DEKRA Automobil GmbH

ROAD SAFETY REPORT 2013
RURAL ROADS

Strategies for preventing accidents on European roads

DEKRA

Accidents:
Reducing the EU-wide high risk potential on rural roads

The human factor:
More targeted checks at potential danger spots

Infrastructure:
To permanently defuse danger spots for safer roads

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Safe travel on rural roads

With the number of deaths caused by road accidents having increased in Germany by just under ten percent from 3,648 to 4,009 in 2011 compared to the previous year, there are signs of a significant recovery based on the provisional figures for 2012. According to information from the Federal Statistical Office, the number of deaths caused by road accidents will drop by 10.1 percent to 3,606 fatalities. This would continue the overall positive trend of the last ten years. There are also provisional figures for 2012 available from France. According to information from the "Observatoire national interministériel de la sécurité routière" (ONISR), it is assuming a reduction of roughly eight percent to 3,645 deaths caused by road accidents compared to 2011. This shows that the EU is on the right track in terms of road safety. The target formulated by the EU Commission in July 2010 to halve the number of annual deaths caused by road accidents on Europe's roads again by 2020 still poses a huge challenge though.

One strategy is to improve the situation on rural roads. As the number of deaths caused by road accidents is still very high on rural roads compared to fatalities on roads in built-up areas and on motorways. Just under 61 percent of all the deaths caused by road accidents lost their lives on rural roads in Germany in 2011. This percentage has hardly changed compared to previous years and this unfortunate trend is likely to be confirmed again in 2012. This situation is not any rosier in many other EU countries, for example in France, Spain, the Czech Republic and Austria.

There is a whole range of causes for the huge risk potential on rural roads. For example, compared to city traffic, there are higher speeds or speed differences between different road users, plus varying quality in road surfaces, oncoming traffic, poor opportunities for overtaking, junctions and unprotected obstacles, such as trees, right next to the road.

The facts and figures mentioned are reason enough for DEKRA to dedicate the 2013 road safety report to accidents on rural roads. This report should at the same time be far more than just a collection of facts about the current state. This report is intended rather to provide food for thought and guidance for politics, road and infrastructure experts, manufacturers, scientific institutions as well as associations and all road users.

The topic of rural roads was also the focus of a DEKRA survey, which was carried out at branches nationally in January/February 2013. What is particularly interesting, among other things, are the answers to the question of what drivers fear most on rural roads. Game crossing roads was mentioned most frequently at 72.2 percent, oncoming traffic/overtaking vehicle (45.9 percent), poor road surface (34.1 percent), motorcyclists (25.1 percent), pedestrians/cyclists (23 percent), narrow roads (21 percent), tractors turning into the road (19.2 percent), sharp bends (18.9 percent) and trees/avenues (10.3 percent) followed significantly further behind.

The figures mentioned are of course only an expression of personal perception, as a glance at real accidents shows. For example, 714 people lost their lives due to impact with a tree next to a rural road in Germany in 2011. That is almost 30 percent of all fatalities on rural roads and just under 18 percent of all road users killed in road traffic. By comparison: There were 20 deaths in total caused by accidents involving game on German roads in 2011.

Clemens Klinke, Member of the Executive Board at DEKRA SE and Chair of the Management Board at DEKRA Automobil GmbH

These examples alone demonstrate that in order to actually achieve the afore-mentioned EU Commission's target of halving the number of deaths caused by accidents again by 2020, sustainable efforts are required to increase road safety on rural roads specifically. The expert organisation DEKRA will also continue to contribute to this. Our expertise is appreciated on national and international bodies. Our accident analysts are also regularly involved when it comes to establishing the causes of road accidents. The vehicle testing and crash tests carried out by DEKRA also ultimately provide valuable findings with regard to providing greater road safety.

Content

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DEKRA Road Safety Report 2013 Rural Roads

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Sensible and prudent driving

Mobility is an essential foundation for the perception of personal freedom and at the same time an important basis for growth and prosperity. As the Minister of Transport, guaranteeing full mobility therefore takes top priority for me. At the same time, mobility must be as safe as possible. We have achieved significant progress over the last few years particularly in this key field. The number of deaths caused by accidents on our roads has dropped from over 21,000 in 1970 to roughly 3,600 last year and that is even though the volume of traffic has trebled over the same period. However, every accident victim is one too many. That is why, even with all the statistical success, we can never slacken our efforts to make our roads even safer.

We have to pay particular attention to our rural roads in our road safety work. As with a share of 25 percent of the total of all accidents with personal injury, roughly 60 percent of road users are killed on our rural roads. There are various causes for this. They range from speeding, inattentiveness and overestimating your own abilities, to the existence of particularly hazardous stretches of road.

We are particularly committed to this problem in our updated road safety programme. Among other things, we want to defuse danger spots by building additional overtaking lanes, safety barriers and rumble strips. For this it is necessary to identify particularly hazardous stretches of road and improve them together with the authorities. This is likely to be even more successful if more citizens are involved in the task. Vehicle engineering also significantly contributes to road safety, particularly on our rural roads. We are therefore campaigning for a greater distribution of "intelligent" safety systems, which significantly contribute to accident prevention, for example through the increased use of driver assistant systems.

It is crucial to raise the road users' awareness of dangers on rural roads. As one thing is for sure: the majority of accidents there are the result of human error. That is why our efforts must focus even more on education. One key focus of our road safety campaigns is deliberately on particularly at-risk road users, above all young drivers and motorcyclists. At the same time we want to slow down those who pose the greatest risks. With the "Rural roads campaign: Be clever – don't take risks!" that we have initiated together with the Deutsche Verkehrswacht, or with the "Slow down" educational campaign we are highlighting the dangers even more and campaigning for sensible and prudent driving on our rural roads.

One thing is certain for the government: we will resolutely continue our intensive and successful road safety work. However, road safety is not a task for politics alone, it is a concern for our whole society. Associations, businesses and initiatives are essential partners when it comes to greater safety on our rural roads. I am therefore very grateful to know I have a reliable partner by my side in DEKRA.

Dr. Peter Ramsauer (MdB),
Federal Minister of Transport, Building and Urban Affairs

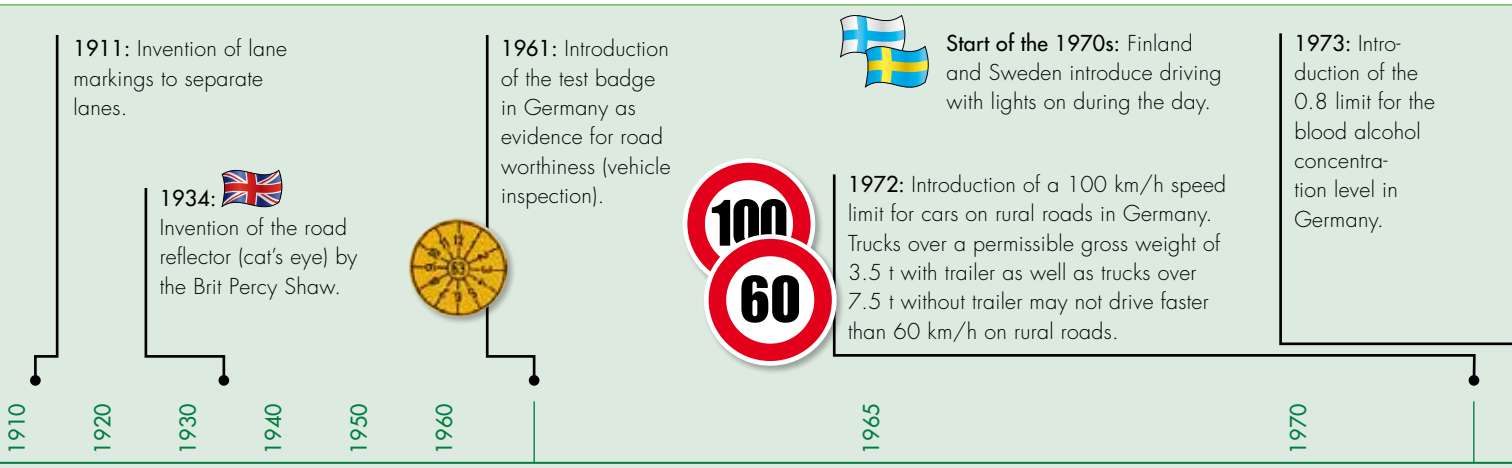
A deceptive idyll

Be it Germany, France or any other EU country: the number of deaths caused by accidents has been highest on rural roads for decades. Even though, according to various studies, road users feel safer here than in the city or on the motorway. The main causes for serious accidents are speeding, obstacles at the roadside, risky overtaking manoeuvres as well as blind bends, junctions and intersections.

The rural road leads past farms and small villages between fields, pastures and forests. Trees line the edge of the road providing shade. A car is waiting behind a combine harvester for the chance to overtake. After a gentle bend the driver loses patience, indicates and pulls out at the same time. In doing so, he overlooks the motorcycle that is just about to overtake him. This is a situation that could happen on a rural road at any time.

Among other things, accident statistics from Germany presented by the Federal Statistics Office show that the countryside idyll is deceptive. 4,009 people in total were killed on German roads in 2011, 2,441 of these were on roads outside built-up areas not on motorways, subsequently simply called rural roads. These include federal, regional and district roads as well as other roads. Fatalities caused by accidents on rural roads made up for just under 61 percent of all deaths caused by accidents. The year before, 3,648 people were killed on German roads, 2,207 of these were on rural roads, therefore 60.5 percent. This ratio has more or less remained the same for decades, not just in Germany but in many other EU countries (figure 1). In some cases the percentage is even higher. For example, according to information from the "Observatoire national interministériel de la sécurité routière" (ONISR), of the 3,963 people killed in road traffic in France in 2011, 2,867 of them were on rural roads (= 72 percent). The percentage was also within this range in 2010.

The figures from Germany are in sharp contrast to the results from a study on the behaviour of Germans in road traffic produced by the AXA Insurance Company in 2012. According to this, almost half



Milestones for road safety on rural roads in Europe

of those surveyed (44 percent) feel safest on rural roads. Just one third of those surveyed felt the motorway was the safest place, 17 percent chose roads in built-up areas. A sense of security therefore has nothing to do with reality: Just six percent of all accidents with personal injury and 11.3 percent of all fatalities were recorded on motorways in Germany in 2011.

The Federal Statistics Office uses road accidents with several parameters in its annual reports. As a result, different risks can be analysed, among other things based on the accident sites. According to this, for every 1,000 kilometres of national traffic (motorways, federal, regional, state and district roads) in Germany, 4,101 accidents with personal injury happened in built-up areas, 465 of these accidents were outside built-up areas but not on motorways and 1,477 accidents were on a motorway. If you just look at the deaths caused by accidents, for every 1,000 accidents with personal injury 5.3 people were killed in built-up areas, 24.8 people were killed on motorways and 31.5 people were killed outside built-up areas not on motorways. How you classify the risks therefore comes down to the reference value. As far as the absolute figures are concerned, most fatalities by far are on rural roads.

A BROAD MIX OF RISKS

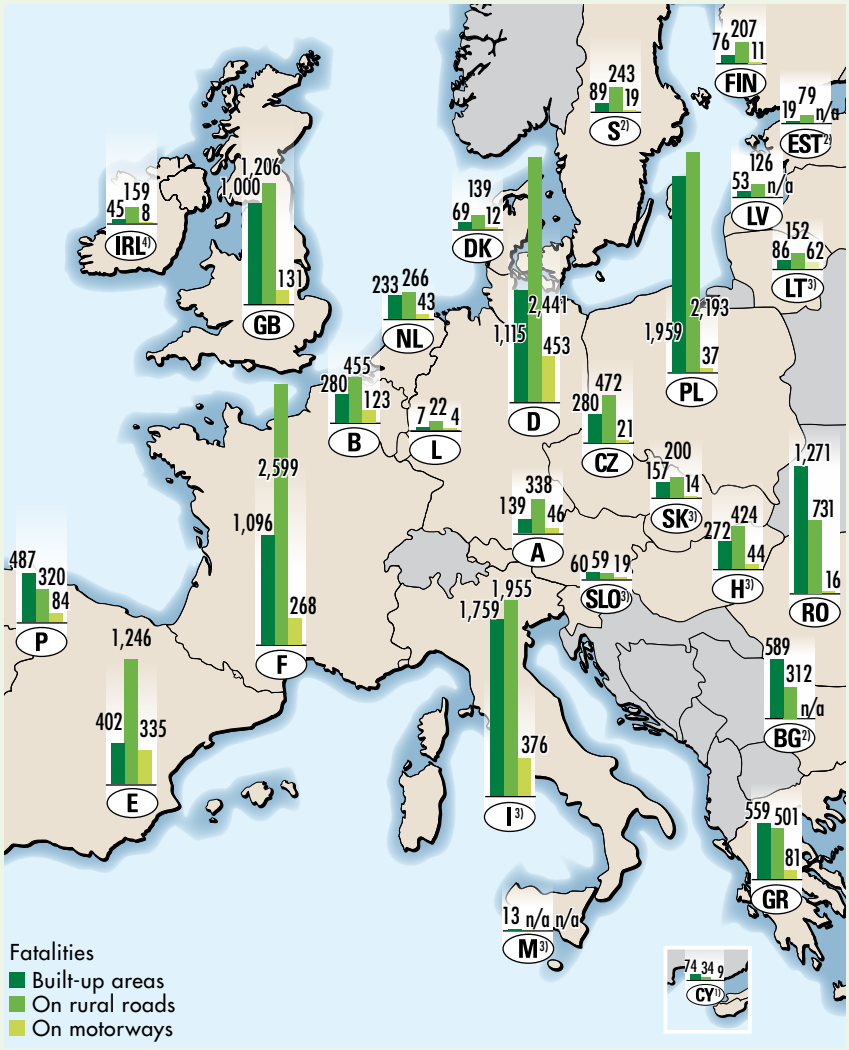
It is also a fact that there are a whole range of different road users travelling on rural roads. Car drivers, commercial vehicles and motorcycles meet agricultural machinery, pedestrians, cyclists and horse riders. Nowhere else do the interests of commuter traffic and recreational activities clash as violently as on rural roads. It is also only here that there is a combination of high speeds and large differences in speed, on-coming traffic and overtaking manoeuvres at the same time. The keyword is speed: The maximum permissible speed for cars on German rural roads is 100 km/h and just 60 km/h for trucks weighing 7.5 tons or more. In France it is 90 km/h for cars and 80 km/h for trucks in Austria 100 km/h for cars and 70 km/h for trucks.

