany and France than in 2013.
- EU-wide, the number of cyclists, motorcyclists and pedestrians involved in accidents has stagnated somewhat.
- Although the risk of being killed in a car accident has fallen dramatically, it is still more than twenty times higher than on public transport.
- EU-wide, the motorcycle is the most dangerous mode of transport.
- Although the figures on the occurrence of bus accidents are small overall, they are occasionally overshadowed by isolated, severe accidents.
- DEKRA explicitly recommends that pedelec riders wear a helmet.
- Children traveling in cars must be restrained in a manner suitable for their age and size.
- Much work still needs to be done EU-wide to bring about a long-term reduction in the number of severely injured road users.



Well-Maintained Roads Are Key

In addition to in-vehicle passive, active and integral safety systems, compliance with traffic rules and correct, attentive behavior on the roads, the infrastructure also makes a key contribution to road safety. A whole range of measures – making hazardous areas safer; maintaining traffic installations and other street furniture; ensuring that road surfacing is safer for traffic; monitoring speed at accidents hot spots; implementing road construction measures to prevent collisions with trees; installing adequate crash barriers; and lots more – offer considerable optimization potential.

Whether in towns and cities or on rural roads, main roads or highways, infrastructure is a not insignificant cause of accidents with casualties and/or material damage. Although by far the most accidents are a result of human error, this human error is in many cases partly the result of a lack of, or inadequate, infrastructure or poor road conditions.

It is not without reason, therefore, that the German Road Safety Council some time ago held a colloquium devoted exclusively to this issue. All participants were unanimous in the view that, in order to improve safety, adapting the road network to take account of the needs and known behavioral errors of drivers, pedestrians and cyclists was of key importance. In the future, the road lay-

out must be designed to take better account of the shortcomings of older drivers, thereby making roads safer for everyone.

Of equal importance in the view of the experts attending the colloquium was that new roads must be constructed and existing roads repaired with a view to ensuring that they are forgiving of mistakes. A minor driving mistake on such a road will then not necessarily lead to a serious or even fatal accident because the road and its surrounding area have suitable safety margins and protective systems. When new roads are being built and when major construction work is underway, the aim should also be to create a road that is “self-explanatory.” On such roads, users quickly and clearly see what driving behavior is required.

SYSTEMATICALLY IDENTIFYING SAFETY DEFICITS

In its “Mid-Term Review of the Road Safety Program 2011–2020”, the German Federal Ministry of Transport and Digital Infrastructure (BMVI) stated that optimizing road infrastructure safety management was among its central tasks for the coming years. According to the BMVI, room for improvement exists primarily on rural roads, which were planned and constructed according to once modern but now frequently outdated technical rules and standards. Rural roads therefore often still follow the course of ancient tracks and in no way fulfill the requirements of modern-day route planning. For this reason, it is especially important to identify specific deficits that could lead to errors of judgment and, in turn, inappropriate responses.

In turn, it is necessary that not only all the measures at our disposal – for example, regional road safety inspections to determine safety potential – are systematically leveraged and that the work undertaken by accident commissions is further intensified and optimized but also that new tools are developed that systematically identify safety deficits and also take account of human factors. Such measures must also include formulating technical rules and standards for audits conducted as needed. The goal must be to implement low-cost measures aimed at identifying and efficiently eliminating shortcomings in road infrastructure, whether this concerns road boundary markings, signage, protective installations or route planning problems.

GREATER SAFETY THROUGH OVERTAKING LANES AND CRASH BARRIERS

Since an average of more than 60% of people lose their lives on rural roads not only in Germany but also in most other EU member states, significant optimization potential exists here in other respects, too. For example, accidents involving collisions with oncoming vehicles on rural roads could in many cases be prevented by implementing section-by-section overtaking bans in combination with additional overtaking lanes. Fortunately, the currently applicable guidelines for designing rural roads in Germany mean that overtaking lanes are included as standard in the planning of new and extension of existing roads as a means of increasing the number of safe overtaking opportunities along these roads. The effectiveness of this measure is uncontested and has in fact

■ *Exemplary cycling infrastructure: The Hovenring is a circular cycle path suspended on a pylon by means of tensioning cables and is positioned above a connecting road between Eindhoven and Veldhoven in the Netherlands. The roundabout can be approached on four sides via 16-meter-long ramps.*

Grażyna Lendzion

Former Director of the Administration of Urban Roads in Warsaw; member of the Masovian Road Safety Council



Social campaign for road safety

Road safety in Poland is a rather neglected issue. We all want to be safe when out and about on the roads, and yet so many road users still ignore red stoplights and speed limits. Police statistics show that as many as 70% of drivers in Poland exceed the speed limit by 20 km/h. Indeed, there are some who don't think twice about driving at 100 km/h through a 50 km/h zone, especially at night. Despite higher-quality roads, many accidents with fatal consequences are still happening. Pedestrians do not feel safe, even when crossing a road at a pedestrian crossing. More than 60% of pedestrians killed are killed while crossing the road.

So we asked ourselves how we can solve this problem. The roads themselves are getting better all the time, and there is nothing wrong with the signage. We came to the conclusion that not only are the drivers to be held liable but that the traffic solutions implemented are also to be explained to the

people of Warsaw. In Warsaw, a number of institutions are responsible for road safety and they work together only to the extent that the law requires. We have spent the past ten years focusing on road safety. I have decided to launch Poland's first city-budget-financed social campaign for road safety.

As part of this, our slogan „Red – stop, green – go. It's that easy!” has become embedded in everyone's minds. Over the next few years, we launched a number of other campaigns with slogans aimed at specific road user groups. Since our first campaign in 2012, the number of accidents, fatalities and persons suffering injuries has fallen significantly. In addition, we have undertaken important tasks such as repairing roads and sidewalks and constructing cycle paths. Overall, we can observe an ever-increasing awareness in society, which, in turn, is helping to make our roads increasingly safe.

Dr. Dušan Mladenović

Assistant Professor at the Faculty of Transport and Traffic Engineering at the University of Belgrade

**Introduction of a national road safety strategy**

Between 2001 and 2014, Serbia traveled a long and difficult road toward improving its road safety, a process that took place in two phases. In 2001, there were 1,275 traffic fatalities – or 18.21 persons per 100,000 inhabitants. By 2014, this figure had fallen to 536, or 7.7 per 100,000 inhabitants.

The first phase began with a new government and the systematic enforcement of regulations through campaigns and police measures. Between 2001 and 2009, preparations were made to change the road safety system and create new laws. However, this process was hampered by numerous obstacles, resistance to the changes and a lack of political will. Policy-makers and experts were in constant dialog with each other.

The second phase began with the adoption of the new road safety act. Among the most important activities in this phase were changes to the financing of road safety measures; the establishment of road safety authorities, the government's coordination unit and that of the municipalities and districts; the purpose-specific allocation of resources for promoting road safety; the increase in capacities; a strengthening of the integrity of institutions and persons; and the introduction of a national road safety strategy.

On top of these, other changes were made that provide essential support for the system but that are not necessarily so readily identifiable: Science/education – For the first time, road safety is based on scientific principles; political will – Parliament, government and local authorities play a bigger role; (vertical and horizontal) coordination is beginning to show effect; the definition of responsibilities for road safety has improved and the media, politicians and experts have brought the issue to the fore.

In addition, the following measures have been implemented and facilitate a comprehensive road safety system: Knowledge sharing, research, publicity work, road safety education, campaigns, capacity expansion, a rethink in the public sector and strong integration of road construction authorities.

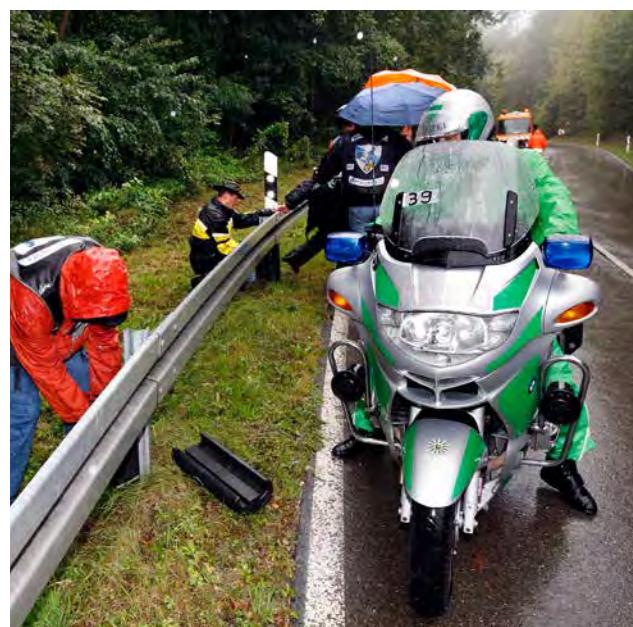
Serbia fully implemented the Type Approval System and Vehicle Periodic Technical Inspection System based on the EU model.

The next phase will focus more on improving the information platform for managing the regular technical vehicle inspections.

been confirmed by the findings of the “Improving Safety on Single-Carriageway Non-Urban Roads” (AOSI) research program conducted by the German Federal Highway Research Institute (BASt). The optimum solution, as implemented in Sweden, would be to widen alternating sections of the road to three lanes, with the carriageways physically separated.

Great attention must also be devoted to the problem of collisions with trees because such accidents tend to be especially severe. In Germany in 2014, 555 people lost their lives on rural roads after their vehicle collided with a tree – that’s around 27% of all 2,019 traffic fatalities on these kind of roads. Despite the positive trend over the past few years, collisions with trees are still disproportionately represented in the statistics on fatal accidents. Since it is not possible for the edges of all roads to be completely free of hazards, however, suitable measures have to be taken on existing roads and in the planning of new roads – for example, by applying the recommendations for protecting against collisions with trees (“ESAB”) and the guidelines for passive protection on roads through vehicle restraint systems (“RPS”). According to the BMVI, recommendations proposed by national committees have also meant that the possibility of erecting special protective installations in front of trees is being considered.

The latter is particularly important on rural roads and in particular for motorcyclists who, after car occupants, account for the biggest number of fatalities on rural roads in nearly every EU state.



■ Padding has been attached to crash barrier posts along many sections of road hazardous to motorcyclists. Crash barriers with skirting, however, offer even greater protection.



■ *Rescue corridors for emergency vehicles can help to save lives.*

The effectiveness of crash barriers erected at bends in the road should be increased by installing continuous skirting. The plastic padding attached to hazardous posts was an emergency measures that can now be replaced by more effective protective elements. The "Euskirchen Plus" system, for example, which was developed by DEKRA on behalf of the German Federal Highway Research Institute, offers much greater protection for motorcyclists who collide with the crash barrier.

SITUATION-SPECIFIC SPEED LIMITS AND WARNINGS

When it comes to infrastructure, however, measures have to encompass a lot more than just the road design. Given that excessive speed is a common cause of accidents, other measures that can be taken include management of traffic flows and suitable speed management. Whether variable speed limits, warnings of adverse weather conditions and traffic jams, lane closures, information about public transport or advice on alternative routes to avoid traffic jams, the examples show the huge potential offered by dynamic signage systems designed to influence traffic. Future interaction between vehicles and traffic computer systems (Rural Road 4.0) will far exceed what we are familiar with today.

The benefits are clear: Speed limits, warnings and information can be activated in specific situations so that only the most relevant information is

Make way for the blue lights and sirens!

How should I respond if I see an emergency vehicle appear behind me with blue lights flashing and siren wailing? This is a question drivers are faced with time and again. The main thing, first of all, is not to panic. Instead, stay calm and figure out what's happening. Where is the noise coming from? In what direction is the emergency vehicle – or emergency vehicles – traveling? How many emergency vehicles are there? Once you have answered these questions, reduce your speed to the extent necessary and, if in dense traffic or a traffic jam on highways or on multi-carriageway roads, form a "rescue corridor" through which the emergency vehicle(s) can pass.

This rescue corridor has been mandatory since 2012 in only four EU countries – Germany, the Czech Republic, Austria and Hungary. In Switzerland and Slovenia, rescue corridors are voluntary. A rescue corridor is a free section of road between the outermost lane on the left (in right-hand traffic) and the lane next to it that allows emergency vehicles to pass through. The drivers in the left lane have to move over to the left as far as they can go and those in the right over to the right as far as they can go. On multi-

lane carriageways, drivers in the left lane move over to the left as far as they can go, while everyone else moves right. This rule applies in Germany, Austria, Hungary, Slovenia and Switzerland. In the Czech Republic, the rescue corridor must be formed on sections with more than two lanes in one direction, between the middle and right lane. Vehicles in the right lane have to move over to the right as far as they can go, while everyone else moves over to the left as far as they can go.

Something else that is important: Don't only think about forming a rescue corridor when traffic is at a standstill,. In traffic jams, when vehicles are already very close to each other, it can often be difficult to move over to the side to form a corridor, which is why drivers should always stick to the edge of their lane in congestion so that the rescue corridor remains open. And whether in an accident or an emergency, if you have to leave the vehicle, all occupants if possible should wear a standards-compliant reflective vest and head for the side of the road where it is safe. It is a good idea to carry as many reflective vests in your car as there are occupants – in fact, in some European countries, this is prescribed by law.



■ Accidents in tunnels can also have fatal consequences – especially if the vehicles involved catch fire.

instantly conveyed to drivers, who no longer have to select and categorize the information they process. As a result, static displays such as 80 km/h in wet conditions, 100 km/h between 10 p.m. and 6 a.m. or risk of traffic jams can be replaced with an effective alternative. In addition, targeted speed limits can help to prevent traffic jams. If the volume of traffic increases further along the road, leading to an increased risk of a traffic jam, the volume of approaching vehicles can be curtailed by reducing the speed limit accordingly. Not every traffic jam can be avoided in this way, but it does at least ensure the best possible traffic flow for the current traffic density.

Of course, this can work only if all road users take notice of the specifications, but experience consistently shows that variable speed limits have a higher level of acceptance than static displays.

SYSTEMATIC SAFETY INSPECTIONS

The EU, too, has implemented a range of measures aimed at optimizing the infrastructure in order to enhance road safety. For example, plans have been drawn up to improve the movement of people and freight between the member states by linking the national road networks more efficiently. According to the EU Commission, by 2020 these trans-European networks (TEN) will encompass a total of 90,000 kilometers of highways and high-quality expressways. In addition, the EU is planning to participate in safety management of the roads integrated

in the trans-European road network by conducting safety checks in the development phase and regular safety inspections of the road network. So far, the EU has already funded a number of monitoring and inspection projects including "Road Infrastructure Safety Protection", in which engineers investigated various ways of conducting road safety checks. This resulted in recommendations for a range of tried-and-tested road safety check procedures. In addition, as part of the "Euro-Audit" project, the EU commissioned the development of a training plan for EU road safety inspectors.