Road users frequently travel the same familiar stretches of roads in their region, they therefore have a sense of security and tend to speed. Unexpected on-coming or slow/stationary vehicles may appear on bends and blind stretches of road, this is especially dangerous if the lanes are not clearly separated. If a vehicle leaves its lane, trees, walls and pylons on the edge of the road are obstacles likely to cause injury and even fatalities.

The fact that the risks are underestimated is shown by the causes of accidents, where inappropriate driving style, mis-

1

Road traffic fatalities in the EU based on location



1) Figures from 2004, 2) Figures from 2009, 3) Figures from 2010, 4) Figures from 2011 Data source: CARE

1974: A general 90 km/h speed limit applies on rural roads in France.

1974: From 1st January, three-point safety belts are mandatory for front seats in newly licensed cars in the Federal Republic of Germany. The seat belt obligation for back seats in all new cars comes into force on 1st May 1979.

1979: First electronic ABS (Mercedes Benz S-Class and 7 Series BMW).

1980: First German car with airbag (Mercedes Benz S-Class).

1983: Introduction of the 0.8 blood alcohol limit in France.

August 1984: Introduction of fines for not complying with the seat belt regulation in Germany.

1988: Motorcycle ABS in series production (BMW K 100).

1988: A 90 km/h speed limit is introduced on rural roads in Italy.

1975 1980 1985 1990

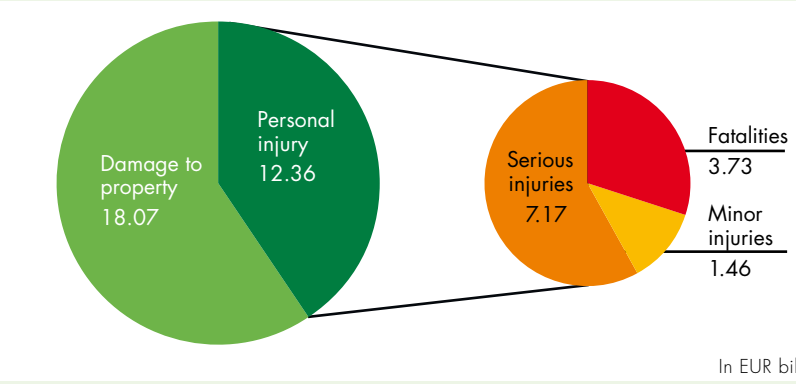
judgement and inattentiveness top the list. And many people pay for this with their lives or serious injuries on rural roads. Added to this are other factors that increase risks, for example the partly old road network that is in need of repair, the increased need for mobility and high traffic congestion (in 2011 the mileage of cars licensed in Germany alone was higher than ever before with over 600 billion kilometres), as well as the rapid increase in commercial vehicles on rural roads.

HIGH COSTS TO THE ECONOMY

Besides all the human suffering, there are also immense costs associated with road accidents. An estimate compiled for France shows this: The ONISR is assuming costs of just under EUR 1.3 million for every death caused by an accident for 2011. A person with serious injuries results in expenditure of roughly EUR 132,000, minor injuries cost just under EUR 5,300. The damage to property per accident is estimated at just under EUR 6,800 on average. Therefore with 3,963 deaths caused by accidents, 29,679 serious injuries, 51, 572 minor injuries and just under two million road accidents with damage to property we come to total costs of approximately EUR 23 billion. Any accidents not recorded by the police are not included in these calculations.

The Federal Highway Research Institute (BASt) has put together a similar calculation for 2010 for Germany (figure 2). According to this, the costs to the economy caused by road traffic accidents amounted to just over EUR 30 billion. Personal injury accounted for roughly EUR 12 billion of this, including just under EUR 4 billion for fatalities, roughly EUR 7 billion for serious injuries and just under EUR 1.5 billion for minor injuries. The percentage of costs for damage to property was 59.4 percent, which corresponds to roughly EUR 18 billion. For each road traffic fatality, the BASt calculates costs of slightly over EUR one million, roughly EUR 114,000 for a seriously injured person and approximately EUR 4,460 for a person with minor injuries. The cost breakdown according to road categories is also interesting: With rural roads the accident costs to the economy add up to roughly EUR 8.9 billion and to EUR 3.1 billion with motorways. Accidents on rural roads made up for approximately 29 percent of all the accident costs to the economy in 2010.

2 The accident costs to the economy in 2011 in Germany



Source: Federal Highway Research Institute (BASt)

INCREASED MEASURES BY THE EU FOR GREATER ROAD SAFETY

It has been a major concern of all the European Union's member states for years to increase road safety. In its "3rd Road Safety Action Programme" from 2001, the European Commission set the target of halving the annual number of deaths caused by road accidents by 2010. In 2001, roughly 54,350 people in total lost their lives in road traffic accidents in the 27 countries that belong to the EU today. To halve this figure the number of fatalities in the EU would have to have reduced to roughly 27,175 in 2010. The decrease to roughly 31,100 actually only equalled "just" 43 percent though. In total, the number of fatalities in the EU has dropped on average by five percent every year between 2001 and 2010, in some years the reduction was even eleven percent, like in 2010. This trend significantly slowed down in 2011 when the number of deaths caused by accidents on European roads only dropped by two percent (figure 3). In Germany, the number of deaths caused by accidents even increased by almost ten percent to 4,009 in 2011.

According to provisional figures for 2012 there has been a rapid recovery. According to information from the Federal Statistical Office, the number of deaths caused by road accidents will drop by 10.1 percent to 3,606 fatalities compared to 2011. This means the number of fatalities has dropped even more rapidly than expected in 2010 and would even be below the previous record low of 3,648 fatalities in 2010. The number of deaths caused by road accidents on rural roads even dropped by 11.8 percent compared to last year (2,441 fatalities) according to provisional figures. 2,152 people lost their lives on rural roads from January to December 2012.

In order to permanently sustain the previous long-term positive trend, the European Commission developed new plans in July 2010 to reduce the number of annual deaths caused by accidents on

1985

Since 1990 the roundabout has experienced a renaissance as a traffic regulating measure for greater safety on German rural roads. 50 percent of all roundabouts worldwide are located in France.

1990

The 1990s: "Vision Zero" is applied for the first time in Sweden in the field of road traffic. Basic philosophy: People make mistakes, therefore the traffic system must be designed so that it allows for mistakes without endangering the lives of road users.

VISION ZERO INITIATIVE
TRAFFIC SAFETY BY SWEDEN

Europe's roads by half again in the next ten years. This is documented in the "European Directive for Road Safety Policy 2011 to 2020" published in March 2011. The proposed initiatives range from higher standards for vehicle safety to infrastructure measures and better training for road users through to enforcing road traffic regulations more strictly. The strategic aims also specifically include increased road safety on rural roads. For example, there is an appeal for EU countries to extend the safety regulations that already apply to motorways and tunnels to rural roads.

THE MOST IMPORTANT AREAS FOR ACTION ARE THE HUMAN FACTOR, INFRASTRUCTURE AND VEHICLE ENGINEERING

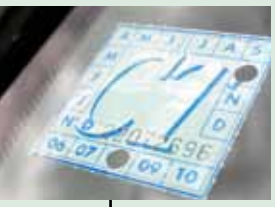
The EU Commission promises a strong drive towards better road safety through the increased use of modern technology. As part of the implementation of the action plan to introduce intelligent transport systems in Europe and the proposed directive for intelligent transport systems, the Commission will specifically propose technical specifications that are required for the exchange of data and information between vehicles, between vehicles and the infrastructure and between infrastructures. Furthermore, it is to be analysed in more depth whether the application of advanced driver assistant systems, such as lane keeping assistants, anti-collision systems or pedestrian recognition systems, can be expanded by retrofitting commercial and/or private vehicles that are already on the road. A quick launch and extensive market success of these kinds of safety improving applications must be supported so that they can develop their full potential. In addition, the guidelines state: "Intelligent transport systems should significantly contribute to more effective and faster rescue measures over the next few years, in particular through the introduction of the onboard European-wide eCall emergency call system." The effect of the system as well as the options for expanding its application

3 Trend of the number of road traffic fatalities in the EU (all road users and all locations) from 2001 to 2012

The work on implementing the EU road safety action programme from 2011 to 2020 is being stepped up even further. In addition, the Vice President of the Commission has announced his intention to make greater efforts to promote enforcement measures at national level and to particularly focus on the situation of at-risk motorcyclists.

Member state	Deaths caused by road accidents for every 1 million inhabitants			Trend		
	2001	2010	2012	Total decrease 2001–2010	Ø Annual decrease 2001–2010	Ø Annual decrease 2010–2012
Austria	119	66	64	-45%	-5%	-2%
Belgium	145	77	73	-47%	-5%	-3%
Bulgaria	124	103	82	-17%	-2%	-10%
Cyprus	140	73	59	-48%	-5%	-10%
Czech Republic	130	76	71	-42%	-5%	-3%
Denmark	81	46	32	-43%	-5%	-15%
Estonia	146	58	65	-60%	-7%	6%
Finland	84	51	48	-39%	-4%	-3%
France	138	62	56	-55%	-6%	-5%
Germany	85	45	44	-47%	-5%	-1%
Greece	172	111	92	-35%	-4%	-9%
Hungary	121	74	60	-39%	-4%	-9%
Ireland	107	47	36	-56%	-6%	-12%
Italy	125	68	62	-46%	-5%	-4%
Latvia	236	97	86	-59%	-7%	-6%
Lithuania	202	90	100	-55%	-6%	6%
Luxemburg	159	64	65	-60%	-7%	1%
Malta	41	36	26	-12%	-1%	-14%
Netherlands	68	32	32	-53%	-6%	0%
Poland	145	102	93	-30%	-3%	-4%
Portugal	163	79	71	-52%	-6%	-5%
Romania	109	111	96	2%	0%	-7%
Slovakia	114	68	55	-40%	-4%	-10%
Slovenia	140	67	59	-52%	-6%	-6%
Spain	136	54	41	-60%	-7%	-12%
Sweden	60	28	31	-53%	-6%	5%
United Kingdom	61	31	28	-49%	-5%	-5%
Total (EU-27)	**112**	**62**	**55**	**-45%**	**-5%**	**-6%**

Sources: ETSC PIN Report June 2012 and press release by the European Commission on 19th March 2013



1992: Introduction of the vehicle inspection in France. New vehicles have to be presented for the first time after four years, then every two years afterwards.

1995: First series ESP from Bosch (Mercedes Benz S-Class).

1995: The blood alcohol limit is decreased in France to 0.5 g/l.

May 1998: Introduction of the 0.5 limit for the blood alcohol concentration level in Germany.

1998: The first sign with a "Black Spot", which stands for particularly dangerous roads, is placed on Rural Road 2 near Blonie in Poland on 7th September. 20 more signs follow in the same year.

1995

2000

Heavy trucks on rural roads demand the greatest attention from road users.

to improve rescue measures for road users involved in accidents must be checked.

The "2011 Road Safety Programme" launched by the Federal Ministry of Transport, Building and Urban Affairs shows the high priority given to road safety, among other things on rural roads, by policymakers in Germany. This programme specifies the target of reducing the number of fatalities in road traffic by 40 percent by 2020. The Minister of Transport, Dr. Peter Ramsauer, sees the three very important areas of action as being the human factor, infrastructure and vehicle engineering. Great importance is specifically attached to the infrastructure for rural roads. To this end the "2011 Road Safety Programme" states: "The provision of a functional and efficient infrastructure is an important foundation to pave the way for safe road traffic. Factors that contribute to accidents must be eliminated by road construction and traffic regulating measures and danger spots must also be defused to the extent that the consequences are as minor as possible in the event of an accident."

As a result of the above-average severity of accidents on rural roads it is necessary to continue to alleviate accident blackspots and thus reduce the negative consequences of accidents. The specified measures include:

- To prevent overtaking accidents with additional overtaking lanes
- To prevent accidents involving impact with an obstacle next to the road,
- Motorcyclist-friendly safety barriers, for example guard rails with (additional) beams,
- To increase road safety at junctions,
- To use speed checks at accident hotspots and
- To evaluate measures against accidents involving game.

Part of the "2011 Road Safety Programme" is the "Rural Road Campaign" (www.riskiernichts.de) implemented by the Deutsche Verkehrswacht. Underlying this is a campaign, which is specifically aimed at young drivers between 18 and 24 years old and motorcyclists between 40 and 50 years old, i.e. the two road user groups that are most at risk on rural roads. The campaign very deliberately uses social networks and interactive involvement. The topic of road safety is introduced directly into the daily lives of the target groups mentioned through the campaign's interactive nature. At the same time, being confronted with the risks and dangers should motivate them to look into this topic and take it seriously. Finally, many people have already experienced dangers in road traffic themselves, some have lost friends or family members due to an accident. The campaign provides a platform for them to share experiences. Other sponsors of this campaign, besides the Federal Ministry of Transport and the Deutsche Verkehrswacht (DVW), are the Federal Highway Research Institute (BASt) and the German Road Safety Council (DVR), which also has increasingly focused on rural roads as part of the "Slow down" campaign.

TENSIONS BETWEEN ROAD DESIGN AND SPEED

In this context, the 18th DVR "Safety and Mobility" forum held at the start of June 2012 in Potsdam cannot go unmentioned. Under the title "Focus on rural roads – the potential for safety audits and other measures", experts from science, research and associations discussed current developments and options for reducing the risk of accidents on rural roads. Questions were discussed there such as: How can road design contribute to reducing the number of accidents? What are the findings from audits already carried out? And what are the options for raising road users' awareness of the dangers on rural roads?

The experts' conclusion at the DVR forum was: Safe roads and vehicles alone would not be enough to increase road safety and reduce the number of victims. Speed must be reduced on rural roads as a

2000: The development of rural roads based on the 2+1 principle with a middle barrier starts in Sweden. Up to 80 percent less accidents happen on these roads.

2002: Compulsory lights on during the day is introduced on motorways and in non-built up areas in Italy.

2003: Use of radar speed checks in France.

2003: Approval of the "Euskirchen" system. It offers impacting motorcyclists better protection. Building on this, DEKRA developed the "Euskirchen Plus" system on behalf of BASt. It offers even better impact protection, even for occupants of cars travelling at greater speeds.

2000 2005

The right balance between construction work and speed restrictions

Frédéric Péchenard, inter-ministerial delegate for road safety in France

"The death toll for accidents on rural roads is highest in France where there is a clear concentration of department-level roads. Although it should be noted that department-level roads only make up 36 percent of the total road network and only 39 percent of the total road traffic is represented on them. Therefore the risk of being involved in a fatal accident on a department-level road is six times higher than on a motorway.

There are several reasons for this increased risk: In contrast to motorways, department-level roads are usually two lane roads which are navigable in both directions at the same time. A quarter of all deaths caused by road accidents are as a result of frontal impact here. Added to this there are other factors that increase the risk, such as commonly a narrow lane width of less than six metres, a lack of hard shoulders and numerous obstacles at the edge of the road. Minor driving errors can also have fatal results. 40 percent of fatalities die here as a result of an impact with an obstacle (tree, deep roadside ditch, electric pylon etc.).

Despite these increasing factors, accidents on these roads where there is a maximum permissible speed of 90 km/h often taken place at excessive speed. Thanks to the increased use of speed measuring devices (one in two of the stationary radar devices is on this kind of road) the death toll could in fact be reduced by eight percent between 2007 and 2011. However, this decrease was still much smaller than over the entire road network (14 percent).

It must be taken into account in terms of the road infrastructure that the majority of the French road network is managed by regional authorities. As in addition to department-level roads, which they have always been responsible for, they were also given responsibility for another 18,000 kilometres of national roads in the years 2005/2006. The general councils of the departments are making various efforts as the operator of department-level roads, in particular by improving the safety of their infrastructure. They are also actively involved in drawing up local policies for the benefit of road safety, for example department safety plans and plans for road traffic checks. It would be sensible to evaluate these efforts in order to apply good practice uniformly across the board.

The French state provides regional authorities with the methods and tools that are being developed to improve safety within the traffic infrastructure that falls within its remit. It also offers departments implementation in their road traffic network. One example of this is the implementation of the SURE approach on the most hazardous stretches of road (SURE stands for "Sécurité des Usagers sur les Routes Existantes" = "Road user safety on existing roads").

What is important here is establishing the right balance between construction work and speed restrictions. It is therefore appropriate to design roads more clearly using joint measures and thus make them safer for road users. Improvement measures of this kind could contribute to achieving the target set by the Ministry of the Interior to halve the number of deaths caused by accidents by 2020."

key measure. This would require a greater density of speed checks and the associated better financing of the police. In addition, it is also about public relations work in terms of a safety culture. The current regulations and audits would have to be applied and enforced consistently and the education and training of road builders would have to be improved.

Road construction generally plays a key part in discussions about road safety on rural roads. This was made more than clear at the DVR "The road environment of the future" seminar in November 2012. Background: It has been proved that a road's construction features and traffic flow conditions have an impact on the speeding behaviour of road users. Roads, for example, which are deserted and offer plenty of space both visually and for driving, encourage higher speeds. During the seminar it was discussed, among other things, what "self-explanatory" roads which make the respective speed limit clear through their design features should look like. Another talk dealt with the question of whether a speed of 100 km/h is too fast on rural roads.

The topics raised so far clearly show: Road safety on rural roads is a highly complex interaction between a whole range of factors and demands analysis of all the risks. This report highlights what accidents look like in detail, which measures can be used to efficiently counteract them and where there is a need for remedial action regarding this. When the report refers to rural roads it generally means single carriageway roads outside built up areas, therefore not roads that are similar to a motorway due to their lack of junctions and dual carriageways. This difference is important as it is specifically the single carriageway (two lane) rural roads that have potential accident risks such as oncoming traffic, junctions, intersections and game or trees at the edge of the road. And it is precisely the risks that arise from these that must be contained.

2011: Daytime running lights become mandatory in the EU for all new cars and trucks.

2011: All new vehicle models launched on the market in Europe must be fitted with the electronic driver assistant ESP as standard since 1st November.

November 2014: Mandatory ESP applies to all new cars.

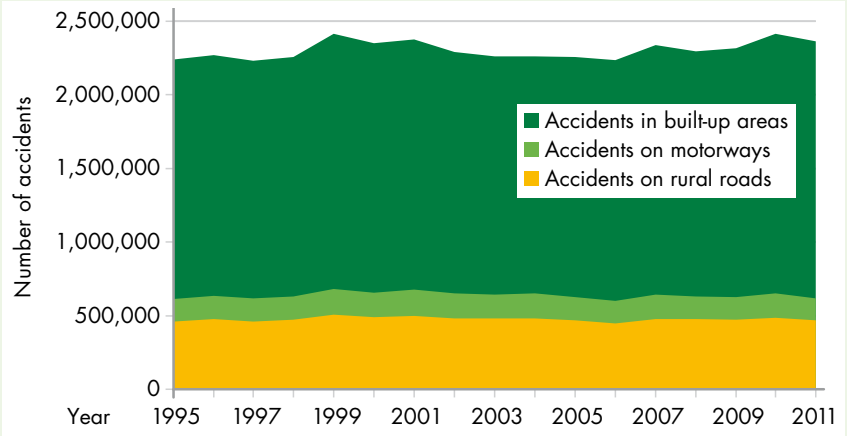
2010 2015

Reducing the EU-wide high risk potential on rural roads

Although only roughly a quarter of all accidents with personal injury happen on German rural roads, over 60 percent of the people killed in road traffic lose their lives here. Rural roads are the most dangerous roads by far compared to motorways and roads in built-up areas. This risk distribution not only applies to Germany but also to most European countries. The fact that the severity of accidents on rural roads is so great is related, among other things, to significantly higher speeds combined with oncoming traffic or intersections, compared to traffic in built-up areas. The most frequent causes of accidents are driver error, distraction and inattentiveness. Technical defects on vehicles, for example on brakes and the chassis, are of major importance on rural roads.

4

Accidents in and outside built-up areas



Accidents with personal injury in 2011 in Germany by road comparison

	Accidents with personal injury	Percentage	Fatalities	Percentage	Serious injuries	Percentage	Minor injuries	Percentage
Total	306,266	100%	4,009	100%	68,985	100%	323,380	100%
Rural roads	77,549	25.3%	2,441	60.9%	26,808	38.9%	82,586	25.5%
Motorways	18,290	6.0%	453	11.3%	5,223	7.5%	23,458	7.3%
Built-up areas	210,427	68.7%	1,115	27.8%	36,954	53.6%	217,336	67.2%

Data source: Federal Statistics Office

If accidents on German rural roads over the last two decades are reviewed then the trend is quite positive at first glance, at least as far as the absolute number of fatalities is concerned. Whilst there were 6,399 fatalities on German rural roads in 1991, this number dropped to 2,441 by 2011. This means a decrease of roughly 62 percent. The number of fatalities on all roads dropped by just under 65 percent from 11,300 to 4,009 during this period. The decrease in fatalities in built-up areas is just under 67 percent (1991: 3,349; 2011: 1,115), on motorways the decrease in fatalities is 71 percent (1991: 1.552; 2011: 453). The 62 percent mentioned on rural roads should definitely be seen as evidence of a clear improvement in road safety. However, that's only one side of the coin. As the percentage of all deaths caused by road accidents on rural roads is still high at roughly 60 percent.

As the figures published by the Federal Statistics Office for 2011 show, a total of 2.4 million accidents were recorded by the police. As far as the 306,266 accidents with personal injury are concerned, most of them happened in built up areas at 68.7 percent but only 27.8 percent of fatalities were registered here (figure 4). 25.3 percent of ac-

cidents with personal injury happened on roads in non-built up areas (not on motorways) but 60.9 percent of fatalities died here, as already mentioned. Six percent of all accidents with personal injury and 11.3 percent of all fatalities were recorded on motorways.

This makes it clear that the severity of accidents is significantly increased on roads in non-built up areas. Compared to traffic in built-up areas this can be traced back to higher speeds, compared to motorways there is no separation from oncoming traffic, poor opportunities for overtaking, junctions and unprotected obstacles, such as trees, right next to the road. Collisions with oncoming traffic and accidents caused by lane departure usually have very serious consequences. If you take the ratio between the number of fatalities and accidents with personal injury as a benchmark for the severity of the accident this is then confirmed: whilst there were five fatalities for every 1,000 accidents with personal injury in built-up areas in 2011, the corresponding percentage for motorways was 25 and even 31 for rural roads.

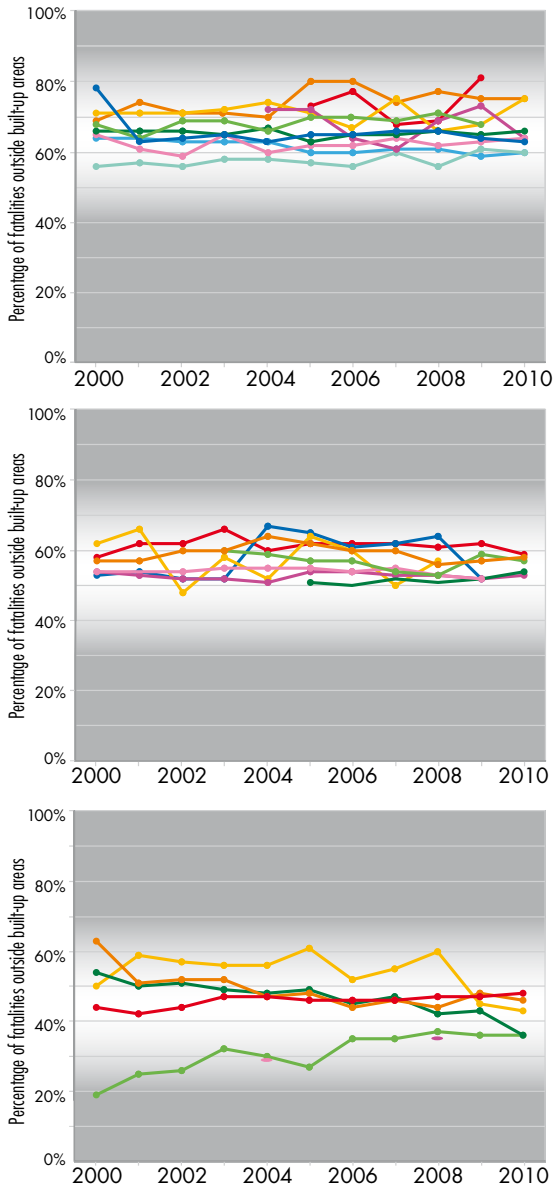
THERE IS A SIMILAR PICTURE TO GERMANY ALL OVER EUROPE

Germany is not an exception in terms of the severity of accidents on rural roads. In many other EU states (figure 5), the percentage is similarly high to on German roads, including for example in Austria (64 percent), Spain (63 percent), Czech Republic (60 percent and Denmark (59 percent). Sometimes the percentage of fatalities on rural roads is even higher, for example in France (66 percent), Finland (75 percent) and Estonia (81 percent), figures from 2009). On the other hand, there are countries where the percentages are significantly lower, for example in Italy and Greece (48 percent), Slovenia (43 percent) and Portugal (36 percent). 16,277 people lost their lives on rural roads throughout Europe in 2010. Compared to 1999 (24,169) this means a decrease of roughly 33 percent (figure 6). The most frequent fatalities were