Special attention must also be paid to tunnels because accidents in tunnels can often have very serious consequences. Many tunnels are old and not designed for high volumes of traffic. According to EU law, minimum safety requirements are in place for tunnels, including measures designed to prevent accidents from resulting in fatalities. By 2019, more than 1,300 kilometers of high-traffic road tunnels are to be upgraded so that they fulfill the most stringent safety standards. The EU-supported "Safe-T" project has proposed tried-and-tested procedures designed to prevent accidents in tunnels, such as improving technical installations (ventilation systems, shelters, safety tunnels); amending traffic regulations (e.g. traffic restrictions, alternating closure/opening of just one lane); harmonizing safety information; upgrading communication and other equipment to ensure speedy evacuation in the event of a fire; training service personnel in responding to serious acci-

Regular checks to ensure safety at gas stations

The roadworthiness of a vehicle is a basic precondition for its safe use on the roads. With this in mind, road users must also ensure that their vehicles do not come to a standstill because they have run out of gas and, in so doing, became a road hazard. Filling up with gas is a routine task when you run a vehicle. Hardly anyone even considers that fact that even the refueling process itself and running a gas station are not uncritical when it comes to safety. Gas stations are facilities subject to mandatory inspection and, in Germany and many other countries, must be regularly inspected in accordance with various areas of law, for example by expert organizations such as DEKRA.

During inspection of the fire and explosion safety of a gas station, for example, the electrical systems and all gas pumps are checked to ensure that they

are safe and function properly and all pipelines and storage tanks are checked to ensure that they are leak-tight. Every gas station must also have a liquid-tight driving surface to prevent land pollution. The drainage channels for this driving surface are routed via a separator system. The condition of the filling area and separator must therefore also be regularly checked – after all, gas stations hold an average of more than 100,000 liters of fuel, so just imagine what would happen if the groundwater were to become contaminated as a result of a leak. The risk of explosion cannot be underestimated, either – gasoline is a highly flammable liquid that vaporizes even well below room temperature, creating a potentially explosive atmosphere.

Vapor recovery ensures that vehicles can be refueled with gasoline safely

and without odor as far as this is possible. Gas pump nozzles are therefore fitted with a suction mechanism that, during refueling, returns the fuel vapors from the vehicle tank to the underground storage tank.

This equipment, too, must also be inspected in accordance with the German Federal Immission Control Act.

Further requirements arise from the fact that more and more gaseous fuels are now available. Germany currently has around 6,000 natural gas fueling stations, most of which are located on the same premises as conventional gas stations offering gasoline and diesel. Special attention must be paid to the safety-relevant interaction of these completely different fuel types.

dents (e.g. organizing emergency medical services, telling people what to do in the event of a fire).

Another area of focus for the EU are road-level railroad crossings. Although just a small number of road accidents occur at railroad crossings (no more than 2% of all traffic fatalities), they account for around 30% of railroad fatalities. To prevent accidents at railroad crossings, therefore, the EU is

calling for improved cooperation between rail and road operators. The main cause of such accidents – as with many other traffic situations – is often inappropriate actions on the part of road users, e.g. poor judgment of risks, inattention and the failure to observe road signs and warnings – or, in other words, human error. Good infrastructure can play a key role here in mitigating the associated increased risk of accidents.

The facts at a glance

- New roads must be constructed and existing roads repaired with a view to ensuring that they are forgiving of mistakes so that minor driving mistakes do not necessarily lead to serious accidents.
- New roads should be designed to be “self-explanatory.” On such roads, users quickly and clearly see what driving behavior is required.
- Critical sections of rural roads must be widened to include a third traffic lane in alternating directions to allow safe overtaking.
- To protect motorcyclists, the effectiveness of crash barriers erected at bends in the road should be increased by installing continuous skirting.
- Targeted traffic flow management and variable speed limits are effective safety measures.
- The road network must be subject to more safety inspections.
- The technical equipment in many road tunnels throughout the EU must be upgraded and optimized.
- Improved cooperation between rail and road operators is necessary for improving safety at road-level railroad crossings.



Paying Attention Is the Best Safety Strategy

Whatever mode of transport you use, road accidents generally have multiple causes – above all, excessive speed, inattention or alcohol. The person at the wheel is the biggest risk factor, which is why our attention must also be focused on people if we want to make our roads even safer. This begins with considering whether a person is even fit or proficient enough to drive at all, but it also involves other aspects such as proneness to distraction or daytime drowsiness, voluntary health checks for elderly road users and driver training.

Anyone in Germany who wants to drive a car on public roads must first prove that they are able to drive and pass the mandatory driving test. Whether a person is fit to drive a car at all, however, is not generally checked before the driver's license is issued. Section 2, paragraph 4, clause 1 of the Road Traffic Act addresses the question of who is deemed fit to drive a vehicle, where, among other things, it states: "Persons deemed fit to drive motor vehicles are those who fulfill the necessary physical and mental requirements and who have not seriously or repeatedly violated traffic regulations or criminal law."

The German Federal Ministry of Transport and Digital Infrastructure is authorized to enact rules regarding fitness to drive with the consent of the Bundesrat. Among such rules is the driver's

license ordinance (FeV), which in sections 11–14 and annexes 4, 4a, 5 and 6 stipulates the details of the assessment of physical and mental fitness. Annex 4 of the FeV (fitness and conditional fitness to drive motor vehicles – in addition to sections 11, 13 and 14) contains a list of somatic and mental illnesses/impairments that could potentially affect a person's fitness to drive. This list contains not only specific illnesses/impairments but also covers areas relating to alcohol, narcotics, other psychoactive substances and medicines.

FITNESS TO DRIVE VERSUS ABILITY TO DRIVE

In the case of documented, conspicuous behavior such as drunk-driving or certain illnesses such as diabetes, cardiovascular disease or mental im-

pairments, the German administrative authorities can order an expert medical (pursuant to section 11 of the FeV) or medical-psychological (pursuant to section 13 of the FeV) assessment. Through this expert assessment, the person in question has an opportunity to put to rest any doubts on the part of the authorities regarding his or her fitness to drive. The contract to draw up an expert assessment is concluded between the person in question and an assessment center for driving fitness, which he or she is free to choose.

Only assessment centers that comply with the professional and organizational guidelines issued by the German Federal Highway Research Institute (BASt), which also form the basis for regular monitoring, are officially accepted. The expert medical or medical-psychological assessment is used as a basis for the driver's license authorities to decide, taking into account all aspects of road safety, whether a person is allowed to either be granted their first driver's license, have their driver's license re-issued or retain their existing driver's license.

The expert assessment on fitness to drive concludes with a prognosis concerning whether, despite the facts known to the authorities (drink- or drug-driving, illnesses, criminal or motoring offenses), the person in question can be expected to drive a motor vehicle safely or whether his or her road use constitutes a hazard. Fitness to drive, therefore, is a general term covering the mental and physical requirements a person must fulfill in order to be a safe road user. The German terminology differentiates between the fitness and the ability to drive. The term "inability to drive" describes a momentary state whose causes could be temporary or permanent. For example, section 2, paragraph 12, clause 1 of the Road Traffic Act indicates that temporary problems such as fatigue are not relevant to driving fitness if the person experiencing fatigue is not driving a vehicle (Paternmann, 2015). So if a person feels nauseous due to food poisoning, for example, and decides not to drive a car he/she obviously is not able to drive but still has the overall driving fitness.

STATISTICS ON THE EFFECTIVENESS OF MPAS

Evaluation studies with increasingly unequivocal results prove that medical-psychological assessments (MPAs) are a highly effective means of increasing road safety. In the most recent evalua-

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Multi-agency sharing of data

The term "fitness" is currently most commonly applied in the context of road traffic. From a German legal perspective, fitness is defined in section 2, paragraph 4, clause 1 of the Road Traffic Act, which states the following: "Persons deemed fit to drive motor vehicles are those who fulfill the necessary physical and mental requirements and who have not seriously or repeatedly violated traffic regulations or criminal law." Conversely, this means that certain misconduct such as alcohol or drug abuse, serious criminal or motoring offenses as well as any mental or physical impairments could render a person unfit to drive.

It is the job of the driver's license authorities to establish whether there are any facts that could call into question a person's fitness to drive. Various decrees, regulations, scientific guidelines and established criteria are in place for assessing whether a person is fit to drive on the roads. A great deal of expert knowledge has been acquired and published in this field – knowledge that can be applied to other modes of transport. Particularly in light of last year's tragic airplane accident, the physical and mental fitness of anyone operating any mode of transport must be re-examined. It

does indeed seem contradictory that, for example, the driver's license ordinance (FeV) calls into question the fitness of a person suffering from depression to drive a car and that this person could even have their driver's license withdrawn – and yet the same person might still be allowed to pilot an airplane or navigate a ship.

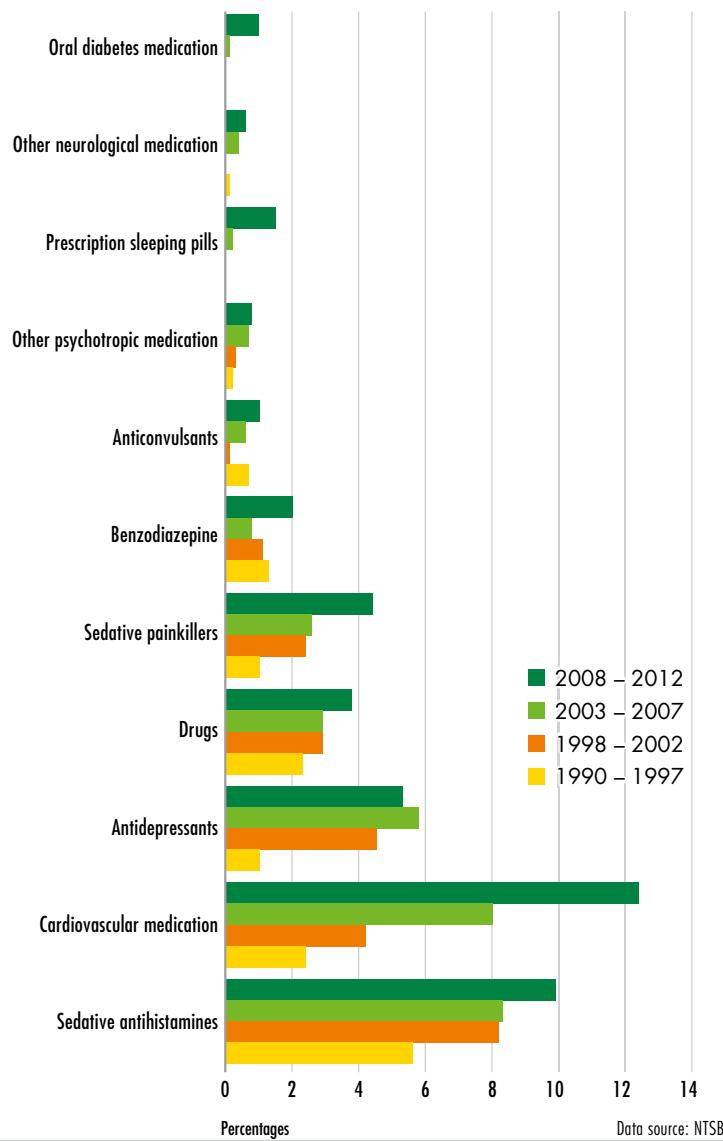
The multi-agency sharing of data could play an important role here. This could take the form of a body for conducting personal checkups, in which a person's fitness to operate any mode of transport can be assessed. After all, despite all the technical instruments and assistance systems involved in the operation of ships, trains, airplanes or cars, it is the physical and mental performance of human beings that remains the key element in the human-machine system. Accident statistics clearly show that human error remains the most common cause of accidents, which is why efforts to improve road safety that focus on human behavior and health – whether on the roads, in the air, at sea or on the railways – harbors the greatest potential for preventing accidents and/or mitigating the consequences of accidents.

tional research, "EVA-MPU" (Hilger et al., 2012), the continued law-abidingness of drunk-drivers three years after their MPA is determined using data obtained from the Federal Office for Motor Vehicles. The recidivism rate is between 6.5% among first-time offenders and 8.3% among repeat offenders. When evaluation studies were first conducted, the figures were much higher. In the first MPA evaluation conducted by Stephan back in 1984, the recidivism rates after three years were 24.9% among first-time offenders and 16.7% among repeat offenders. The recidivism rate among third-time and serial offenders was as high as 26.7%. The positive trend toward sharply declining recidivism rates is testament to the increasing

27 Drugs and medicines found in fatally injured aircraft pilots



Toxicological examination results of 6,677 fatally injured pilots over four time periods. This graph shows not only that the use of narcotics and medication is increasing as a whole, but also that the rise in the use of sedatives, tranquilizing medication, and cardiovascular medication is particularly steep.



effectiveness of MPAs, which, among other things, can be attributed to the systematic application of a scientifically sound list of criteria for assessing conspicuous drivers (DGVP & DGVM, 2013).

In Germany, any driver whose behavior comes to the attention of the authorities can undergo a driving fitness assessment (MPA or medical opinion) in order to put to rest any doubts on the part of the driver's license authorities regarding his or her fitness to drive. The driver's license authorities, however, do not generally have access to data on other modes of transport, which means that the captain of a ship, for example, might have his or

her driver's license withdrawn due to drunk-driving, but is still authorized to navigate a cruise ship. The same applies to air and rail transport. Especially given this fact, it would appear sensible to consider a possible "personal checkup", that is, a personal check of a person's fitness to operate any mode of transport.

Statistics from the USA demonstrate the importance of considering the introduction of a body for conducting medical-psychological personal checkups. An analysis of 1,524 pilots killed in accidents between 1999 and 2003 showed that 830 (52%) were under the influence of alcohol or drugs (Chaturvedi et al., 2005). An analysis of 1,353 pilots killed in accidents between 2004 and 2008 showed that 507 had drugs in their system and 92 had a blood alcohol concentration of more than 0.4 (Canfield et al., 2012). It is highly likely that all of them had driven or ridden some form of transport on the roads, too, in the period prior to their accident. A study conducted by the National Transportation Safety Board revealed a significant increase among pilots in the consumption of narcotics and medication (Figure 27).