5

Fatalities on rural roads in the EU between 2000 and 2010*

Trend over time of the percentage of fatalities outside built-up areas from all deaths caused by road accidents in the year 2010 or the stated year…



…in ten EU countries with corresponding percentages of 60% to 81%

- Estonia 81% (2009)
- Ireland 75%
- Finland 75%
- Sweden 68% (2009)
- France 66%
- Latvia 64%
- Austria 64%
- Spain 63%
- Germany 60%
- Czech Republic 60%

…in eight EU countries with corresponding percentages of 52% to 59%

- Denmark 59%
- Belgium 58%
- Luxemburg 57% (2008)
- Hungary 57%
- Slovakia 54%
- Poland 53%
- United Kingdom 52% (2009)
- Netherlands 52% (2009)

…in seven EU countries with corresponding percentages of 29% to 48%

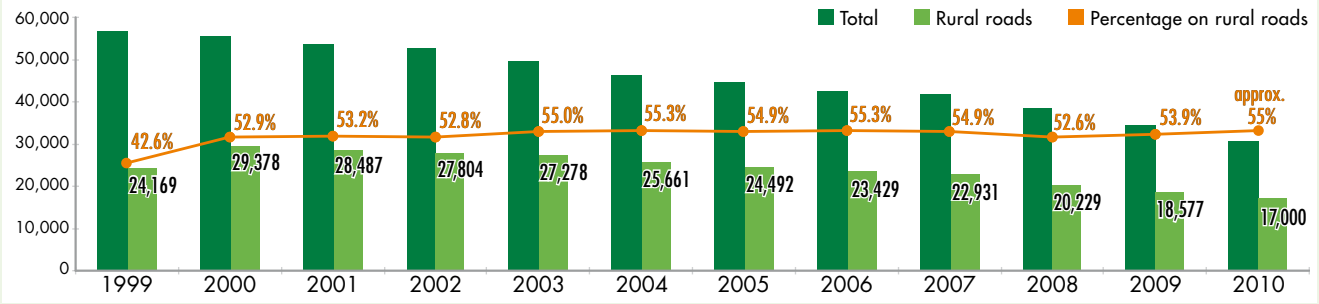
- Italy 48%
- Greece 48%
- Slovenia 43%
- Romania 36%
- Portugal 36%
- Bulgaria 35% (2008)
- Cyprus 29% (2004)

Malta: Fatalities only in built-up areas
Lithuania: no data

Data source: CARE. *The lines in the diagrams have been shortened correspondingly for countries where the required data is not available for all the years from 2000 to 2010.

6

Fatalities on rural roads in the EU between 1999 and 2010



Data source: CARE and IRTAD

7 Parties involved in road accidents with fatalities in the EU in 2010 based on type of vehicle or road use

Fatalities	Total	Cars	Motorcycle	Pedestrians	Bicycles	Vans	Trucks > 3.5 t	Tractors
Total	31,000	14,514	4,472	6,001	2,023	740	550	176
Of these on rural roads	17,000	9,936	2,447	1,550	899	478	291	111
Percentage	approx. 55%	68%	55%	26%	44%	65%	53%	63%

Data source: CARE. Figures for EU-27 (in 2010). Figures from 2009: Estonia, Netherlands, Sweden, United Kingdom. Missing countries with types of road users: Bulgaria, Cyprus, Malta. Missing countries: Slovak Republic, Estonia, Latvia, Hungary.

8 Parties involved in road accidents with personal injury on rural roads in Germany in 2011 based on type of vehicle or road use

	Total	Fatalities	Serious injuries	Minor injuries
Road users involved in accidents on rural roads	111,835	2,441	26,808	82,586
Road users				
Car drivers	82,152	1,476	16,618	64,058
Motorcyclists	11,625	508	5,032	6,085
Moped drivers	2,946	44	857	2,045
Goods vehicle drivers	4,294	73	896	3,325
Agricultural machinery drivers	360	14	98	248
Bus drivers	586	3	53	530
Drivers of other vehicles	490	7	135	348
Cyclists	7,394	158	2,490	4,746
Pedestrians	1,637	154	537	946

Data source: Federal Statistics Office

car occupants, followed by motorcyclists, pedestrians, cyclists and other road users (figure 7).

However, let's get back to Germany: if we look closer at accidents on local rural roads in 2011 we notice that car occupants make up the majority of fatalities with 60.5 percent (= 1,467 fatalities). In second place are motorcyclists with 508 fatalities or 21 percent and then cyclists and pedestrians follow some distance behind (figure 8). As already mentioned, this order also applies to almost all other EU states.

Just about half of all fatalities (1,198 = 49 percent) lost their lives in accidents involving two vehicles. Very many, in fact 910 people (= 37 percent) were killed in single-vehicle accidents. As far as light and road conditions are concerned, just under 71 percent of accidents on rural roads happened during the day. In 70 percent of cases the road was dry.

SERIOUS ACCIDENTS INVOLVING IMPACT WITH AN OBSTACLE

The detailed analysis of accidents also provides a very telling picture (figure 9). As far as the accident types are concerned, driver-related accidents dominated in 2011 at 37 percent, followed by accidents involving longitudinal traffic at just under 25 percent. Most road users lost their lives with these two accident types with a total of 1,776 fatalities (= 72.8 percent). The most frequent accident types on rural roads were lane departure accidents (34.6 percent), followed by collisions with vehicles turning in or crossing (20.4 percent). The percentage of fatalities in lane departure accidents was 39.5 percent. Collisions with oncoming vehicles recorded the highest percentage of fatalities on rural roads. Although this type of accident only made up 13 percent of all accidents on rural roads, its percentage of fatalities was 30.8 percent. The reason for this are usually risky overtaking manoeuvres, for which the opposite lane has to be used. The driving time saved is of course incommensurate with the risk of a serious accident.

Most accidents happened near a bend at 28 percent, accounting for roughly 40 percent of all fatalities on rural roads. Junctions and intersections pose another risk on rural roads as they are often not easy to see. Motorcyclists in particular are often seen too late as a result of their narrow silhouette and fast acceleration rate. Therefore extra caution is called for from all road users at intersections, even if they have right of way, or sometimes only assume they do.

Numerous crosses on rural roads are a striking symbol for deaths caused by accidents and a reminder of casualties.

9 The nature of accidents on rural roads with personal injury in Germany in 2011

	Total	Percentage	Fatalities	Percentage	Serious injuries	Percentage	Minor injuries	Percentage
Total accidents with fatalities/injuries on rural roads	77,549	100%	2,441	100%	26,808	100%	82,586	100%
Type of accident (conflict situation that led to the accident)								
Driver-related accident	28,632	36.9	1,171	48.0	11,757	43.9	24,029	29.1
Turning off accident	8,414	10.8	131	5.4	2,630	9.8	10,893	13.2
Turning in/crossing accident	12,971	16.7	304	12.5	4,336	16.2	15,948	19.3
Pedestrian crossing road accident	591	0.8	84	3.4	270	1.0	387	0.5
Accident due to stationary traffic	327	0.4	6	0.2	84	0.3	354	0.4
Accident involving longitudinal traffic	19,250	24.8	605	24.8	5,508	20.5	24,249	29.4
Other accidents	7,364	9.5	140	5.7	2,223	8.3	6,726	8.1
Type of accident (type of collision)								
Driving into stationary vehicle	2,239	2.9	12	0.5	362	1.4	2,910	3.5
Driving into moving vehicle	11,321	14.6	81	3.3	1,698	6.3	15,819	19.2
Side collision in same direction	2,455	8.6	35	1.4	687	2.6	2,575	3.1
Oncoming traffic	10,128	13.1	751	30.8	5,860	21.9	12,680	15.4
Turning in/crossing	15,787	20.4	369	15.1	5,381	20.1	19,615	23.8
Vehicle-pedestrian impact	1,417	1.8	142	5.8	550	2.1	1,054	1.3
Driving into an obstacle	973	1.3	17	0.7	225	0.8	858	1.0
Lane departure to the right	16,366	21.1	544	22.3	6,006	22.4	13,219	16.0
Lane departure to the left	10,446	13.5	421	17.2	3,983	14.9	8,592	10.4
Other type of accident	6,417	8.3	69	2.8	2,056	7.7	5,264	6.4
Nature of accident site								
Junction	9,163	11.8	205	8.4	2,925	10.9	11,853	14.4
Intersection	16,018	20.7	283	11.6	4,601	17.2	19,652	23.8
Entry or exit	1,840	2.4	35	1.4	563	2.1	2,134	2.6
Climbs	4,185	5.4	157	6.4	1,710	6.4	4,073	4.9
Downhill stretch	7,587	9.8	288	11.8	3,249	12.1	6,800	8.2
Bend	21,720	28.0	980	40.1	9,208	34.3	19,793	24.0
Impact with obstacle								
Tree	9,066	11.7	714	29.3	4,275	15.9	6,862	8.3
Pylon	1,066	1.4	28	1.1	387	1.4	1,181	1.4
Abutment	226	0.3	8	0.3	115	0.4	222	0.3
Guard rail	4,257	5.5	196	8.0	1,758	6.6	4,167	5.0
Other obstacle	8,765	11.3	205	8.4	3,274	12.2	8,410	10.2
No impact	54,169	69.9	1,290	52.8	16,999	63.4	61,744	74.8
Road conditions								
Dry	54,349	70.1	1,782	73.0	19,552	72.9	57,467	69.6
Wet	18,733	24.2	577	23.6	5,980	22.3	20,488	24.8
Icy	4,467	5.8	82	3.4	1,276	4.8	4,631	5.6
Light conditions								
Daylight	55,000	70.9	1,609	65.9	19,055	71.1	58,929	71.4
Dusk	4,469	5.8	129	5.3	1,461	5.4	4,738	5.7
Darkness	18,080	23.3	703	28.8	6,292	23.5	18,919	22.9

Data source: Federal Statistics Office

Special situation on rural roads in the new German federal states during and immediately after reunification

Two very different transport systems met in a very short time due to the reunification of both German states. As the air and train links were nowhere near up to today's standards, the transport of people and goods was mainly handled on the existing road network. This was considerably outdated in the new federal states and in a very poor condition. Although vehicles licensed in the former DDR were generally very well looked after, most of them were still outdated in terms of safety engineering.

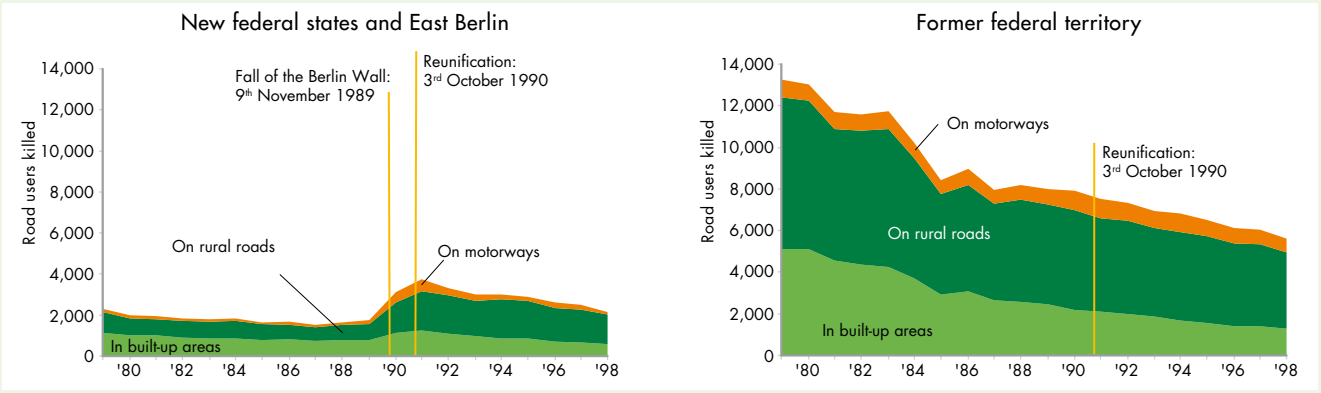
1,784 deaths caused by road accidents were registered in the former DDR in 1988. Of these, 814 people (48 percent) lost their lives as a consequence of road traffic accidents in built-up areas. There were 112 fatalities (7 percent) on motorways and 723 people (43 percent) lost their lives outside built-up areas not on motorways. With the fall of the wall and subsequent reunification, the number of fatalities in relation to the former DDR territory increased in two years to 3,759 in total, therefore by more than double. In 1991, 1,250 road users (33 percent) lost their lives in built-up areas. 602 people lost their lives (16 percent) on motorways and there were 1,907 fatalities (51 percent) on roads outside built-up areas not on motorways. As a result the absolute numbers of deaths caused by road accidents increased in all locations. At the same time there was a clear shift from roads in built-up areas to those outside built-up areas.