According to the German driver's license ordinance (FeV), the regular consumption of medication can call into question a person's fitness to drive. The situation is similar with illnesses such as diabetes, high blood pressure and other cardiovascular problems. On the basis of the medicines taken by the subjects under analysis in this study, it can be concluded that in addition to the consumption of narcotics, the US pilots involved in these accidents also suffered from illnesses that, in Germany at least, would have called into question their fitness to drive but that did not appear to result in a flying ban following their medical examination for pilots.

Given, too, the tragic end of the Germanwings flight on March 24, 2015 in the French Alps, it is only sensible that we at least discuss the introduction of checkups for people exhibiting medical, psychological or behavioral abnormalities in whatever field of transport – road, rail, marine, air – in terms of their fitness to operate any mode of transport.

DAYTIME DROWSINESS INCREASES THE RISK OF ACCIDENTS

A perennial hazard on the roads is fatigue or drowsiness, also defined as "sleep-related fatigue."

It is hard to gather data on this particular hazard because no breath or blood test can give the police any indication of fatigue, unlike with the consumption of alcohol or drugs, for example. As a result, fatigue is frequently not registered in statistics as a cause of accidents, hence the potential for a high number of unrecorded cases.

Fatigue as the potential cause of an accident is indicated in studies in which those involved in an accident are asked about its cause directly afterwards. For example, questioning 9,200 Norwegian people involved in accidents (Sagberg, 1999) revealed that falling asleep at the wheel and drowsiness were the causes of 3.9% of all accidents. This factor played a massive role in nighttime accidents (18.6%), accidents in which the vehicle left the road (8.3%), accidents occurring after the driver had already covered more than 150 kilometers (8.1%) and accidents with casualties (7.3%). A detailed scientific analysis of accidents involving trucks on German highways (Evers & Auerbach, 2003) showed that fatigue was the cause of between 16% and 19% of truck accidents in which people were killed or seriously injured.

Even if the statistical data on drowsiness as the cause of an accident can be interpreted only to a limited extent, the data generated by the Federal Statistical Office of Germany (2015) at least indicates that fatigue as the cause of accidents has increased over the past ten years.



**Prof. Dr. med. Maritta Orth,
Dr. Dipl.-Psych. Hans-Günter Weeß**

Members of the Board of
the German Sleep Society



Daytime drowsiness is the number 1 risk factor

Daytime drowsiness is defined as a compulsive need to fall asleep, particularly in monotonous situations such as driving at night along the highway and, above all, during physiological performance slumps (depending on chronotype or inner biological clock, between 2 a.m. and 5 a.m., in the early afternoon and from 8 p.m.).

Surveys conducted in the USA show that around 60% of all drivers have driven while feeling sleepy, with 17% admitting to having nodded off very briefly at the wheel. In the USA, experts assume that between 10% and 30% of all car accidents can be attributed to drowsiness.

Daytime drowsiness is a particular risk among professional drivers who transport not only merchandise but also people or hazardous goods. In this occupation group, the occurrence of obstructive sleep apnoea syndrome – one of the most common sleep disorders that can lead to daytime drowsiness – is around 16%, so four times higher than among the rest of the population. Up to 25% of drivers admit to having felt sleepy while driving.

The EU bus campaign, which was initiated in 2013, provides the most up-to-date information on driver drowsiness in Europe. As part of the accompanying questionnaire campaign, 12,434 questionnaires – 759 from Germany – were evaluated.

Regarding the question on sleepiness at the wheel, the highest numbers came from the Netherlands (34.7%) and Austria (34.2%). In Germany, 17.1% of people admitted to nodding off at the wheel. The total percentage of fatigue-related accidents was 1.4% (Estonia: 2.7%; Austria: 2.6%; Poland: 2%). The most common specified causes of drowsiness were poor sleep during the previous night (42.5%) and poor sleep in general (34.1%).

On the basis of current studies, the European Parliament (Commission Directive 2014/85/EU of 1 July 2014 amending Directive 2006/126/EC of the European Parliament and of the Council on driving licenses) has identified obstructive sleep apnoea syndrome due to daytime drowsiness as one of the key accident risk factors. The necessary laws and regulations concerning fitness to drive in EU countries were to be elaborated by December 31, 2015. The instructions contained in the Directive are currently being implemented by the German Federal Highway Research Institute in collaboration with the German Society for Sleep Research and Sleep Medicine. On a critical note, however, this EU regulation fails to address other causes of sleepiness at the wheel such as other forms of sleep disorder or somatic illnesses.

■ Fatigue at the wheel is a common cause of serious accidents, which is why regular breaks are recommended particularly on long journeys.

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**Respiratory mask can help in the treatment of sleep apnoea**

For drivers, particularly those who carry people, drive HGVs or travel long distances, sleep disorders that lead to daytime drowsiness are a real problem. Investigations have shown that both the frequency and severity of accidents increase if drivers suffer from daytime drowsiness. The government has responded by amending Annex 4 of the driver's license ordinance (FeV). For a driver's license to be extended, the risk of measurable daytime drowsiness must be excluded.

The most common sleep disorder relevant in this case is sleep apnoea. If your nightly sleep is disturbed by snoring and/or interruptions in breathing, you cannot – or only rarely – enter the slow-wave sleep phase necessary for recuperation. The inadequate supply of oxygen brought about by interruptions in breathing leads to automatic waking sensations in the brain. You wake up to get some air, the sleep routine is interrupted and deep sleep is impossible. As a result, you feel sleepy and unrested during the day – with all the consequences this state brings: Inattention, concentration problems, headaches, even a tendency toward depression. You may also experience "microsleeps", with all the risks that these entail if you are driving or at other places of work that lie outside the remit of the FeV.

In collaboration with lung specialists, the Association of German Transport Companies and the German Statutory Accident Insurance (DGUV), recommendations designed to clarify the issue of whether sleep disorders exist with measurable daytime drowsiness have been formulated. The questionnaire on daytime sleepiness (ESS: Epworth Sleepiness

Scale) must be included with a person's past medical history. Dialog between doctors and patients must also seek to clarify whether a patient snores, suffers from interruptions in breathing or has ever experienced microsleeps. If the doctor identifies any abnormalities, further clarification must be sought from the lung specialist. Only in certain, defined cases is it necessary to declare a person as no longer fit to work. Sleep apnoea can often be effectively treated with the help of a respiratory mask (nCPAP = nasal continuous positive airway pressure). The mask is effective almost immediately, which also means that the sufferer can also resume work immediately. The patient must be informed that their fitness to work depends on their regularly wearing the mask. Equally as regularly, follow-up examinations should be conducted in which the examining doctors must confirm for themselves that the mask is being worn, for example using an invoice for the maintenance of the mask. If a person's risk profile changes – for example, they start to become severely overweight – a reassessment is necessary.

Even if, by our experience, the issue of sleep apnoea in a large transport company is not such a hot topic as it used to be because people are well-educated about this and sufferers have already sought treatment, it is important to use the opportunity – especially as part of occupational health work – to educate and inform. In particular, emphasizing the drastically improved quality of life can motivate sufferers to confront the issue of sleep apnoea and consider the use of a respiratory mask.

SEVERE IMPACT ON PERFORMANCE

Fatigue and drowsiness have a major impact on a driver's performance because they lead to impaired attention, concentration, reaction times and judgment, for example of speed or distance. An experiment showed that the participants who undertook a nighttime test for detecting hazard stimuli were significantly worse at identifying the critical stimuli in potentially hazardous traffic scenarios (Höger, Marquardt & Walter, 2011). The ability of drivers to identify road hazards seems to be worse among beginner drivers compared with more experienced drivers (Smith, Horswill, Chambers & Wetton, 2009). Overall, it can be concluded that some road accidents are caused by the driver's fatigue-impaired ability to identify road hazards.

Another hazard for tired drivers is the "micro-sleep", a person briefly nodding off. This can occur particularly on long, monotonous drives. But, depending on its speed, a vehicle can cover many meters in just a few seconds. During this period, drivers who have nodded off not only risk losing control of their vehicle and, possibly, leaving the road, but they will also fail to spot other road users.

Fatigue can have many causes, including a lack of sleep due to external circumstances such as shift work, medication intake or alcohol/drug abuse. Shift workers, for example, frequently have to battle fatigue and daytime drowsiness. Another reason for daytime drowsiness are sleep disorders and sleep-related respiratory dysfunction such as sleep apnoea.

What should you do if you experience fatigue at the wheel?

Most importantly, you should do anything possible to avoid the risk of suffering fatigue while driving. Make sure that you get enough sleep and rest, particularly before embarking on long journeys. Remember that driving for long periods on monotonous stretches of road (e.g. highways) can make you particularly tired, so make sure that you schedule a sufficient number of breaks. Physical activity during these breaks increases oxygen levels in your blood and brain, helping you to combat fatigue. If you feel your eyelids getting heavy and that you are losing concentration, take a break at the next

If a person is diagnosed as suffering from some form of sleep disorder, it is important that the attending doctors indicate to what extent the disorder could potentially affect that person's ability to drive. The same applies when people are prescribed medication that leads to increased drowsiness.

DRIVING BLIND

Another rapidly growing problem associated with a high risk of accidents is driver distraction. As the results of a survey conducted by DEKRA in the summer of 2015 among 1,100 car drivers in Germany show, many of them do not pay as much attention to the road as they should. Half (52%) of all car drivers surveyed use their cellphone while driving, almost 5% without the prescribed hands-free car kit. And that's not all: More than one in five drivers (22%) program their navigation device while driving, while 8% play around on their smartphone. If their cellphone notifies them of a new text or chat message, 2% of drivers respond while driving and 7% respond while in stop-and-go traffic or at the next stoplight. Half (52%) of all drivers surveyed eat and drink at the wheel; 79% tune in to a radio station or insert a CD in the player. 3% of women apply makeup or brush their hair while driving. Only 5% of car drivers do not carry out any non-driving-related activity.

Young car drivers are especially prone to becoming distracted by their smartphones. Of the respondents aged 25 and younger, 5% respond to text messages while driving. 16% send a message while in stop-and-go traffic or at the next stoplight. 15% of young drivers – so almost double the

available opportunity. In such cases, a short rest – "power nap" – can help you to reduce the risk of causing a fatigue-induced accident.

Drivers who regularly or periodically have to take medication – including antihistamines in anti-allergy treatments – should definitely consult their doctor to find out whether their medication causes drowsiness. The consumption of drugs or alcohol can also – even on the day after – impair performance and cause drowsiness.

PS: Driving with a passenger also reduces the risk of causing a fatigue-induced accident.

Pedestrians: the risk of distraction posed by smartphones

One of the biggest factors when it comes to people becoming distracted while out and about are modern communication devices – above all, smartphones. And this applies to pedestrians, too. To find out just how many pedestrians actually become distracted, DEKRA accident researchers conducted traffic observations involving almost 14,000 pedestrians.

The teams conducted their research in six European cities – Amsterdam, Berlin, Brussels, Paris, Rome and Stockholm. In the city centers, they watched pedestrians crossing roads and logged the number of people using smartphones.

The overall result from all cities and all age groups showed that 7.9% of pedestrians wrote text messages while crossing the road, another 2.6% were making a call. Around 5% were wearing earplugs or headphones without speaking, so were probably listening to music.

As expected, younger pedestrians tended to use their smartphone more frequently than older ones: Among the over-46s, a good 5.6% were writing text messages; among the under-35s, this figure was more than

9%. As far as listening to music is concerned, the highest value – 7.5% – was among those aged 26 to 35.

Gender-specific differences were clearly observed. While more than 12% of female pedestrians aged between 12 and 25 were writing text messages while crossing the road, the figure among male pedestrians in the same age group was just 4.8%. This figure was 10.8% among 26- to 35-year-old females and 8.0% among males in the same age group. In contrast, males listen to music more frequently. Among pedestrians aged between 26 and 35, for example, 10.3% of males and only 4.8% of females listened to music.

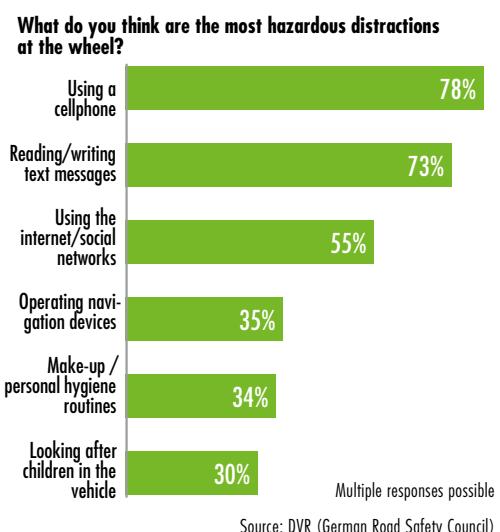
In a city-by-city comparison, the differences are minor. The most striking finding here is that in Amsterdam, smartphone use across all age groups was less frequent than in any of the other cities assessed.

DEKRA experts recommend everyone – including pedestrians – to keep their eyes on the road and not get distracted by smartphones. Overall, the traffic observation showed that a good 83% of pedestrians stick to this rule.



28 Dangerous distractions

In November 2015, the German Road Safety Council (DVR) commissioned the market research institute Ipsos to conduct a representative survey of 2,000 people aged 14 or over on distractions in road traffic. The survey found that three quarters of car drivers think that making cellphone calls and reading or writing text messages are the most dangerous distractions at the wheel. Drivers rated using the internet and social networking as the third most hazardous distractions, followed by operating navigation devices.



Source: DVR (German Road Safety Council)

average – use their smartphone at the wheel. Even talking on a cellphone while driving – with or without a prescribed hands-free car kit – can severely distract drivers from what is happening on the road. The risk of an accident increases significantly especially in more complex traffic situations such as in dense traffic or on winding roads – and this is particularly so for all actions that force the driver to take their eyes off the road ahead (Figure 28). At 80 km/h, even just one second of inattention is equivalent to 22 meters of blind driving.