Remarkably, these changes had practically no effect on the number of deaths caused by road accidents in the former BRD states. This also constantly decreased during reunification and there was also not any significant shift in the location percentages here. From 1991, the adverse development on the roads in the new federal states was ended, not least also thanks to the introduction of the periodic technical vehicle inspection. In subsequent years, the number of deaths caused by road accidents almost continuously dropped here as well, although the distribution over locations remained roughly constant.

How was the dramatic trend of the number of deaths caused by road accidents in the new federal states reversed so rapidly already by 1992? It was mainly down to objective analyses to identify opportunities and the swift, decisive action of all those involved. Round table meetings were convened in the new federal states, which also dealt with road safety and vehicle safety topics. Among other things, the problem of "collisions with trees" on rural roads, predominantly avenues, was systematically tackled at these meetings and at various regional road safety conferences.

In addition, large sums of money were invested in developing the trunk road network. To start with, all motorways were modernised and expanded which led to a marked easing of the burden on rural roads. In the meantime, most of the rural roads have also been modernised. The rapid modernisation and expansion of several major regional airports also contributed to relieving the strain on the roads. The age of the vehicle fleet has also become more similar over the last few years. At the time of reunification, Trabant and Wartburg cars characterised the landscape in the new federal states. Today, the remaining "historical treasures" are loved and nurtured by enthusiasts but are hardly ever used in everyday road traffic. The relevance of intact roads and safe vehicles is clear from all these developments.

Trend of the number of deaths caused by road traffic in the new federal states and in the former territory of the Federal Republic of Germany from 1979 to 1998



Data source: Federal Statistics Office

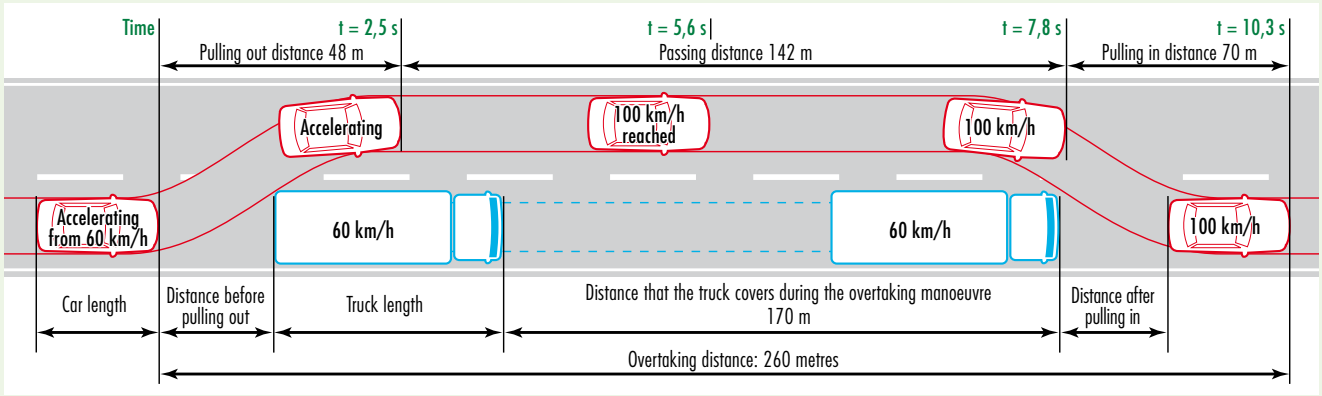
When accidents involving an obstacle next to the road happened on rural roads, this involved a tree in most cases (11.7 percent). These accidents are particularly serious. Impact with trees was the most frequent cause of fatal accidents on rural roads with roughly a third of fatalities. The risk of being killed by collision with a tree, is twice as high for car occupants than with other obstacles and three times as high for motorcyclists. As with collisions with a tree, the whole impact energy is concentrated on a small area of the vehicle. If the vehicle overturns and impacts the tree sideways or with its roof, the passenger compartment is so severely deformed that there is hardly any chance of survival for the occupants.

DANGEROUS OVERTAKING MANOEUVRES

It has already been indicated in previous statements that dangerous overtaking manoeuvres are the second most common cause of fatal accidents on rural roads, following lane departure accidents. The sometimes terrifying severity of the accident is specifically linked to the collision speed. The length of the stretch required to overtake is often underestimated too. As the person overtaking temporarily uses the opposite lane whilst overtaking, the manoeuvre can only be safe if there is sufficient visibility of the open road. However, in doing so it cannot be assumed that the whole visible stretch of road is available. Possible oncoming traffic must be calculated in, which is why the open visible stretch must be roughly twice as long as the stretch of road required to overtake. Overtaking is prohibited near junctions and intersections in any case.

Schematic diagram of an overtaking manoeuvre

The overtaking stretch, for example 260 metres here, is composed of the overtaking vehicle's (car's) pulling out distance, the passing distance (length of the truck being overtaken plus safety distances before and after pulling in) and the pulling in distance. Added to this there is the safety distance to oncoming traffic at the end of overtaking. The open visible stretch must be roughly twice as long, as it must be assumed that oncoming traffic may unexpectedly appear and move roughly as far as the car being overtaken during the overtaking manoeuvre (roughly 300 metres here).



Source: DEKRA. The diagram is not to scale.

The general principle is: the greater the difference in speed between the overtaking vehicle and the vehicle being overtaken, the shorter the overtaking manoeuvre. If the overtaking vehicle accelerates when overtaking, it takes less time to overtake. The faster the vehicle being overtaken is driving the longer the distance is that has to be covered by the overtaking vehicle on the opposite lane. If the vehicle being overtaken brakes, it takes less time and distance to overtake.

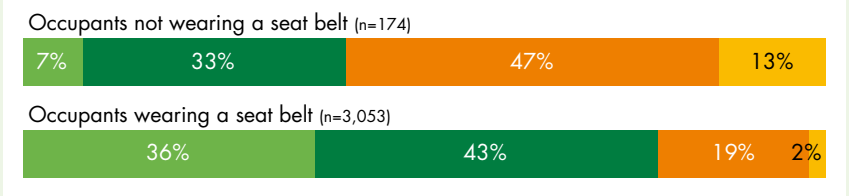
However, if the vehicle being overtaken accelerates during the overtaking manoeuvre, which is illegal but frequently happens and increases the risk of an accident for both parties, then the time and distance required to overtake often dangerously increases. The only means of survival is often to abort the overtaking manoeuvre, for example in the event of sudden oncoming traffic.

The open stretch for overtaking includes the possible distance covered by an oncoming vehicle during the overtaking manoeuvre. Here it should be assumed that oncoming traffic is moving at the maximum permissible speed at least. However, the overtaking vehicle cannot blindly trust that this speed will not be exceeded by oncoming traffic.

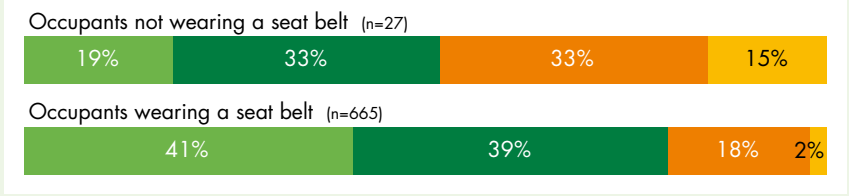
How long the open stretch has to be for an overtaking manoeuvre is shown by the example of a truck, which is travelling at 60 km/h and is being overtaken by a car. Initially, the car is travelling behind the truck at the same speed, it then accelerates and pulls out, passes the truck and pulls in again in front of it. The maximum permissible speed (100 km/h outside built-up areas) is not exceeded whilst accelerating. Added to this there must be a safety distance of roughly 25 to 50 metres as well as the distance that is covered whilst deciding to overtake. As a result the open stretch required at the start of the overtaking manoeuvre is just under 600 metres (see sketch above).

10

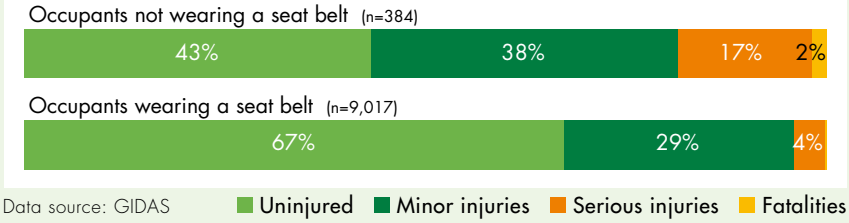
Severity of car occupants' injuries – outside built-up areas



Severity of car occupants' injuries – motorways



Severity of car occupants' injuries – in built-up areas



Data source: GIDAS

Uninjured | Minor injuries | Serious injuries | Fatalities

SEAT BELTS SAVE LIVES

In light of the fact that driving errors and inattentiveness are the main causes for serious accidents on rural roads in many cases, wearing a seat belt should be a matter of course. The seat belt is still the number one lifesaver for car drivers. At the same time it is essential for the car body (residual space) and the airbags as an additional restraint system to be able to develop their full protection. According to information from the BASt, the seat belt safety figures for car occupants on rural roads is 98 percent (motorways: 99 percent; in built-up areas: 97 percent).

These figures are also confirmed by a nationwide survey carried out by DEKRA in May 2012. On the other hand, an analysis of the GIDAS (German In-Depth Accident Study) database carried out in 2006 shows that the rate of seat belt use determined with accidents decreases with an increase in the severity of injuries. A seat belt safety rate of less than 85 percent resulted over all injury categories with regard to all car occupants involved in an accident. What is particularly alarming: 60 percent of the car occupants not wearing a seat belt in accidents with personal injury on rural roads suffer serious or fatal injuries. By comparison: This percentage is 48 percent on motorways and 19 percent in built-up areas (figure 10).

FOG AS A STRESS FACTOR

The header "accident involving fog" immediately conjures up images of multiple pile-ups on motorways in most people's minds. However, this image is deceptive.

In 2011, a total of 711 accidents with personal injury were registered where fog was classified as the cause. 38 accidents involving fog were fatal, resulting in 45 people being killed. 29 of the fatal accidents involving fog happened on rural roads.

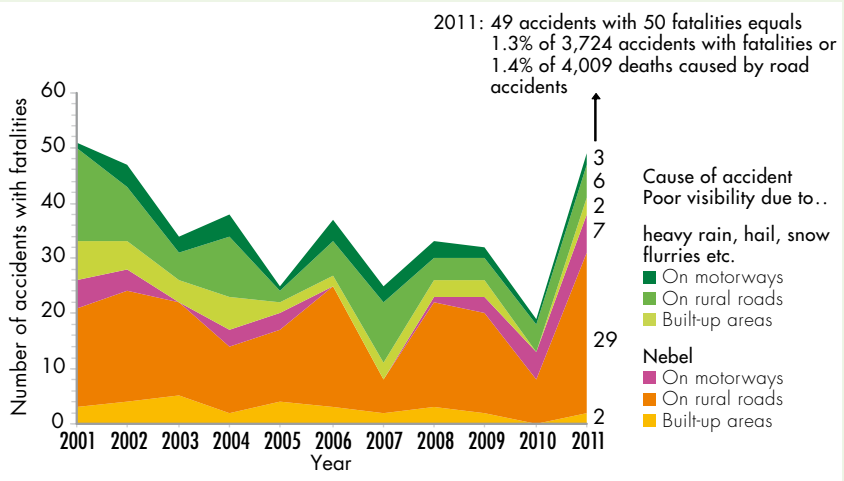
If we extend the category of accidents involving fog by the cause of poor visibility due to heavy rain, hail or snow flurries, then the absolute figure of accidents with personal injury increases to 1,237 and the number of fatal accidents rises from 38 to 49, resulting in 57 people being killed. 35 of the fatal accidents with poor visibility happened on rural roads.

Figure 11 illustrates the trend of the number of fatal accidents from 2001 to 2011, broken down according to locations. If we look at several years it becomes clear that there are some years when not one fatal accident involving fog happened in built-up areas or on motorways. Rural roads were generally affected. Even if these kinds of accidents are not among the top accident causes, they should not be neglected with regards to "Vision Zero".

Accidents on rural roads also dominate in accidents with personal injury and poor visibility due to fog (figure 12). There were 489 accidents in 2011. In 2011, a total of 1,237 accidents with personal injury happened where poor visibility due to fog, heavy rain, hail or snow flurries had been classified as the cause. That is 0.4 percent of all the 306,266 accidents with personal injury. With these accidents as a result of poor visibility, 1,797 road users were injured or killed, equalling 0.5 percent of all road deaths.