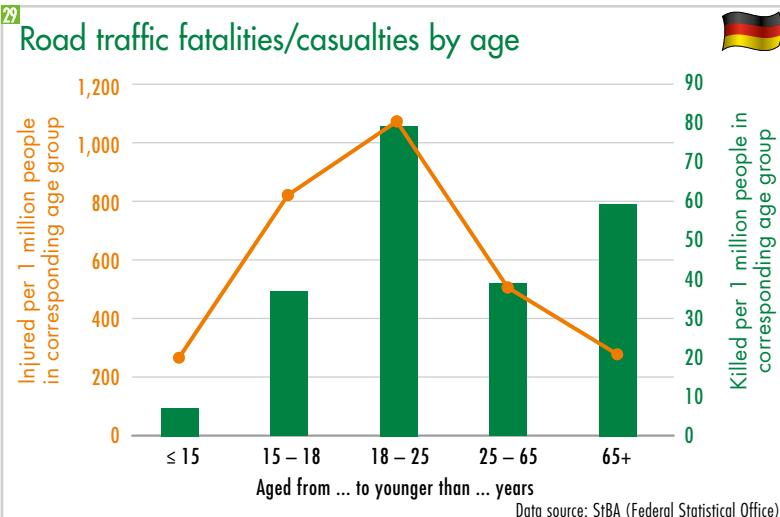
RISK OPTIMIZATION IS ESSENTIAL

Given the hazards that distractions behind the wheel pose for all road users, a special colloquium devoted to this very issue was held at the beginning of December 2015 by the German Road Safety Council. At this event, whose supporters included DEKRA, Professor Mark Vollrath from Braunschweig University of Technology referred to a US study stating that reading and writing text messages increase the risk of an accident 164-fold. It also stated that the distracting effect of talking on a cellphone while driving is equivalent to a blood alcohol concentration of 0.8, while the distracting effect of writing text messages is equivalent to a blood alcohol concentration of 1.1. Furthermore, road users showed insufficient awareness of the dangers of averting their gaze from the road. The compensating measures drivers usually take – for example, slowing down or increasing their distance from the vehicle ahead – are insufficient in the case of text messages.

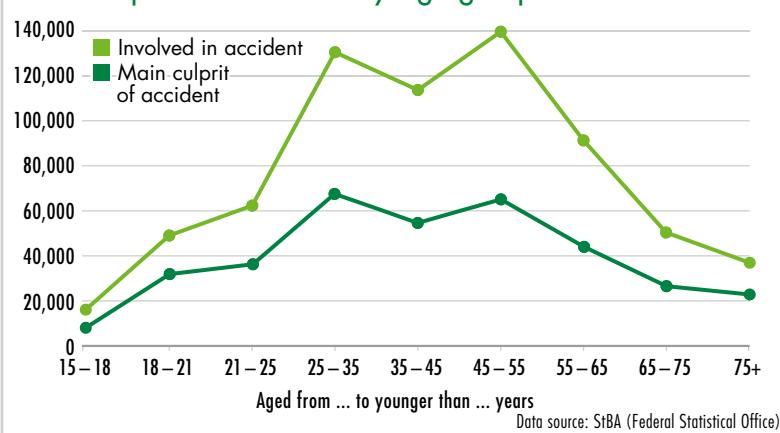
The Austrian psychologist Dr. Gregor Bartl proposed some urgent measures, including the standardized, EU-wide recording of driver distraction as a cause of accidents; the inclusion of a standardized distraction task in driving tests and driver training; and coverage of the issue in the training received by professional drivers. As Dr. Walter Eichendorf – President of the German Road Safety Council – explained, the legal regulations concerning the use of cellphones at the wheel need to be urgently updated, whereby any new regulation should apply not only to drivers of cars or other vehicles but also to pedestrians.

The overall take-away from this is that secondary tasks carried out by people out and about on the roads – whether car drivers or pedestrians – mean that they are unable to devote their full attention to what is happening around them. Even operating the various technical, in-car devices requires some

29 Road traffic fatalities/casualties by age



30 Main culprits of accidents by age group



degree of attention – attention that is no longer focused on the road ahead. Due to the brain's restricted capacity to process information, drivers may fail to spot and process key information.

HIGH-RISK GROUPS: THE YOUNG AND THE ELDERLY

Media reports always highlight two risk groups: Young, inexperienced and, often, allegedly irresponsible drivers; and the elderly, overtaxed driver. But how do these stereotypes stack up with reality? Accident statistics can provide some initial insight. **Figure 29** clearly shows that, as a proportion of the population as a whole, 18- to 25-year-olds suffer the most fatalities and injuries, followed by 15- to 18-year-olds, at least in terms of injuries. In contrast, the over-65s is the age group suffering the second-highest number of traffic fatalities.

Taking the over-65s in isolation, a discrepancy can be observed between the number of deaths and the number of injured persons in this age group. The over-65s are much more likely to die in road accidents than you might assume if one looks at just the number of injured persons (including in comparison with other age groups). Elderly people, therefore, are much less likely overall to be involved in an accident, although they are more likely to be killed if they are involved in an accident – that is, they are a bigger danger to themselves than they are to other road users. For young drivers, however, the statistics look very different. Here, the number of young people injured on the roads is roughly equivalent to the number of fatalities.

Closer analysis of the accident statistics for older drivers shows that car drivers aged 64 or over who were involved in an accident were often (66.9%) the main culprits, too (**Figure 30**). Among the over-75s, this figure was as high as 74.9%.

VOLUNTARY HEALTH CHECKUPS FOR ELDERLY ROAD USERS

Why is it that elderly people are more likely to cause accidents despite the fact that it is precisely older drivers who have more driving experience than young drivers? As we age, many of our sensory, physical and mental abilities start to deteriorate. For example, our reaction speed depends on how fast we can process the relevant information. As we age, it is not the case that the function of one single sensory organ starts to deteriorate; rather, the process of degeneration generally occurs over



Elderly people are generally much less likely to be involved in accidents than people assume. Nonetheless, a regular health check is still advisable.

multiple sensory modalities. The resulting polymodal sensory impairments are associated with significant mental stress and cannot be compensated without assistance, making our surroundings harder to navigate.

These physical changes that occur as we age explain the specific reasons behind accidents caused by elderly road users, which are mostly associated with difficulty in getting one's bearings. The limitations that older drivers encounter due to their age, however, can be offset by their experience and driving expertise. Accident statistics show that older drivers, as a proportion of the population, are less frequently involved in accidents than younger drivers, which leads to the conclusion that driving experience is a protective factor. Older drivers enjoy a level of expertise that compensates for any age-related limitations.

This knowledge can be applied in practice to matters of road safety. It would be sensible, for example, if older drivers voluntarily underwent health checkups focusing especially on their physical and mental fitness to drive. Older road users should be given the opportunity to take voluntary measures to promote, maintain and regain their mobility, thereby ensuring that they can continue to be safe road users. A Danish study investigated the consequences of an obligatory, periodic health checkup among older drivers. The study was initiated following the introduction of a cognitive performance test for older drivers in Denmark. The data on fatal road accidents before and after this test was introduced was compared.

Prof. Ir. Wout van Bommel

Former President International Lighting Commission, CIE



Age, light perception and street lighting

As people age, the physiology of the eye changes. A couple of the more important changes are cloudiness of the lens and a reduction in pupil size. Both have an adverse effect on how light is transmitted to the light-sensitive cells (photoreceptors) within the eye. Among 50- to 65-year-olds, cloudiness of the lens leads to an average reduction in light absorption of between around 60% and 55% compared with a 25-year-old. Under identical lighting conditions, the pupil size of a 50- to 65-year-old decreases by between 65% and 55%. In a 50- to 65-year-old person, the combination of these two factors means that only around 30% to 40% of light strikes the photoreceptors. For comparison, standard sunglasses allow through between 45% and 30% of light.

Reduced light perception can have particularly serious consequences under the lighting conditions on the roads. Younger people can simulate this effect by briefly wearing a very dark pair of sunglasses while driving at night. The "revealing power" can be used as a measure of visibility under street lighting conditions. This describes the percentage vis-

ibility of a large number of objects with dimensions of 20 x 20 cm and a light reflectance factor equivalent to the clothing typically worn by a pedestrian. When these objects are viewed from a distance of 100 meters (i.e. safe braking distance at a speed of 100 km/h to 120 km/h) and under street lighting with a luminance of 1 cd/m², which is generally considered acceptable, the revealing power of 20-, 50- and 60-year-olds is 85%, 0% and 0% respectively.

Older car drivers have two options: Either they do not drive at night or they drive more slowly. Under the same lighting conditions, but over a shorter viewing distance of 75 meters (i.e. safe braking distance at a speed of 80 km/h to 90 km/h), the revealing power of 20-, 50- and 60-year-olds is 97%, 60% and 0% respectively. Although the 50-year-old driver would be "safe" driving at a lower speed, their slow driving would nonetheless constitute a hazard for others. Older people have to drive even more slowly. Street lighting should accommodate the visual faculties of older people more than is currently the case.

The study revealed no difference in the number of older drivers involved in accidents either before or after the introduction of the cognitive test, which means that these kind of checkups do not have any effect on the safety of older road users. One figure that increased significantly, however, was the number of unprotected older (but not younger) road users who were killed during the two-year period under observation. The authors interpreted this dramatic finding as follows: Older road users gave up driving and switched to unprotected, significantly less safe modes of transport such as bicycles.

SIGNIFICANT LACK OF EXPERIENCE AMONG YOUNG DRIVERS

The aforementioned figures clearly show that young drivers, compared with older drivers, constitute the bigger and more dangerous risk group on the roads. The reasons for this lie in the behavior and attitudes of young drivers rather than in any physical aspects. Some young drivers are inclined to take risks, leading to excessive speed or other violations of the rules of the road. In addition, however, certain personality traits are associated with a greater risk of accidents among young drivers. A long-term Australian study (Vassallo et al., 2007), for example, reports that high levels of antisocial behavior and aggression and low levels of empathy are potential indicators among young drivers of risky driving behavior and a tendency to break speed limits. The ability to identify early on young people with risk-seeking dispositions could therefore help to reduce their inclination to take risks at the earliest possible stage.

Another factor in the high accident rate among young people is their inexperience, which means that they lack the knowledge and ability to know how to respond in certain situations. This is where driver training can make a key contribution. The fact is that the theoretical and practical driving license test is an extremely important element in the whole training system for beginner drivers: On the one hand, only beginner drivers who are sufficiently proficient to drive a vehicle on the road are licensed; on the other hand, the training content, assessment criteria and test results are important control functions for the organization of driver training and the individual learning processes of beginner drivers.



Differences in pupil size – eye of a 24-year-old (left) and a 66-year old (right). The picture on the right clearly shows the age-related cataract..

TRAFFIC PERCEPTION TEST FOR BEGINNER DRIVERS

It is essential that driver licensing procedures keep pace with the ever more complex demands of road traffic and innovations in the field of vehicle technology. But what kind of developments can we expect to see here? For a start, the theoretical driving license test is and must remain a test of knowledge. Above all, it conveys explicit knowledge – for example, of the rules of the road or how to properly observe traffic in different situations.

In the practical component of the driving license test, however, learners must demonstrate that they can flexibly apply their theoretical knowledge when driving a car in real-life traffic. This involves picking up routine behaviors and consolidating these through practice. These routine behaviors relate not only to how the vehicle is operated but also to how traffic is perceived and hazards are avoided. The inability to properly observe traffic and avoid hazards is still one of the biggest causes of accidents among beginner drivers, which is why driver training must focus on the skills necessary to develop this ability.

Technical testing authorities in Germany have done their bit to achieve this ambitious goal by developing a traffic perception test. The recent innovation report “Traffic Perception and Hazard Avoidance – Fundamentals and Implementation



Methods in Beginner Driver Training” (TÜV/DEKRA arge tp 21, 2015) presented key scientific premises and research findings, on the basis of which innovative task formats for traffic perception tests are currently being developed and trialled. These tasks are designed to be performed on a computer and, in the future, will constitute a link between the theoretical and practical components of the driving license test.

Of course, traffic observance skills will still play an important role in an optimized practical driving license test. Unlike the practical driving license test, however, a traffic perception test will allow learners to practice the relevant skills much more systematically and without being exposed to real danger because many of the relevant (virtual) hazard situations can be specifically simulated.

Road safety education and driver training must be constantly adapted in line with new challenges on the roads.

The facts at a glance

- Drunk- or drug-driving, the taking of medication, criminal offenses or repeated motorizing offenses can strongly call into question a person's fitness to drive.
- MPAs have proved to be an effective means of improving road safety in Germany.
- In cases of doubt, a person's fitness to operate modes of transport other than road-based vehicles must be checked (where relevant).
- Fatigue as a cause of accidents has increased significantly over the past few years.
- Many road accidents are caused by driver distraction.
- At 80 km/h, even just one second of inattention is equivalent to 22 meters of blind driving.
- Elderly people are much less likely overall to be involved in an accident, although they are more likely to be killed.
- Voluntarily health checkups focusing on physical and mental fitness to drive could prove extremely beneficial for older road users.
- Compared with elderly drivers, young drivers constitute the bigger and more dangerous risk group on the roads.
- Driver training must focus more intensively on developing traffic observance and hazard avoidance skills.

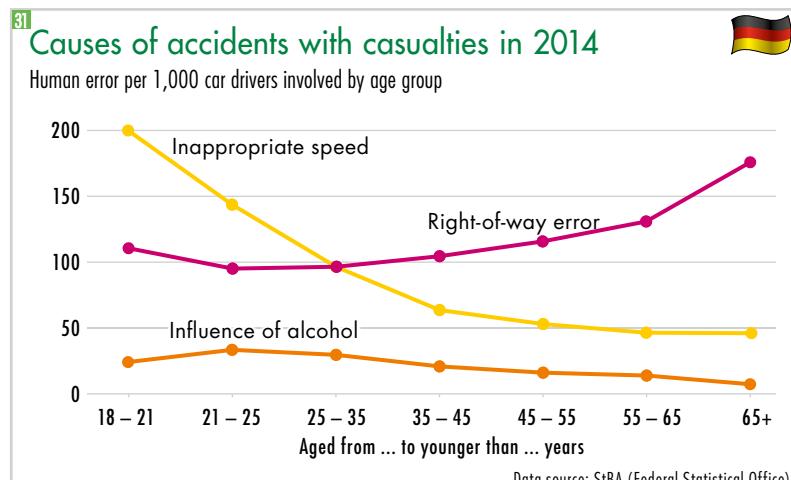


Saving Lives Through Technical Safety

The EU Commission's objective is to have next to no more traffic fatalities on Europe's roads by 2050. To achieve this goal, the focus needs to be on not only driver assistance systems such as ESP but also, increasingly, the next levels of automated driving systems. However, this also immediately raises the question of how these systems can be checked. In the field of vehicle technology, „connected cars“ – thanks to their capability of communicating between vehicles (vehicle-to-vehicle) and from vehicles to centralized systems (vehicle-to-infrastructure) – offer huge potential for preventing road accidents and for rendering more effective assistance following an accident (eCall).

The findings from traffic accident researchers say the same thing time and time again: The main cause of crashes resulting in personal injury and/or material damage is human error. Statistics show time and again that humans are responsible for

more than 90% of all accidents. Experience suggests that errors occur, above all, in perception, in the absorption of information and in the process of accessing information. This applies as much to Germany as it does to most other EU member states.



If one takes a closer look at the figures for Germany, it can be seen that car drivers accounted for 250,000 of the almost 362,000 cases of mistakes recorded in 2014 among operators of any mode of transport. This is equivalent to 70%. Of these, in turn, the most common causes of accidents, at 18.6%, were turning off, executing U-turns, driving backward, pulling in and driving off and, at 17.6%, nonobservance of right of way or priority. The influence of alcohol accounted for 3% of all accidents. Gratifyingly, since 1991, the frequency with which alcohol is a cause of accidents among car drivers has fallen by around 74%. The problem

of inappropriate speed as a cause of accidents has fallen over this period by 64%.

In contrast, turning errors among car drivers have fallen by only 8.3%, while accidents caused by errors in the judgment of distance have in fact increased by 2.5%. As the Federal Statistical Office of Germany explains, certain accidents in which the driver was at fault reveal – per 1,000 persons involved – a clear age or gender dependency: For example, inappropriate speed and errors in the judgment of distance are by far the most common causes of accidents among young drivers, while turning errors or failure to observe right of way increased significantly with age (Figure 31).

ANTICIPATING HAZARDS

To compensate to a certain extent for human shortcomings and errors, the automotive industry has for many years been increasingly focusing on driver assistance systems that are capable of recognizing critical driving and traffic situations early on, warning of dangers and, if necessary, actively intervening. The most important of these systems are electronic stability control, emergency braking systems, adaptive cruise control, lane keeping systems and fatigue warning systems. Their enormous potential for preventing accidents has already been observed in numerous tests and studies: Almost 50% of accidents could be avoided or reduced in severity if innovative driver assistance systems were systematically introduced as standard (see also Table 32).

Regarding the long-term “Vision Zero” – that is, no fatalities or serious injuries in road accidents – these electronic helpers are, in the opinion of accident researchers, indispensable as integral safety elements and should therefore become even more widespread on the market. Politicians take the same view, too. As the “Mid-Term Review of the Road Safety Program 2011–2020” published by the German Federal Ministry of Transport and already cited in this report states, the further development and consolidation of existing, tried-and-tested assistance systems on the road toward automated, connected driving – Mobility 4.0 – is to be given another major boost. Further positive effects can also be expected through the fact that more advanced sensor technologies arising from the development of automated driving functions will also be deployed in conventional assistance systems, meaning that vehicles with automation

■ Vehicle-related measures proposed by the EU to increase road safety and their effect on the occurrence of accidents

Measure	Description	Potential for reducing fatal accidents/fatal injuries
Advanced emergency braking systems (AEBS)	Emergency braking systems combine the use of sensors to monitor the road ahead and a system for automatically activating the brakes (without driver intervention) to mitigate the effects of or avoid collisions.	Reduction in the number of fatal rear-end collisions by 145 to 532; reduction in the number of serious rear-end collisions by 1,402 to 8,808; general reduction in the number of accident victims by 11% (EU-27).
Speed Assist	Alert function: warns the driver if they are driving too fast.	Reduction in the number of fatal accidents by 5% and serious accidents by 4%
	Voluntary: The driver decides whether the system limits the vehicle speed and/or selects the speed that is not to be exceeded.	Reduction in the number of fatal accidents by 21% and serious accidents by 14%
	Obligatory: The speed is actively limited by the ISA (Intelligent Speed Adaptation) system.	Reduction in the number of fatal accidents by 46% and serious accidents by 34%
		Speed Assist leads to a general annual reduction in the number of fatal accidents by 37% according to a report published by the Transport Research Laboratory.
Lane Keeping Assist (LKA)	The LKA monitors the position of the vehicle in relation to the lane markings; if the vehicle threatens to leave the lane, the steering wheel is activated or the brakes are applied.	Annual reduction in the number of fatal accidents by 171 to 3,630 and reduction in the number of accidents resulting in serious injuries by 871 to 17,985.
Safer front-end design of heavy goods vehicles (HGVs)	Greater protection for other road users thanks to a safer front-end design of HGVs.	Annual reduction in the number of road fatalities by 273 to 922
Improved rear underride guards on HGVs	Increased strength and reduced ground clearance of the rear underride guard on HGVs	Annual reduction in the number of fatalities by 43 to 93 and reduction in the number of serious injuries by 694 to 2,063 (EU-25)
Improved side underride guard on HGVs	Side underride guard on trucks and trailers – elimination of exceptions in current legislation	Annual reduction in the number of fatal accidents involving pedestrians and cyclists by 5 to 13
Installation of adaptive restraint systems	Installation of improved (adaptive) restraint systems to reduce chest injuries and injuries suffered by older road users	Annual reduction in the number of fatal and serious injuries to vehicle occupants by 5%
Protection of vehicle far-side occupants (opposite side to impact)	Measures to protect far-side occupants from injury in side impacts and some rollover accidents	Annual reduction in the number of fatal injuries suffered by far-side occupants by 30% and serious injuries suffered by far-side occupants by 18% to 57%
Seatbelt reminders	The system detects when the seat is occupied and issues an acoustic and/or visual signal if the occupant does not put on their seatbelt (currently only the car driver's seat is covered by EU legislation here).	Reduction in the number of vehicle occupant fatalities by 191 and reduction in the number of serious injuries by 1,902 between 2015 and 2025
Detection of driver distraction and fatigue	Systems for measuring driver inattention or fatigue	Potential for reducing the number of collisions caused by driver distraction or fatigue
Alcolocks	The alcohol immobilizer prevents the engine from being started if it is detected that the driver's alcohol level exceeds a predefined limit.	Reduction in the number of fatalities by 3,500 to 5,600 for cars; reduction in the number of fatalities by 7 to 137 during use in special programs for known drink-drivers; reduction in the number of fatalities by 125 when installed in HGVs; reduction in the number of fatalities by 5 when installed in transit buses and coaches
Event data recorder	Event data recorders (EDRs) record a range of vehicle data over a short period before, during and after a threshold value has been exceeded and are normally used for recording road accident data.	Hard to quantify

Source: Road safety study for the interim evaluation of Policy Orientations on Road Safety 2011–2020



■ Head-up displays can make a major contribution to road safety, although they may also pose the risk of distracting drivers from what is happening on the road ahead.

levels 0 (driver only) and 1 (assisted) can also be driven more safely.

HEAD-UP DISPLAYS: TOO MUCH INFORMATION?

Supplementing the range of driver assistance systems, one element of the human-machine interface that is available in more and more vehicles is the head-up display (HUD), a visualization system that projects useful information for the driver as a virtual image into the driver's field of vision directly in front of the windscreen. The HUD means that the driver no longer has to take the eyes off the road in order to see the information – such as vehicle speed, information provided by the traffic sign recognition system or warnings of any pedestrians or cyclists detected by the night vision system – displayed on the instrument cluster.

This system can be enhanced with “augmented reality” technology. Controlled by a camera equipped with image detection software and tak-

ing into account the vehicle's movement, the HUD features an additional display level. For the driver, it looks as though the information provided is in fact part of the actual driving environment ahead of the vehicle – for example, the navigation system's turn arrow does not just appear to float in the air pointing to the right, it actually marks the intended turn-off point; or, the automatic adaptive cruise control places a glowing, orange-colored bracket onto the road directly behind the vehicle ahead. And when the lane departure warning system is active, the lane markings start to flicker as soon as the car gets too close.

That said, cautionary voices have been raised, too: A study conducted by the University of Toronto concluded that augmented-reality HUD systems in particular can be too distracting for drivers. After all, the very act of processing the information displayed requires concentration, which, in turn, can potentially distract attention from what else is happening on the road. When a warning is issued, the driver has to be able to register both the traffic situation and the warning itself, leading to a division of the capacity to absorb information. With this in mind, therefore, it is questionable whether augmented-reality HUDs can be viewed with unreserved enthusiasm in terms of road safety.

CONNECTED CARS AND SAFETY

To increase safety on our roads, intelligent networking and digitalization inside and outside the

ECALL COULD CUT THE NUMBER OF TRAFFIC FATALITIES IN THE EU BY 10% YEAR ON YEAR.

vehicle is set to play an increasingly important role in the future. “Connectivity” means that vehicles can communicate both with each other (vehicle-to-vehicle, or V2V) and the road infrastructure (vehicle-to-infrastructure, or V2I) such as stoplights and traffic management systems. This communication – also known under the umbrella term “car-to-X” communication – warns and informs drivers instantly of hazardous situations along the route, even if these are not yet visible to the driver themselves. During highly or fully automated driving, the vehicle would brake autonomously in such cases or change lanes in order to bypass the hazard at a safe distance without the driver having to intervene.

Various communication technologies are available for ensuring the required level of connectivity, including:

- Standardized, general-purpose short-distance technology (Bluetooth™, Wi-Fi, wireless power, NFC etc.)
- Technology developed specially for vehicle connectivity (e.g. IEEE 802.11p, a Wi-Fi-like short-distance communication standard for V2V and V2I)
- Mobile network coverage (GSM, UMTS, LTE and all associated variants)

A COMPARISON OF TECHNOLOGIES

The enforcement of a ban on using cellphones in the car without a hands-free kit has contributed to the popularity of Bluetooth technology, which allows drivers to control incoming and outgoing calls via the dashboard and connect the audio signal to the hands-free microphone and loudspeaker in the vehicle. Standardization was advantageous here because the Bluetooth Special Interest Group has developed a specific profile for this scenario: The hands-free profile (HFP).

Wi-Fi is the certified and generally preferred process for providing vehicle occupants with infotainment services. The car itself can act as a hotspot. Wireless power allows wireless charging of cellphones, smartphones and other devices without any action on the part of the user – that is, without the driver having to perform any distracting task; at the same time, the mobile device is always ready to communicate (in the car via Bluetooth and fully charged when the driver leaves the vehicle).

IEEE 802.11p – a technology similar to Wi-Fi – was developed to facilitate V2V and V2I communication. There is, however, still a long way to go before this technology becomes widespread in the automotive industry because it can be leveraged to its full potential only when used on a mass scale

Erik Jonnaert

Secretary General of the European Automobile Manufacturers' Association (ACEA)



Increasing road safety through intelligent transport systems (ITS)

The European Automobile Manufacturers' Association (ACEA = Association des Constructeurs Européens d'Automobiles) is committed to further improving the safety performance of the vehicles produced by its 15 members. Over the past few years, EU road fatalities have been halved from their 2001 figure of 55,000, in part as a result of the significant investments made by the automotive industry in safety features.

To support reduction efforts even more, manufacturers are continuously working to bring smart, active safety technologies to the market, such as automatic emergency braking and lane keeping assistance. These will help to prevent accidents from happening, rather than simply reducing their impact, and thus will help save even more lives. The European automotive industry spends a significant portion of its research and development investments, worth €41.5 billion last year alone, on improving vehicle safety.

In the near future, intelligent transport systems (ITS) are expected to play a role of increasing importance in improving road safety. Connecting vehicles with each other and with the infrastructure, together with the introduction of automated vehicles, can prevent accidents from happening. Today 90% of accidents are caused by driver errors, but increasing degrees of automation will see some tasks removed from the driver in the future, with the potential to reduce accidents due to human errors.

More progress can be made if all stakeholders join forces. That is

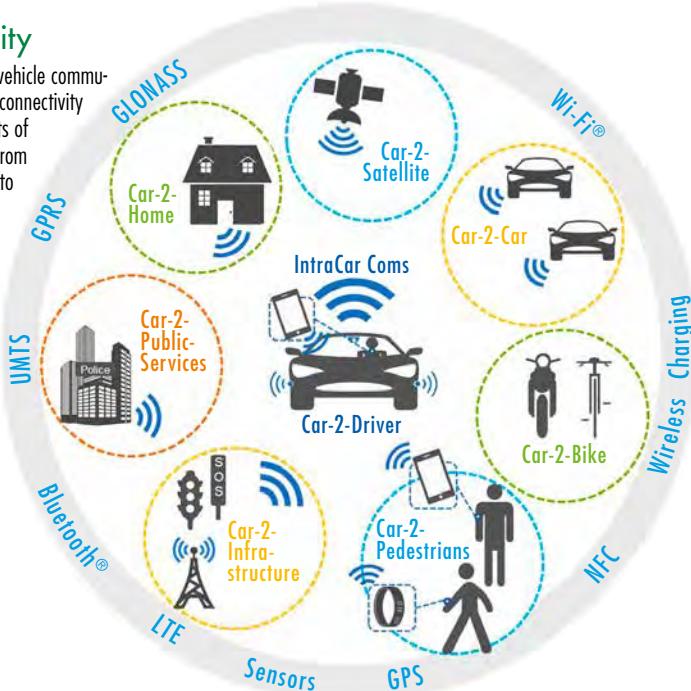
why ACEA advocates an integrated approach to further reducing fatalities. Additional improvements to road safety will only happen when all relevant stakeholders are committed to working together. This means combining innovative vehicle technology with improved driver training, improved infrastructure, better road design, and enforcement of existing traffic regulations, complemented by ITS measures.

Better road infrastructure also includes greater emphasis on applying infrastructure safety rules. By lowering risk exposure – for example by using cleverly-designed infrastructure that encourages sensible, attentive driving – accidents can be significantly reduced. For the moment, the large discrepancy in road safety outcomes between EU member states is explained by the varying approaches to the management of infrastructure, and traffic in general, across Europe.

Additionally, the importance of the driver cannot be underestimated. Consistent, higher quality driver training is needed in order to instil in road users the role of responsible driver behaviour in preventing road traffic accidents. Training, in turn, should be complemented with improved enforcement of traffic rules. Safe driver behaviour, better road infrastructure and enforcement, combined with automated and connected cars, should help to further improve European road safety. To this end, ACEA is calling on policy makers to do more to make it possible for smarter cars to be driven on better roads by safer drivers.

33 Vehicle connectivity

In addition to in-vehicle communication, vehicle connectivity takes place at lots of different levels: from car to driver, car to occupants, car to car, car to road infrastructure and at lots of other communication levels.