11

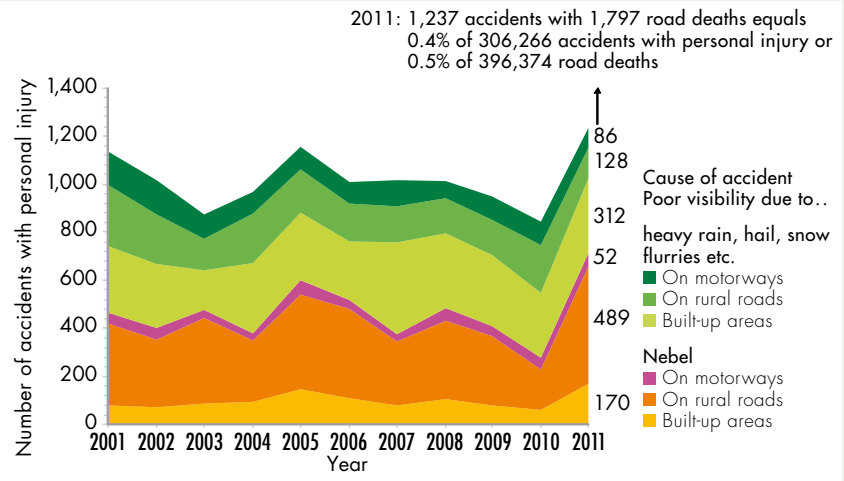
Accidents with fatalities and very poor visibility as the cause, broken down according to locations in Germany, between 2001 to 2011



Data source: Federal Statistics Office

12

Accidents with personal injury and very poor visibility as the cause, broken down according to locations in Germany, between 2001 to 2011



Data source: Federal Statistics Office

EFFECTIVE, CORRECTLY ALIGNED FOG LAMPS

Be it on the coast, near floodplain meadows, in the mountains or in congested urban areas: fog can be reckoned on anywhere. The density of the fog also varies. Misty days with relatively good visibility are suddenly confronted with fog banks with less than 50 metres' visibility sometimes. However and wherever this happens: fog reduces visibility, dulls contrasts and leads to glare due to the reflection of one's own headlamps in the fog's droplets of water. Similar poor visibility also exists with heavy rain, snowfall and with sand storms, even though they only happen regionally.

Road traffic regulations stipulate in Section 17 (3): "If fog, snowfall or rain significantly impair visibility, then you must also drive on dipped beam during the day. Fog lamps may only be switched on in this kind of weather." In the event of fog, speed must also be immediately adapted to the reduced visibility. If visibility is less than 50 metres, rear fog lamps may also be used. You must not drive faster than 50 km/h with the rear fog lamps switched on, however this is knowingly or unknowingly ignored by many drivers though.

The German road traffic regulations allow for additional headlamps and lights in Section 52 (1). For example, vehicles may also be fitted with fog lamps, multi-track vehicles such as cars and trucks with

Driving in dense fog is one of the most demanding challenges on rural roads.

two, motorcycles, also with a sidecar, with just one (the relevant EU Directive allows for motorcycles to also have two fog lamps installed symmetrically to the centre). The fitting of vehicles with fog lamps is advised for safety and comfort aspects.

In certain weathers, fog lamps may also be switched on in addition to parking lamps, dipped beam or full beam. However, the use of the full beam in particular is often counterproductive, as it results in a "white wall effect": the droplets of water in the air reflect the light, drastically reducing visibility. The advantage of fog lamps is mainly in the wide radiation of the light beam to brightly illuminate the edges of the road. This helps the driver's orientation.

Driving in dense, changeable fog is one of the most demanding challenges when driving a motor vehicle. Effective and correctly aligned fog lamps can help you to cope with these kinds of situations in a safe and to some extent comfortable

Scientific research makes an important contribution to road safety

Prof. Ing. Lorella Montrasio, Director of Centro di Ricerche DISS, Università degli Studi di Parma, Italy

"The ACI-ISTAT data collected for 2011 on accidents in Italy proves that the probability of becoming the casualty of a road accident is four times higher on a rural road than in the town. Roughly 50 percent of accidents on rural roads are caused by three main causes: careless driving (20 percent), speeding (18 percent) and not keeping a safe distance (12 percent).

The causes of careless driving and not keeping a safe distance in combination with the usual higher speeds on rural roads allow for a simple conclusion to be drawn about the more serious consequences of accidents. The accident cause of speeding does not need any further comment.

Improving road safety outside built-up areas requires both active strategies that aim to reduce the probability of an accident and passive strategies to lessen the consequence of accidents. The contribution of scientific research on excellence is therefore of crucial importance as it is the basis for Centro di Richerche DISS and other research institutes at university level, which have been tackling research into the most suitable solutions to reduce the number of road traffic casualties for some time.

In this context, it should be stated that active safety measures are already being analysed and then perfected that aim to make roads and vehicles "intelligent" using technical innovations. As far as the road is concerned, an "intelligent road network" is being considered by applying communication from vehicle to vehicle via smartphones. As far as vehicles are concerned, research into excellence is increasingly aimed at the perception of the vehicle environment and innovative technologies, which enable the vehicle itself to support the driver, as required and take their place in extreme cases. In this context, some ADAS (Advanced Driver Assistance Systems) and fully automatic vehicle prototypes have already been completed.

Research is also achieving results fast and efficiently in terms of passive safety. Currently, systems are being developed for "advanced infrastructure protection", for which innovative materials from the recycling of waste products are provided. These include impact absorbers, which work based on a "mixed" kinetic/inertia principle. They are made out of rubber elements that are taken from discarded tyres. In this impact protection system, the deflection effect is achieved by several rows of tyres layered on top of each other, which are bonded together according to specific criteria. In this way, the stack of tyres not only work due to their moment of inertia but are also clad by an additional casing to hold the different stacks of tyres together and thus achieve a kinematic function and deflect the impacting vehicle in the event of a glancing impact.

The projects mentioned are just a few examples for the increasingly important role that broad-based academic research plays in defining measures to contain road accidents."

13 Enhanced fog lamp as a component of a light-based assistant system

Distribution of the standard dipped beam in fog (figure: Daimler AG)

Distribution of the enhanced fog lamp (figure: Daimler AG)

way. A new fog lamp class (F3) was introduced with the 03 series of amendments to ECE-R 19 on 19th August 2010. With this the photometric properties of fog lamps were further improved with regard to the breadth of the light beam, the minimum luminosity, driver glare and glare for other road users. Although only bulbs used to be permitted as light sources for fog lamps modern gas discharge lamps and LEDs are also used nowadays. With the F3 class fog lamps, adaptive light distribution is now also possible, permitting the asymmetric distribution of the fog lamp as well. Figure 13 shows an example of this.

Here the so-called "enhanced fog lamp" is activated depending on the speed by switching on the rear fog lamp. As when switching on a conventional fog lamp, the driver has to be proactive first. The system then improves orientation in poor visibility thanks to the broader illumination of the edge of the road on the driver's side and the reduction in driver glare from the light reflected by the fog.

Modern vehicle technology therefore already allows us to significantly reduce the stress factor of fog today. The driver always has overall responsibility though.

To prevent glare for the traffic behind, rear fog lamps may only be switched on in case of visibility less than 50 metres. Marker posts that are placed 50 metres apart on straight stretches of road in Germany provide good guidance for this. The distance is 33 metres apart in Austria. Speed must also be reduced accordingly to poor visibility. The maximum permissible speed is then 50 km/h.

STOPPING SIGHT DISTANCE – A PARTICULAR CHALLENGE ON RURAL ROADS

On many rural roads, you can drive up to 100 km/h with an open road and good visibility. However, Section 17 of the road

People are very vulnerable

Prof. Dr. med. Felix Walz, Chairman of the working party on accident mechanics at AGU Zurich, Switzerland, Second Chair of the Gesellschaft für Medizinische und Technische Traumabiomechanik gmttb, Board Member of the International Research Council on the Biomechanics of Injury IRCOBI

"Accidents on rural roads have always been very serious. The main reason for this is the increased risk potential as a result of higher speeds. We know a lot about this nowadays, thanks to continuous research into the impact of high acceleration loads on the human body over more than 60 years, in particular in the USA, Europe and Japan. Incredibly extensive expert knowledge has resulted over the last few decades. This is one of the important foundations for the development of very safe vehicles today compared to in the past. Important elements of passive vehicle safety, such as high-strength passenger compartments, the rounding and cushioning of the interior, seat belts and airbags have already reached a high degree of maturity in the 1990s. Since then they have been perfected further. Other additional benefits will only be possible here with major efforts.

The potential of active safety measures is also being exploited more and more. Examples of this are ESP, which can prevent serious accidents involving lane departure or an automatic emergency braking system that helps to prevent accidents due to the driver's carelessness by braking early or by reducing the impact speed. Besides vehicle occupants, pedestrians and (motor)cyclists also benefit from this. However, additional potential can only be gained with even greater efforts in this area.

At the end of the day, the boundaries of a person's vulnerability cannot be moved. In particular, the increasing number of senior citizens in road traffic as drivers or pedestrians have to be better protected as a result of their diminished biomechanical capacity. This makes a holistic approach even more important: in the "driver/vehicle environment" the person is the least resilient element. They also make mistakes. Driving errors are human and should not be punished by injury or even death. Besides "vehicles that forgive mistakes", "roads that forgive mistakes" must also make their contribution. It is obvious that many rural roads still have significant development potential here."

traffic regulations also requires that you drive slower with reduced visibility, if necessary. This is not always easy to implement in practice though. The driver does not have a sensory organ to accurately estimate the current "perception distance" and a technical system in the vehicle cannot help them with this either yet. Generally the driver bases their driving on the maximum permissible speed alone. If the driver has overlooked the current regulatory sign but they have a navigation system with the right information or even an assistant system with road sign recognition, then a friendly announcement helps out: "Please observe the speed limit." However, in the event of reduced visibility, this speed may still be too high.

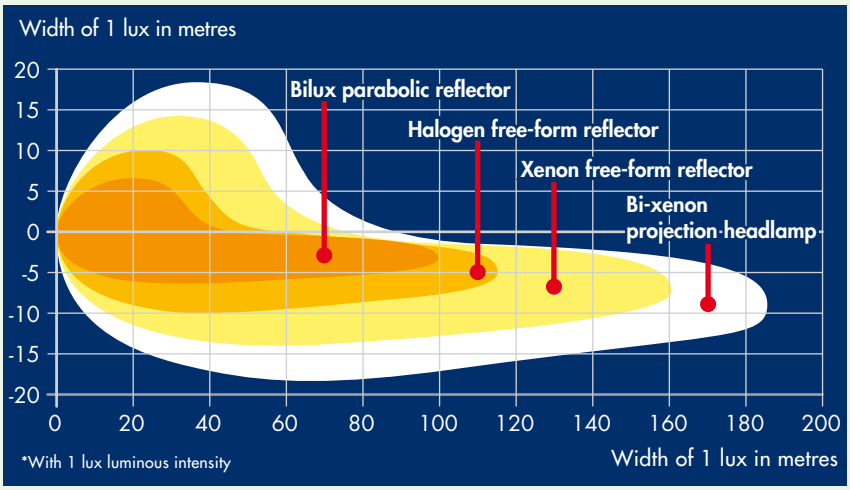
The driver's second handicap is their inadequate knowledge of the right stopping distance. They can read the speed on their speedometer. In driving school, they learnt the rule of thumb for being "on the safe side". For example: Reaction distance = three times the displayed speed divided by ten, braking distance = displayed speed divided by ten, times the displayed speed divided by ten, stopping distance = reaction distance plus braking distance. You can work it out in your head. But is your head up to this whilst driving? So we tend to drive "by our gut feeling" or as fast as the others. Anyone who deliberately drives slower in poor visibility than is allowed in good visibility will quickly find themselves being tailgated or overtaken dangerously.

It can be even more critical when driving on dipped beam on dark nights. To start with there is some good news here: effective headlamps have a much greater range today than they used to. Classic headlamps with dual-filament lamps and paraboloid reflectors typically had the range of an asymmetrical dipped beam of up to 100 metres in your own lane (figure 14). Headlamps with halogen bulbs and free-form reflectors illuminate up to roughly 115 metres under the same conditions. High-performance projection headlamps with xenon bulbs even reach up to 180 metres. This information refers to the so-called 1 lux line. Here the illumination directly on the road is 1 lux. That is roughly equal to the light of a candle from a distance of one metre. This is sufficient to read a newspaper.

If you take the 3 lux line as a reference, which is more appropriate for perception distances in road traffic, then you significantly shorten the headlamps' associated ranges. 50 to 70 metres can be assumed for this with current headlamps. However, this only relates to the illumination of the road. The dipped beam is directed downwards in order to not cause glare for other road users. Therefore only the very bottom of obstacles or living beings on the road are illuminated. It is not enough to only vaguely see their shoes to recognise a pedestrian as such. A clear silhouette only emerges together with the legs and also with the upper body, where applicable. Background lighting as well as the colour and reflectivity of clothing continue to play a part. It is therefore quite possible that a pedestrian in dark clothing on the road or at the edge of the road can only be recognised from distances of 30 metres or less on a dark night (figure 15).

Against this backdrop, pedestrians in particular should only move on the furthest outer edge of the left hand side of the road outside built-up areas in the dark and should also always wear bright clothing with retro-reflective materials. In turn it is an absolute must for survival for cyclists on rural roads at night that their bikes are equipped with reliable fully working active and passive lighting according to regulations, regardless of any advances in modern vehicle lighting systems. Cycling without lights at night in well lit built-up areas may be seen as a fineable offence but this kind of behaviour outside built-up areas quickly becomes lethal and often leads to lifelong trauma for the vehicle driver, who could not consequently prevent the accident.

14 Dipped beam range in various headlamps, illustrated using the 1 lux line on the road



Source: Daimler AG

15 Illustrations for visibility and recognition of pedestrians in a car's dipped beam

Pedestrians on edge of road with oncoming traffic.

Distance 40 m | Distance 30 m | Distance 20 m

Pedestrians on the road at distances of 40, 30 and 20 m.

The responsibility is always with the driver

"The further development of active and passive vehicle safety contributes a great deal to improving road safety, as does the improved design of infrastructure, not least on rural roads. But one thing must be clear at the end of the day: the driver is always responsible.

In my sport, it's like many journeys on rural roads "in real life": the courses are unknown, I have not driven them before and have not been able to familiarise myself with the particular danger spots. Naturally I have to adapt my driving style to these circumstances. I have to drive cleverly and be alert to win an event like the Dakar Rally. And I always have to be prepared for the unforeseeable.

Exactly the same also applies to driving on rural roads. Anyone on these roads must assume anything can happen: that a slow vehicle is just behind the next hill, that the bend that looks dry from afar is suddenly in fact wet in a shady spot, that a tractor unexpectedly crosses the road. It is essential to sharpen your senses to possible dangers, in rally sport as on rural roads.

To be responsible as a driver and expect anything also means always building in a safety cushion as far as speed is concerned.

Jutta Kleinschmidt, rally driver, winner of the Dakar Rally 2001

As you cannot defeat physics, even with the very best assistant systems. And rural roads are certainly not the right place to test out the laws of physics. Anyone who wants to put their foot down can do so nowadays in a safe environment on many race tracks, without endangering other road users."

FULL BEAM IN THE DARK – IF THE SITUATION ALLOWS

If pedestrians are run over at night, the question of guilt often has to be clarified in court afterwards with the support of an expert. For this, the expert narrows down the perception distance to be assumed in the given case. If necessary, complex tests must be carried out for this at the accident site in the same light and visibility conditions. The crucial questions are then: Did the driver react in time or too late? Would they have been able to stop in time if they had reacted quicker at the same speed? How slow would they have to have been driving to be able to stop in time? Experts use precise kinematic calculations with clearly defined parameters (figure 16) to calculate the stopping distances. The figures are assumed to be right for the respective case and can therefore also be understood by other experts.

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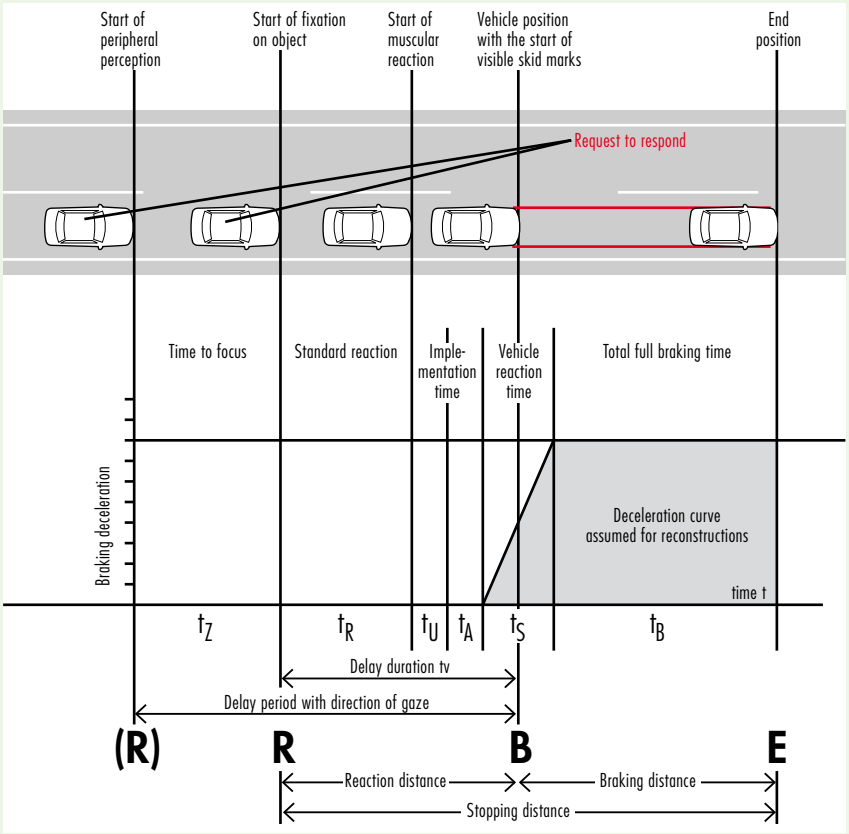
Diagram of reaction and stopping process when emergency braking using the example of a pedestrian accident



Source: Dettinger, 2008

Standard values from accident reconstruction practice are the full breaking deceleration between 6.5 and 7.5 m/s² and delay periods between 0.6 and 1.3 seconds. With this the stopping distance is between 68 and 95 metres with an initial speed of 100 km/h. If the perception distance is 70 metres for example, it is almost impossible to stop in front of a person with a driving speed of 100 km/h. On the other hand, if you are driving at 70 km/h, as is often stipulated by road signs on rural roads near junctions, the stopping distance is between 37 and 54 metres with the aforementioned assumptions. This is not a guarantee for safe driving in the dark, especially with difficult visibility conditions of 30 metres.

In order to be able to see as far as possible at higher speeds on rural roads full beam should always be used in the dark, if the situation allows. With this the headlamps' ranges are generally 200 metres or more. However, it is rarely possible to drive with full beam on in heavy traffic. Many car drivers completely do without full beam for convenience. This is to the detriment of safety. Full beam assistants are helpful. They automatically turn on and off depending on the traffic situation in front of the vehicle detected by a sensor.

Further advanced systems have a swivelling range of illumination. In the process, the dipped beam's range is gradually increased to full beam using a variable glare slide in the headlamp subject to the distance to other road users. Another alternative is the so-called glare-free full beam. Here the areas in which the system has detected other road users that might be

subject to glare are masked using a variable glare slide in the distribution of the automatically activated full beam.

However, even with these kinds of onboard assistants the driver always has overall responsibility. They have to manually switch to dipped beam if the system does not detect pedestrians, cyclists or oncoming traffic appearing on hills or if it reacts too late. Otherwise other road users are exposed to the glare from the full beam being turned on. Solving the conflict between good visibility and glare for other road users is often not easy. If visibility is poor and the conditions are complex, there is always one safe alternative: slow down! Dynamic directional headlamps are also helpful. They can increase the range of vision in bends by up to 80 percent (figure 17). This is associated with huge safety benefits on rural roads in particular.

LESS FATALITIES IN THE DARK

Vehicles whose headlamps are misaligned or even defective are particularly noticeable during the dark months. As the results of the periodical technical monitoring and voluntary light tests carried out regularly every year in Germany under the patronage of the Deutsche Verkehrswacht and ZDK show, the percentage of vehicles that are on

Road safety inspections help to prevent accidents from the outset

Univ. Prof. DI Dr. Ernst Pfleger, CEO viewpoint Blickforschung-Sicherheitsforschung GmbH, Academic Director of EPIGUS Institut für ganzheitliche Unfall- und Sicherheitsforschung, Vienna, Austria

"Carrying out road safety inspections (RSI) on roads with public transport using eye tracking is currently the most modern form of road safety work. The analyses aim to identify and analyse weaknesses in the existing road network in order to prevent accidents and reduce the number of accidents and lessen the consequence of accidents. A RSI can be introduced at accident blackspots, at spots with a particularly diverse structure of accident types, with safety deficits, potential hazards or similar accidents over longer stretches of safe roads (sections longer than 250 metres, periods longer than three years) as well as on the basis of indications, serious deficits and other information as the situation demands. A technical road safety, physiological and psychological perception scan is carried out during the viewpointsystem® analysis.

There is evidence that directions of gaze have an order of priority based on colours, shapes, contrasts and movements on roads. This means that an information overload and perception deficits can generally be assumed in practice for road traffic relevant contexts. Many accidents can be explained in these contexts. RSI with view analysis highlight these causes and therefore guarantee an overall view of the human/road/vehicle system, the disclosure and analysis of risks specific to accidents, analysis of how information is displayed, processed and absorbed in road traffic (visibility and comprehensibility), analysis of the uniformity and homogeneity of the road layout and interactions between the environment and driving behaviour.

RSI should therefore not only be carried out regularly on high-ranking TEN roads (roads that have the lowest risk of accidents) as previously but on all roads, in particular also secondary rural roads with a high percentage of road accidents with personal injury, as they offer great improvement potential for road safety work."

Daytime running lights increase safety

According to an EU Directive all new car and van types must be fitted with daytime running lamps from 7th February 2011 and all new commercial vehicle types from 7th August 2012. There is no retrofitting obligation for older vehicles. Daytime running lights are additional lighting that is usually integrated into the front spoiler or into the vehicle's headlamps. These front lights automatically turn on once the engine is started. The vehicle is therefore more visible for other road users, in particular in avenues, street canyons and on rural roads with changeable light conditions.

The proposal that all vehicles should also drive with lights on during the daytime has been discussed for many years nationally and internationally. According to a study by the Federal Highway Research Institute (BASt), a significant improvement in road safety could be expected in Germany with the mandatory introduction of this road safety measure. Decreases in accidents are on a scale of over three percent. The fear that disadvantages may on the other hand result for weaker road users, specifically motorcyclists and that their probability of an accident rises, could not be substantiated by this study.

The Dutch Institute for Road Safety Research (SWOV) also carried out a study on the safety effects of driving with lights on in the daytime for the EU Commission. Based on this, 5,500 fatalities and 155,000 people with injuries could be prevented across Europe every year.

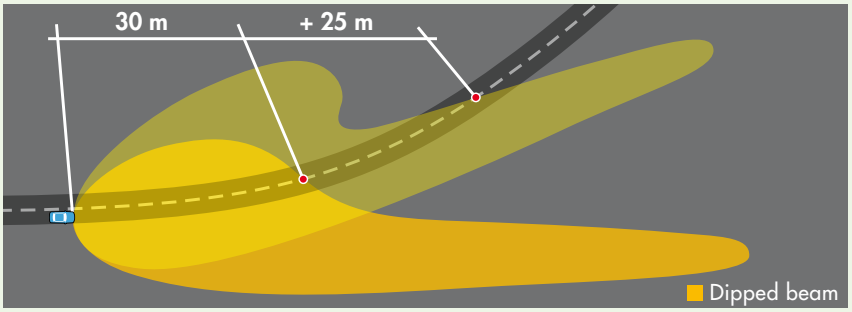
The daytime running lights obligation was already introduced in Sweden in 1977. The result was extremely positive, as a study published by the National Road & Traffic Research in Linköping in 1981 shows: There were ten percent less accidents caused by frontal impact, nine percent less accidents due to side impact, two percent less accidents in the same direction of travel (overtaking manoeuvres), 21 percent less accidents between cars and two-wheelers and 17 percent less accidents between motor vehicles and pedestrians.

However, besides the obvious gain in safety, there is a problematic issue associated with daytime running lights: the activated daytime running lights are often the only lights on for too long, for example as dusk advances, with a sudden deterioration in visibility, for example due to heavy rain or snow or when entering an underpass or tunnel. Under certain conditions these may cause glare, they are also unsuitable for lighting up the road and ultimately the vehicle is then generally on the road without any rear lights.

Based on a study by the BASt from 2005, the German delegation at the ECE in Geneva has been campaigning for a so-called twilight switch for a long time for this reason. It ensures automatic switching to dipped beam and the turning on of all other statutory lights in the event of low ambient brightness. As this kind of regulation could not be agreed by a majority for many years, it was only adopted into ECE Regulation No. 48 (amendment series 05) about the installation of lighting and light-signalling devices in 2011. In compliance with these transitional regulations, a twilight switch is now specified for new vehicle types that are homologised from 2016 according to ECE-R 48.

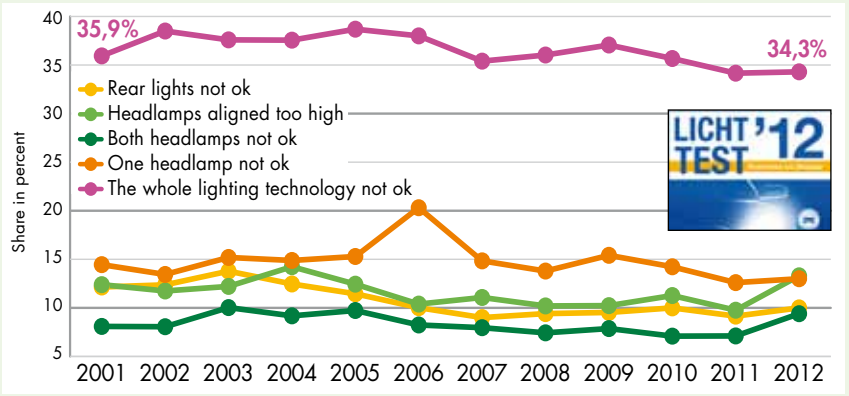
Accidents involving game are the most frequent cause of damage in reported insurance cases in Germany.