Source: DEKRA/AT4 wireless

and the necessary investments are made in the (road) infrastructure.

In the field of connectivity, mobile communication technologies are not only an important basis for V2V and V2I communication but also the key to on-board eCall emergency call systems, which, by March 31, 2018, will be mandatory EU-wide in all cars and light-duty commercial vehicles presented for homologation at that time. In the event of a serious accident, the system ensures that emergency medical services are alerted, even if the driver or other vehicle occupants are themselves unable to make an emergency call or speak on the cellphone. According to the European Parliament, eCall could potentially reduce the number of traffic fatalities by 10% per year. The member states are required to install the necessary infrastructure by October 1, 2017.

ENSURING CONNECTIVITY IS A KEY SAFETY REQUIREMENT

eCall is standardized for use in 2G (GSM) or 3G (UMTS) networks, but not in 4G (LTE) networks – network operators, however, are already implementing 4G and are currently testing future 5G networks. Although 2G networks have universal coverage in Europe, they are set to be disabled in the not-too-distant future. 3G networks already have good coverage in Europe.

MAJOR SAFETY GAINS THANKS TO AUTOMATED IN-VEHICLE SYSTEMS.

Safety-relevant applications of driver information and assistance systems

- Attention detection systems that detect driver distraction or fatigue in order to prevent related accidents. Drunk-driving can also be detected and prevented – for example, sensors embedded in the driver's seat and in the gearshift lever can detect alcohol in the driver's sweat.
- Special warning systems that use, for example, GPS and map data to alert drivers if they accidentally veer into the other lane.
- Information about tire pressure; this warning can potentially be crucial in preventing accidents. The tire pressure is measured by sensors in the tire and conveyed to the driver inside the vehicle by means of short-distance communication technology such as Bluetooth.
- Load management systems that restrict cellphone calls, text messages, instant messaging, Internet access and other potentially distracting activities. The system can, for example, divert incoming calls to the mailbox if the driver is currently accelerating or disable use of other services while the vehicle is moving.
- Automatic alerting of the emergency medical services in the event of an accident. This takes place either via the standardized eCall mechanism or via commercial systems supported by car manufacturers.
- Obstacle detection sensors that measure distances to nearby objects and so inform drivers of the distance to objects close to the vehicle.
- Collision avoidance systems (also known as "pre-crash systems", "collision warning systems" or "collision mitigation systems") that reduce the risk of collisions. Radar, lidar, laser and optical cameras are used here. At low vehicle speeds (less than, say, 50 km/h), collisions can be avoided through braking.
- Automatic adaptive cruise control, which adjusts the vehicle speed to ensure that a safe distance between vehicles in the same lane is maintained. Radar sensors and a longitudinal controller are used here.
- Reversing sensors that alert drivers to the presence of hard-to-see objects during reversing maneuvers.

Something else that has to be considered, however, is the frequency band. In Europe, there are multiple frequency bands used for 2G and 3G, which means that an eCall modem has to support different frequency bands to ensure interaction with mobile communication networks in the whole of Europe. LTE/4G is a mobile communication network featuring state-of-the-art technology only recently introduced by network operators. However, LTE is a non-voice technology used exclusively for transmitting data.

Most smartphone users want high-speed data transmission, but are unaware that this technology does not support voice calls. Voice calls are possible only because the telephone itself switches down to 3G mode when a call is received or the user makes a call, although this is set to change when the new VoLTE technology is launched, which is currently undergoing testing and which some operators have already introduced. Test programs for these devices should therefore definitely ensure that eCall is supported not only by 2G or 3G cellphones and modules but also by 4G cellphones and modules.

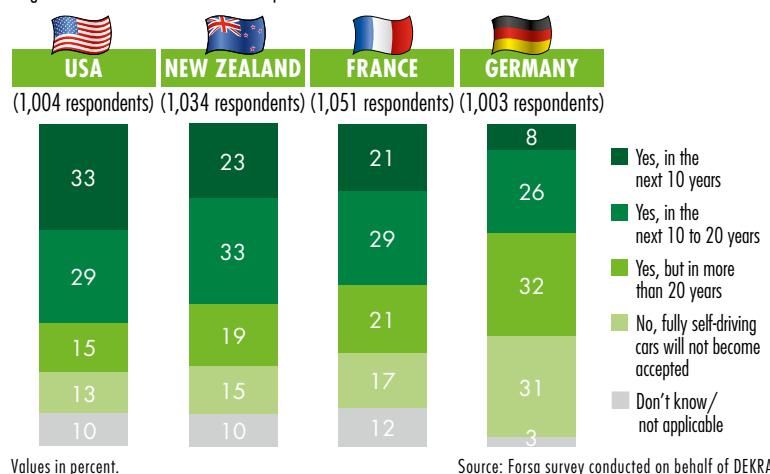
In summary, the functions featured in most “connected car” applications rely on communication technology. For non-safety-related applications, the loss of signal is not critical – users can easily check whether or not connectivity is available. For safety-related services and applications like eCall, however, warnings should be issued to inform users of any loss of communication capability. The system should also be able to automatically restore functionality as soon as the signal is stable again.

AUTOMATED DRIVING: GERMANS MUCH MORE SKEPTICAL THAN OTHER NATIONALITIES

One notable aspect with regard to driver assistance systems and the different levels of automated driving is the often rather skeptical attitude among car drivers in different countries, as revealed by a 2015 survey commissioned by DEKRA. According to this, only 8% of respondents in Germany believe that fully autonomous cars will catch on within the next ten years. 32% expect that it will take more than 20 years, while a further 31% even believe that fully autonomous cars will not become an established concept at all. The term “fully autonomous” in this context refers to automation level 5 of the VDA classification, whereby the

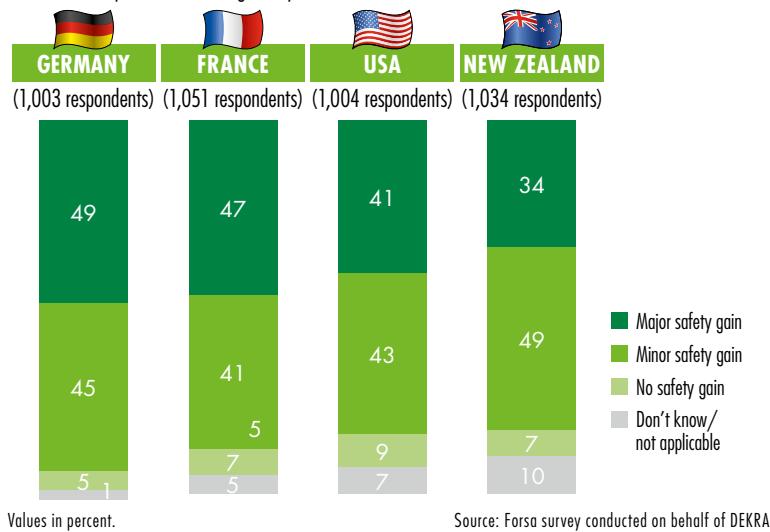
34 Future of fully self-driving cars

„Do you think that self-driving cars – i.e. cars that drive themselves using sensors and other measuring instruments – will become accepted in the future?“



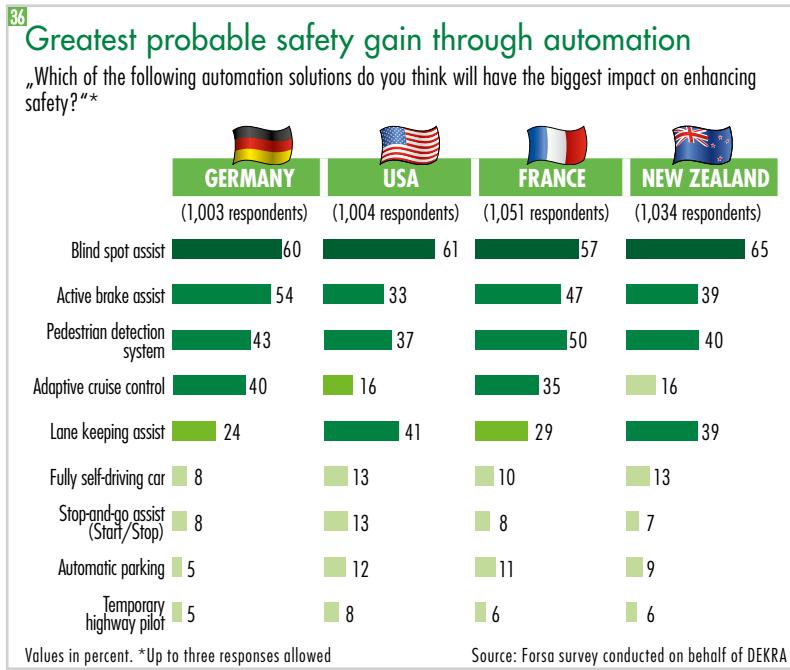
35 Safety gains through automation

„Do you think that the increasing level of automation in passenger cars has a major, minor or no impact on enhancing safety?“

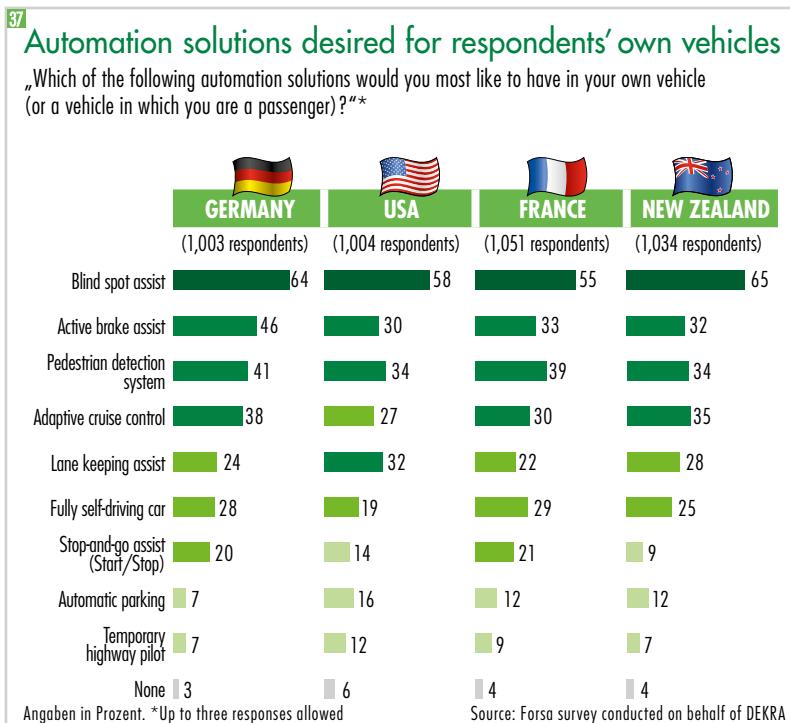


vehicle is driverless and, therefore, all occupants are merely passengers. Among the other countries covered in the survey, significantly more respondents – 21% in France, 23% in New Zealand and 33% in the USA – expect autonomous cars to become a success by 2025 (Figure 34).

In all four countries, a significant majority think that the increasing level of automation in cars will bring about an increase in overall safety (Figure 35). In Germany, almost as many as half (49%) envisage major safety gains. Only a slim minority (5%–9%) in all countries believe that automation will not lead to any safety increases at all.



Drivers in all of the countries surveyed expect the blind spot assist system to enhance safety most of all (Figure 36). In all countries, it was most commonly listed among the three systems with the greatest relevance to safety, with the percentage of respondents ranging from 57% to 65% depending on the country. Below the top rank, the countries show a number of considerable differences. Whereas lane keeping assist, for example, is rated as extremely relevant to safety in both the US (41%) and New Zealand (39%), it plays a less important role for respondents in France (29%) and Germany (24%). Europeans consider active brake assist to be a more important safety feature, for instance (Germany 54%, France 47%). According to the results of the survey, the outlook for the acceptance of driver assistance systems and higher-level automated driving doesn't look too bleak in the four countries concerned (Figure 37). Only a minority of between 3% and 6% would not like any electronic assistance at all in their own cars.



However, even in new cars, state-of-the-art safety systems are nowhere near as widespread as people sometimes assume. This is revealed by a current study – conducted by the business consultancy McKinsey & Company – of more than 5,500 car buyers worldwide. According to this study, Adaptive Highbeam Assist is the most common modern assistance system and is to be found in 23% of new vehicles. Functions such as blind spot assist or traffic sign recognition systems, however, are included in just one in ten cars. Although 72% of German car drivers are aware of the most important driver assistance systems, only one in four actually try them out on test drives. Nevertheless, customers who drive a car equipped with driver assistance functions are extremely satisfied: Nine out of ten respondents said that they would request these functions again the next time they buy a car. These figures underscore the need to further raise people's awareness of the benefits these systems offer in terms of safety and comfort – especially as these technologies pave the way toward partially, highly and fully automated cars and could potentially help to prevent accidents caused by human error.

MAIN INSPECTION BECOMES INCREASINGLY IMPORTANT

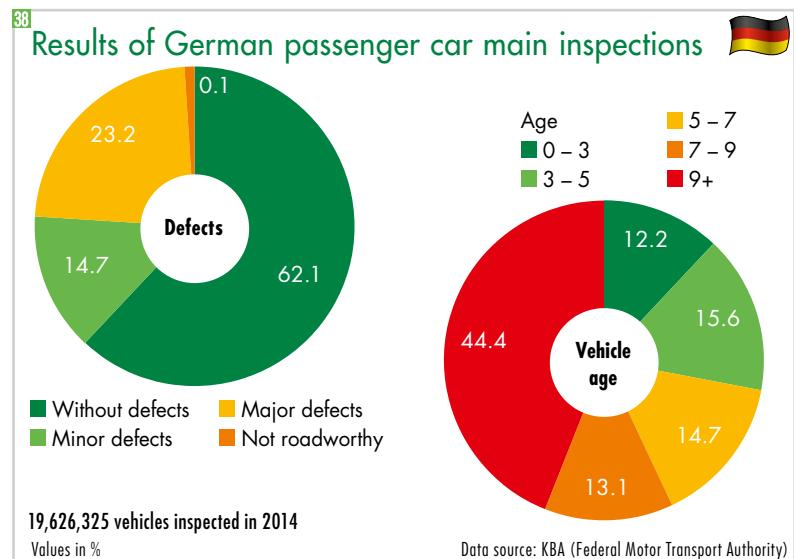
When systems for assisted and automated driving are installed in a car, care must be taken to ensure that they – along with the passive, active and integrated safety systems – work reliably throughout the vehicle's service life. Only in this way can they

AS A VEHICLE AGES, THE DEFECT RATE INCREASES SIGNIFICANTLY.

have their desired impact. Regular vehicle inspections will therefore become even more important than they already are, not least because of the growing complexity of the systems and the risk of electronic tampering. Given the rapid increase in the number of electronic systems, the safety partnership between vehicle manufacturers and the inspection organizations must be realigned. As early as the vehicle development and homologation stage, rules must be laid down specifying how inspection experts will be able to inspect these vehicles later down the line.

The main inspection adapter, introduced in Germany on July 1, 2015, will take on a central role here. This tool allows experts to query the availability and version of the safety systems installed, monitor current sensor data and check the function and state of the safety-relevant vehicle systems. Initial experience has already shown that the main inspection adapter is an important step in increasing road safety. For example, studies conducted by FSD Fahrzeugsystemdaten GmbH confirm that this new tool has identified a whole host of problems with ESP systems as well as many cases where the brake power on the rear axle of passenger cars was far too low.

The potential of this adapter is far from exhausted, which is why FSD are working in collaboration with the authorities and inspection organizations to intensify and further optimize inspection methods using the vehicle interface. These efforts are being complemented by enhancements and refinements in conventional areas such as deceleration measurement on motorcycles or



in future areas such as eCall and safety-relevant car-2-X functions.

Despite all the advances made in the field of electronic components, mechanical systems will of course continue to play a key role when it comes to road safety. During the main inspection, therefore, the brake and steering systems will be subject to every bit as rigorous an examination as the lights, axles, wheels and tires, suspension systems, chassis, frame and structure as well as visibility conditions, to name just a few examples.

One look at the results of the main inspections performed in Germany in 2014 clearly demonstrates the importance of this regular check (Figure 38). According to the Federal Office for Motor

Periodic vehicle inspections make an important contribution to road safety.



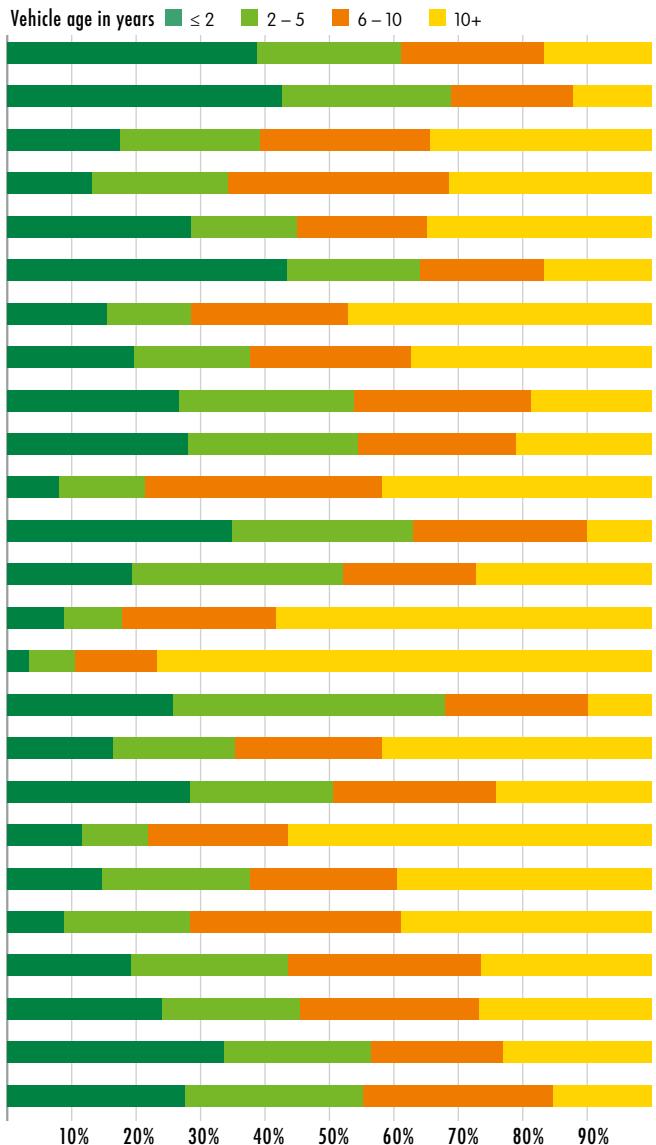
39

Comparison of passenger cars in EU



In eastern European countries in particular, cars that are more than ten years old account for more than half of all the cars on the roads.

Vehicle age in years



Values in %. Date from 2012, Date from years: ¹⁾ 2011, ²⁾ 2008, ³⁾ 2009.

Source: Eurostat

Vehicles, defects and shortcomings were found in 38% of all the vehicles inspected; 23% were found to have serious defects. Problems with the lights accounted for the lion's share (25%), followed by brakes (almost 20%) and the axles, including wheels and tires (14%).

Nevertheless, the number of vehicles with problems has fallen steadily over the past few years. In 2000, almost 50% of cars had faults. One decisive factor is, of course, the vehicle age. It is interesting to note here that the proportion of cars inspected in Germany aged nine years or older has increased steadily. In 2012, 8.34 million cars fell into this category – by 2014, this figure had risen to 8.73 million, which constitutes more than 44% of all vehicles inspected. This clearly indicates that Germans are holding on to their cars for longer, a trend that can be partially attributed to demographic change and, as such, is expected to continue. The average age of all cars in Germany is now 9.2 years. According to data from the European Automobile Manufacturers' Association (ACEA), the average age of all cars in the EU in 2014 was almost 9.7 years – in 2006, its was "just" 8.4 years (Figures 39 and 40).

EVEN TODAY, THREE QUARTERS OF CARS DRIVEN BY YOUNG PEOPLE HAVE SOMETIMES SERIOUS FAULTS

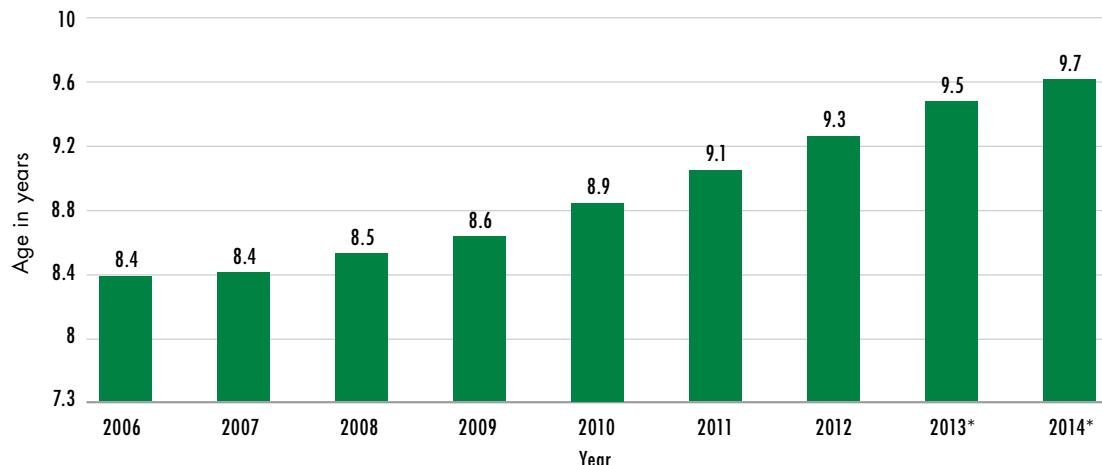
The fact is that as a vehicle ages, the defect rate increases significantly. And it is especially young people who, for financial reasons, tend to drive older cars. The SafetyCheck campaign, which was once

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An ever-aging fleet

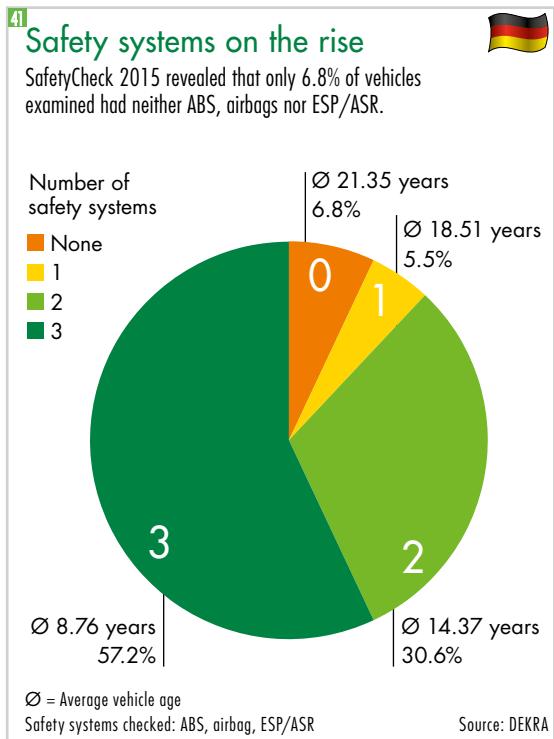


The average age of passenger cars on EU roads has risen significantly since 2006.



Data source: IHS

again launched Germany-wide in 2015 by DEKRA, the German Road Safety Council and the German Road Safety Association (Figures 41 to 43), revealed that the average age of the cars inspected as part of this campaign was 11.9 years. 29% of vehicles under three years old had faults, with this figure rising to 70% of 7–9-year-old vehicles. For 13–15-year-old cars, the figure was almost 90%. Around 46% of all cars examined had problems with their chassis, wheels/tires and bodywork, 42% with the lighting, electrical and electronic systems, and 32% with the brake system.



Maria Seguí Gómez

Spokeswoman for the Spanish traffic authorities



Adaptation of monitoring and control systems and initiatives for networked mobility

In Spain, road safety enjoys a high political priority. After a peak in 1989 of 241 traffic fatalities per one million inhabitants, today we are a country that enjoys one of the lowest traffic fatality rates thanks to improved roads and vehicles and better driver training. In 2014, the number of traffic fatalities had fallen to 36 per one million inhabitants. Spain has a population of 46 million, with 26 million holding a driver's license. On top of this, Spain welcomed more than 65 million tourists in 2014. A total of 33 million vehicles are registered, covering more than 660,000 kilometers on public roads – 156,000 of these on rural roads

Despite all the advances we have achieved, we still face a number of challenges such as an aging population, aging vehicles and less monitoring on cross-country roads, where most fatal accidents occur, which is why we are in the process of developing short- and medium-term plans aimed at achieving further advan-

ces toward our target of zero road deaths.

With our short-term plans, we are concentrating our monitoring capacity on driver behavior and on locations prone to more serious accidents. We are looking to adapt the monitoring and control systems employed by the police and deploy technical solutions designed to identify specific instances of human error – for example, identifying sections of road that require more intensive speed checks and gradually increasing the number of alcohol and drug checks. To reduce the risks associated with aging vehicles, we will be checking whether car owners actually fulfill their duty to have their cars checked for roadworthiness.

Over the medium term, we want to encourage people to make better decisions regarding the routes they take, car safety systems and equipment and intelligent speed management. Furthermore, our focus is on new initiatives for networked mobility aimed at improving road safety.



The campaign also revealed that electronic safety systems are now widespread in older vehicles, too: Nine out of ten cars inspected as part of SafetyCheck 2015 were equipped with ABS and airbags, while well over half had ESP/ASR on board. Only under 7% of vehicles inspected did not have any of the three aforementioned systems. However, the campaign also found that 6.6% of ESP/ASR systems, 2.5% of airbags and 2.2% of ABS did not actually work.

When one considers that 18–24-year-olds still constitute the road user group at highest risk of accidents and death and are more likely than any other group to be driving older cars, it quickly becomes clear that significant potential still exists in improving the technical condition of vehicles and, in turn, road safety.

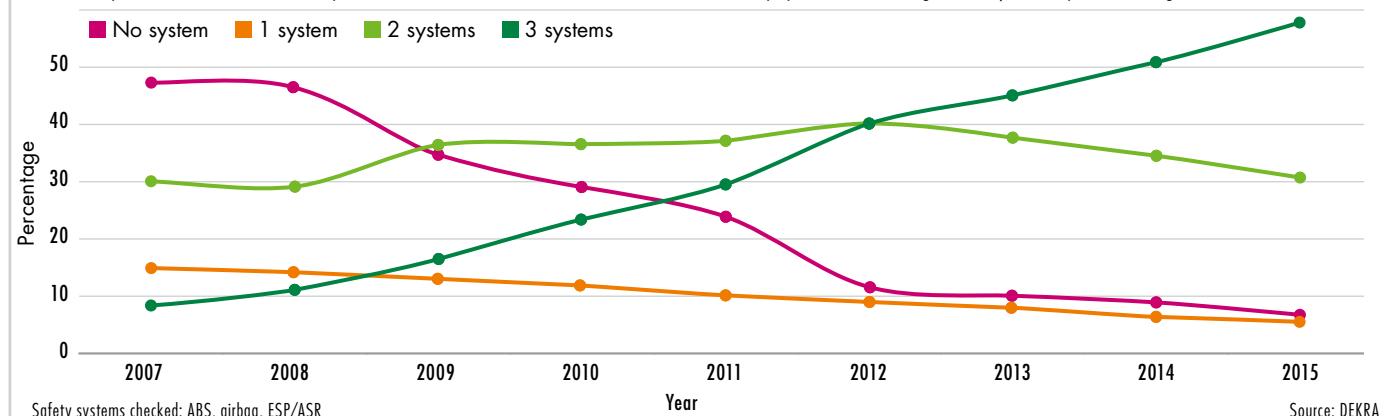


■ Considerable potential exists for increasing the safety of motorcyclists, too.
Crash tests yield important findings here.

42 Positive trend



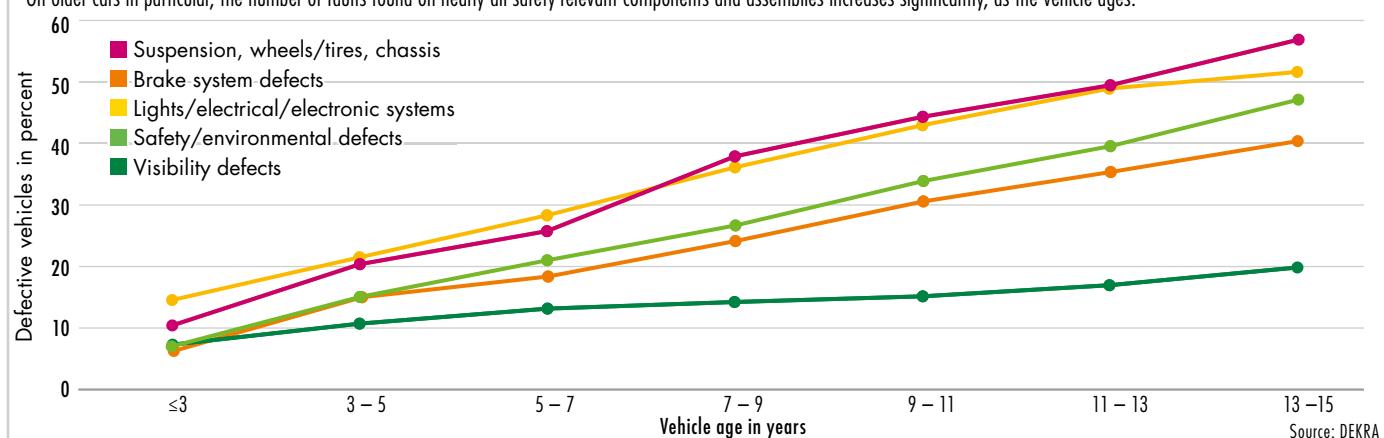
While SafetyCheck 2007 revealed that only 8.4% of cars examined were fitted with at least three safety systems (ABS, airbag, and ESP/ASR), by 2015 this figure was more than 57%.



43 Fault rate according to DEKRA SafetyCheck 2015 by assembly and vehicle age



On older cars in particular, the number of faults found on nearly all safety-relevant components and assemblies increases significantly, as the vehicle ages.



Greater motorcycle safety thanks to ABS

Even if the number of motorcycle accidents has fallen considerably over the past few years, 2014 still saw 675 motorcyclist deaths, around 10% more than in the previous year – a tragic change in the trend on German roads. The future mandatory requirement for all new motorcycles to be fitted with ABS is a move that certainly offers a realistic chance of preventing a quarter of all motorcycle-accident-related fatalities and injuries.

This is because the systems prevent the wheels from locking. Especially during full braking operations or sudden deceleration on a slippery surface, ABS allows motorcycles in particular to come to a standstill much more safely and riders to maintain better control at the physical limits of riding.

Europe has taken appropriate action here: From 2016, all newly type-approved motorcycles must be equipped with ABS; and from 2017, no motorcycle without ABS is allowed to be newly registered at all. This universal requirement for all motorized two-wheelers of 150 cc or more to be equipped with ABS is another key contribution in the spirit of "Vision Zero."

Regardless of this, more than 25 years after the first ever motorcycle was optionally fitted with ABS (1988), more than one third of all new motorcycles in Europe now come with ABS as standard. Most manufacturers offer ABS as standard with selected models or at least as an optional extra. In the future, even small motorized two-wheeled vehicles of more than 50 cc (mopeds and scooters) must come with, if not ABS, then at least a combined brake system, whereby the front and rear wheel are braked simultaneously when the brakes are applied.

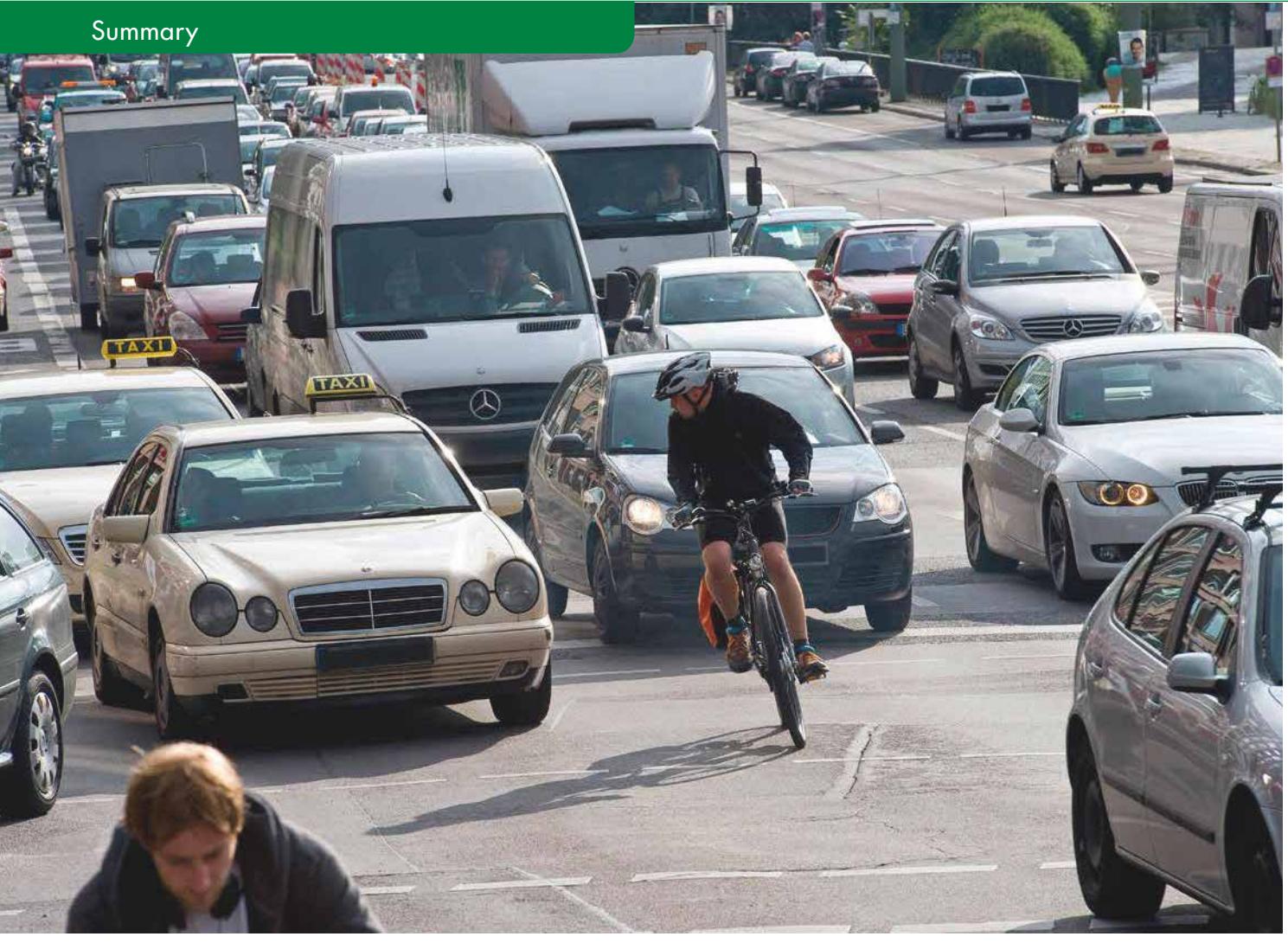
In the meantime, ABS technology has seen technical advances toward the development of an electronic stability control system for motorcycles, a tried-and-tested and today widespread technology – generally known as ESP – for multi-track vehicles. Motorcycle stability control – presented under the name MSC for the first time ever by Bosch – will result in further safety gains in the future because the system, which uses the ABS data and is additionally supported by a lean sensor, intervenes precisely when two-wheeled vehicles are undertaking their most hazardous ma-

neuver: cornering. Almost one in two of every fatal motorcycle accident occurs during cornering.

According to Bosch, MSC offers the greatest possible protection during accelerating and braking, even during fast cornering maneuvers. The intervention of the brake system is precisely coordinated with the angle of lean. Brake pressure is applied gently but still builds up quickly while the bike is cornering. The system also detects if either the front or rear wheel has lifted off the road surface during strong acceleration or braking. When this occurs, the MSC system instantly counteracts this by intervening in the brake controller or engine management system so that the forces are transmitted to either the front or rear wheel. According to analyses of figures obtained by the German In-Depth Accident Study (GIDAS), a project conducted jointly by the German Federal Highway Research Institute (BASt) and Research Association of Automotive Technology, the stability system could help to prevent two thirds of all rider-induced cornering errors.

The facts at a glance

- Driver assistance systems could significantly reduce the number of accidents attributable to human error.
- Almost 50% of accidents could be avoided or reduced in severity if innovative driver assistance systems quickly became standard series features.
- A study conducted by the University of Toronto concluded that augmented-reality HUD systems could be potentially distracting for drivers.
- Ensuring connectivity is an important precondition for vehicle communication with other vehicles and with the infrastructure.
- Skepticism of autonomous driving is relatively high among German drivers.
- The use of diagnostic technology – e.g. main inspection adapters – during periodic vehicle inspections in Germany is an important tool for enhancing road safety.
- Young people often drive older cars afflicted with many serious problems – a factor that further increases their accident risk.
- The mandatory requirement for all motorcycles to be fitted with ABS could almost instantly prevent a quarter of all motorcycle accidents with fatalities and injuries.



A Clear Goal: Let's Get Back onto the Road to Success

Although the risk of suffering fatal or serious injuries in passenger transportation has decreased significantly over the past few decades in nearly every EU member state, we must not rest on our laurels when it comes to the efforts to improve road safety even further. As this report has demonstrated in the preceding chapters, action still needs to be taken in a number of areas. Measures relating to vehicle technology and road infrastructure should enjoy just as high a priority as raising risk-awareness among all road users. Legislation, traffic monitoring, emergency services and road safety education can also play a key role in reducing the number of traffic fatalities and serious injuries.

The latest accident statistics from Germany, France and Italy, among other countries, are alarming. Although the figures are still provisional, they reveal a clear trend – and, in the countries named, the trend is unfortunately negative. According to preliminary figures released by the Federal Statistical Office of Germany, the number of traffic fatalities in Germany in 2015 increased by 2.9% to 3,475; the “Observatoire National Interministériel de la Sécurité Routière” (ONISR) is forecasting 3,464 traffic fatalities in France (+ 2.4%); and in Italy, initial estimates of the Istituto Nazionale di Statistica (Istat) show a 1.3% increase in the number of traffic fatalities to around 3,425.

In light of this, the EU Commission’s strategic target of halving the number of traffic fatalities between 2010 and 2020 seems more challenging than ever – in fact, in Germany and France, the figure for 2014 was higher than for the previous year. And that’s not all: In 2014, there were 10,142 traffic fatalities in Germany, France and Italy, which equates to almost 40% of all traffic fatalities in the EU. So if the figures can increase even in those countries where people have comparatively modern cars, this highlights just how urgent the need is to reverse the trend and mirror the successes of previous years, especially given that the use of passenger transportation – which dominates the

accident statistics and is the focus of this report – is set to increase even more across the EU over the next few years.

ELECTRONIC SYSTEMS AS INTEGRAL SAFETY ELEMENTS

One major area where measures can be taken to efficiently counteract negative trends in road safety is, and remains, the car. Take Germany, for example: In 2014, almost two thirds of all people involved in accidents resulting in casualties were car drivers; for serious accidents resulting in material damage, this figure was even as high as 86%. The main cause of accidents resulting in personal injury and/or material damage is human error. As statistics show time and time again, people are responsible for around 90% of accidents. Not without reason, therefore, has the automotive industry for many years been increasingly focusing on driver assistance systems that are capable of recognizing critical driving and traffic situations early on, warning of dangers and, if necessary, actively intervening. Mobility 4.0 key technologies play an important complementary role here, too. Thanks to intelligent infrastructure and the networking of vehicles to facilitate communication either between cars (car-to-car) or from cars to centralized and decentralized systems (car-to-infrastructure), these technologies can also help to further reduce the number of accident-critical situations and, in turn, the number of serious accidents resulting in death and serious injury.

It is essential that all such electronic systems function properly throughout the vehicle's service life. Only in this way can they have their desired impact. Regular vehicle inspections will therefore become even more important than they already are, not least because of the growing complexity of the systems and the risk of electronic tampering.

To conclude, however, we must not lose sight of one clear fact, as stated in the previous years' DEKRA road safety reports: To prevent hazardous road traffic situations from arising in the first place, responsible behavior, proper assessment of one's own capabilities and a high level of acceptance of rules among all road users are, and remain, absolutely essential. Even the very best vehicle technology and road infrastructure cannot change that.

DEKRA's demands

Vehicle technology

- Greater market penetration of electronic driver assistance systems, including through competitive pricing, education and, if necessary, the further development of assistance systems for protecting yourself and other road users.
- Ongoing development of vehicle inspection to take account of new electronic systems and safety-relevant communication technology.
- Greater access for inspection organizations to manufacturer's data relevant for checking electronic systems.

Infrastructure

- Promotion of intelligent infrastructure (car-to-infrastructure communication) to ensure that the potential of assisted and automated driving systems is leveraged to the full, including through the intelligent networking of modes of transport (Mobility 4.0).
- Prioritization of road safety over cost when it comes to the planning and maintenance of infrastructure (e.g. road surfaces optimized to improve braking deceleration).

The human factor

- Mutual courtesy and the ability to put oneself in the position of other road users.
- Active and attentive participation in road traffic, combined with the greatest possible avoidance of distractions – this applies to drivers, cyclists and pedestrians alike.
- EU-wide standardization of procedures for assessing driving fitness, using the tried-and-tested German MPA system as a template.
- Driver fitness tests required for drivers with a blood alcohol content as low as 1.1 or more, not 1.6 as currently in Germany.
- Where applicable, expert assessments of driving fitness should be used in the assessment of a person's fitness to operate other modes of transport, too (e.g. for pilots or train drivers), rather than viewed separately.
- Increase in seat belt usage in cars to 100%, including with the help of suitable and effective checks.
- Systematic implementation of the Europe-wide compulsory wearing of seat belts in coaches and long-distance buses.
- Easy-to-understand information campaigns about the existence, function and limits of driver assistance systems; clarification of the driver's responsibility at all times.
- Earliest possible road safety education as early as preschool and primary school age, for example through cycling proficiency training and tests.
- Targeted Driver training with greater emphasis on promoting skills in anticipatory traffic observation and hazard avoidance.
- Even more intensive promotion of safety-conscious and responsible behavior among all road users, for example through driving safety training to identify one's own limits; work to raise awareness of distractions (e.g. smartphones); raising awareness of the importance of taking care and being considerate on the roads.
- Increase in helmet usage among cyclists – particularly those using pedelecs, which have higher average speeds.
- Standardization of traffic regulations in Europe, as far as possible and reasonable.

Any questions?

TESTING TECHNOLOGY

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