17
Increasing the range of vision using dynamic directional headlamps



Source: Daimer AG

18
Percentage of faults during voluntary light test for cars in Germany from 2001 to 2012



Source: ZDK and DVW

the road with lighting defects is constantly over 30 percent (figure 18). When driving on rural roads this reduces your own field of vision, makes it more difficult for your own vehicle to be seen and increases glare for oncoming traffic. As a result, other road users become irritated when a dual-track vehicle is on the road in the dark with only one headlamp working.

The drop in the percentage of fatalities in road traffic at night is consistent with the constant improvements to the dipped beam's range. In 1998, 38.2 percent of the 5,081 road users killed in accidents outside built-up areas not on motorways in Germany lost their lives during the hours of darkness (figure 19). In 2011, there were "just" 28.8 percent of 2,441 fatalities. However, there is even more potential for future improvements.

FOCUS WHEN DRIVING AT NIGHT

It is not uncommon for car drivers to look into the headlamps' beam of oncoming vehicles in the dark. As a result of this the glare and the time in which you could find it more difficult to recognise hard to see objects in the dark on unlit roads becomes even longer and thus more dangerous. Your direction of gaze being attracted to the light is a physiological reaction but is very dangerous especially on rural roads in the dark. Car drivers would therefore have

to actively stop and force themselves not to look in the direction of oncoming traffic and into the headlamps' beam. In fact, they would have to literally search the dark right hand area of the road in front of their vehicle to see if pedestrians, cyclists or unlit or difficult to see objects are there.

We find the glare from oncoming traffic more unpleasant on rural roads than on motorways. This is linked to the lateral distance of the light source from the driver's line of sight. The smaller the distance, the stronger the glare effect. This is especially the case on rural roads. The lanes are wider on motorways, there are several lanes in each direction and there are also central reservations. On rural roads it helps (slightly) to deliberately direct your gaze towards the right hand edge of the road.

Oncoming vehicles with xenon lights are often perceived as being particularly unpleasant and glaring because they have a very white almost blue-like colour. This impression is reinforced if the headlamps' light beam area is very small. Xenon headlamps, which distribute the light over a larger surface, are by contrast felt to be more pleasant. This so-called subjective

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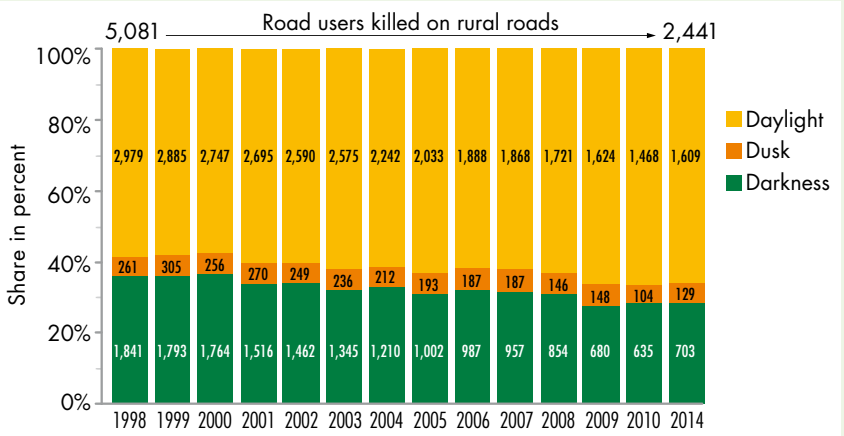
Trend of percentage of fatalities in darkness, at dusk or during daylight on roads outside built-up areas not on motorways in Germany from 1998 to 2011.



Year	1998	2011
Percentage of fatalities in daylight	58.6%	65.9%
Percentage of fatalities at dusk	5.1%	5.3%
Percentage of fatalities in darkness	38.2%	28.8%

Data source: Federal Statistics Office

Accidents involving game

According to information from the German Insurance Industry Association (GDV) accidents involving game are the most frequent cause of damage in reported insurance cases. Between 200,000 and 250,000 accidents involving game are recorded in Germany every year. For the animals the collisions usually end fatally. In 2011, roughly half a million animals were killed on German roads, 20 people died in the process and roughly 2,500 were in part seriously injured. What is interesting in this context, are the results of a DEKRA survey, which was carried out on the topic of "Safety on rural roads" at branches nationally in January/February 2013. According to this, 72.2 percent of the car drivers surveyed most fear game crossing roads.

Discussions about the best option to prevent accidents involving game have been around for a long time. Insurance companies' accident research analysed over 5,000 accidents involving game in a project over several years and compared the individual methods for preventing accidents involving game in before and after comparisons. So far odour barriers, visual and acoustic reflectors, cutting back hedges and bushes at the side of the road and putting up "Game crossing" warning signs have been recommended. A surprising result: none of these measures effectively and sustainably reduces accidents involving game.

The research area was the Oberbergische District, where all 5,000 accidents involving game documented by the police were analysed using the EUSKA electronic accident type map. The different methods for preventing accidents involving game were tested on six stretches of road over three years each in before and after comparisons and the results were compared with 37 control stretches of road. Spread over the year, there were peaks in accidents involving game on average over several years in May, October and November, the deviations between the months were relatively low though. Most accidents involving game happened in the morning between 5 and 8 am as well as in the evening or at night between 7 pm and midnight. In 80 percent of all accidents involving game, the car collided with a deer, in 10 percent with a wild boar.

Accident researchers see possible measures to prevent accidents involving game as being, among other things, to improve the existing guard rails, to check existing wildlife fences, the use or testing of game warning reflectors as well as aluminium strips on trees and posts, stationary speed checks and the use of variable message signs.

Driver assistant systems might also play an important part in preventing accidents involving game in future. For example, the "BMW Night Vision" system is also supposed to have animal recognition from the summer of 2013. According to information from BMW, an infrared thermal imaging camera recognises whether it is a person or animal from a distance of roughly 100 metres through the thermal radiation emitted by objects using pattern recognition. If the assistant system's control device analyses a risk of impact with animal recognition, just like with person recognition, a real-time video image in the control display warns you of this. A symbol of a deer also appears in the head-up display, jumping to the left or right depending on the situation. In addition, "dynamic light spots" start to deliberately flash the animal. The high frequency at the start is supposed to grab the driver's attention.

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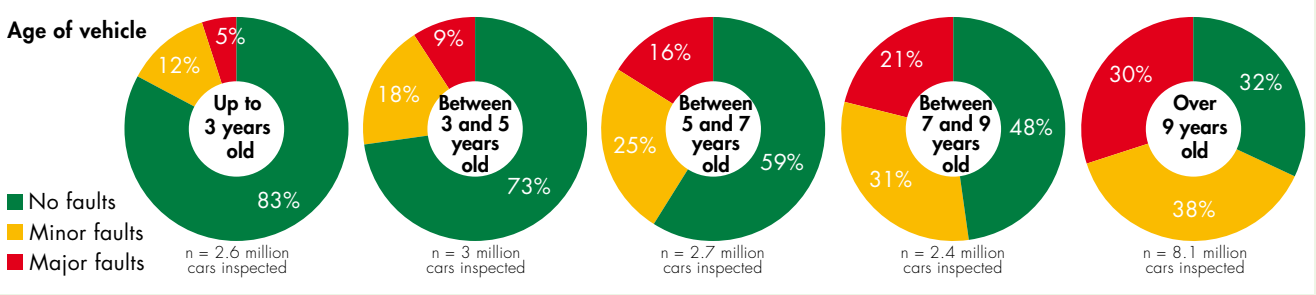
Results of vehicle inspections in 2011



Source: KBA

glare does not reduce the perception distance to unlit or poorly lit objects but is a perceived sense of comfort. The slightly yellowy light from halogen headlamps is also perceived to be more pleasant.

However, the situation is less favourable in terms of the lens on wet roads, as xenon headlamps reflect significantly more amounts of light towards the observer over the heavily reflective wet surface in front of the vehicle and increase glare from the lens. It can therefore be recommended that with a lack of lighting on rural roads you should stick to a speed that is significantly below the maximum permissible speed of 100 km/h. This takes into account the fact that unlit objects are often only recognisable from a distance of 30 to 40 metres. In this way you have the chance of being able to stop in front of objects or if applicable people at-risk.

TECHNICAL FAULTS AS A CAUSE OF ACCIDENTS

Technical faults are ranked far behind the other prevailing causes of accidents on rural roads. Nevertheless, they must not be swept under the table. The fact that technical faults hardly ever appear as a possible cause of accidents in official statistics is down to the police procedure for recording accidents. This includes, among other things, objective facts like collecting information from those involved or injured, as well as forensics including photos and individual assessments by the officers recording the accident. After recording the accident, the police officer produces a traffic accident report, in which the important information about the accident is stored.

Information about the causes of the accident is an initial assessment made by a police officer. It is based on the information the police officer has shortly after the accident and their own experience. The accident report is usually produced within 24 hours of the accident. Changes are only made to the accident report in terms of people who subsequently die and the blood alcohol level reading from the hospital. Findings about technical faults that caused the accident from accident reconstruction expertise are only entered

Eliminating danger spots and establishing safer speeds

Fred Wegman,
Institute for Road Safety Research SWOV,
the Netherlands

"A third of all fatal accidents on Dutch roads are accidents caused by lane departure (study period 2005–2009). For this reason, the SWOV road safety institute carried out a detailed study of 28 accidents, where a vehicle had drifted out of the lane on a rural road to analyse the characteristics, individual scenarios and possible measures to prevent these accidents (Davidse et al., 2011). Roughly half of these accidents happened on roads with a 80 km/h speed limit. With approximately ten percent of the accidents a vehicle left its lane and collided with an oncoming vehicle when the driver tried to steer the vehicle onto the road again. Eight percent of occupants suffered fatal injuries, 15 percent serious injuries (MAIS 2+). The worst injuries were established with accidents where the vehicle collided with an obstacle or landed in water. It was obvious that these kinds of obstacles (for example a tree or lamppost) were located in an area that should actually be free of obstacles. Roads users should have the chance to stop safely in normal conditions in this obstacle-free area. Therefore there should not be any obstacles in this area.

The analysed accidents caused by lane departure were broken down into four sub-categories: risky driving behaviour (e.g. speeding), inability to respond quickly (e.g. tiredness), distraction and swerving manoeuvres (e.g. unexpected traffic incident). Several factors promoting accidents were established: general factors (e.g. wet roads), human factors (e.g. new drivers), vehicle factors (e.g. tyres) and road factors (e.g. no surfaced hard shoulders). Various measures can be taken to prevent accidents caused by lane departure and to reduce the severity of the consequences. As is expected, the most effective are rumble strips cut in to the hard shoulders as well as a sufficiently wide obstacle-free area. Another study (van Petegem, 2012) came to the conclusion that 50 percent of accidents caused by lane departure on rural roads in the Netherlands could be prevented by a one to two metre area next to the rural roads, if this area was set up on all roads in the Netherlands.

The accidents caused by lane departure analysed in the detailed study usually happened on stretches of road between two junctions and only one vehicle was generally involved in the accident. Accidents at junctions on rural roads with an 80 km/h speed limit were often side collisions with other road users. Of the people fatally injured at junctions, roughly 40 percent were car drivers and 30 percent were cyclists. According to Tingvall & Haworth (1999) effective measures are the elimination of danger spots and the establishment of safe speeds. These measures were also adopted into the Dutch "Sustainable Safety" concept (Wegman & Aarts, 2006)."

Speed limits because of poor road conditions can also be a temporary emergency measure.

into the accident report retrospectively in exceptional cases. Added to this, technical faults can only be identified to a limited extent on vehicles at the accident site by the police, as they are often only visible once the assemblies have been taken apart. This is one explanation for why roughly 50 percent of all technical faults recorded in the statistics that caused accidents were detected on two-wheelers.

What is remarkable is that according to official statistics for 2011 in Germany, just under 64 percent of all technical faults relevant to accidents, i.e. 1,199 out of 1,879, were established outside built-up areas (including motorways). For cars, the most frequently mentioned faults were tyres in 718 cases and brakes in 97 cases. 21 people in total lost their lives due to technical faults on cars in 2011, according to official statistics. DEKRA has analysed the available expertise from accidents in the period from 2002 to 2011 in order to be able to carry out a more accurate differentiation based on rural roads and motorways. According to this, 52 percent of all technical faults relevant to accidents were recorded on rural roads in this period.

VEHICLE INSPECTION REVEALS FAULTS RELEVANT TO SAFETY

A high degree of road safety is only possible if vehicles are in a good technical condition and this is also regularly checked. During the vehicle inspection, testers therefore inspect the brake and steering systems as well as the lighting systems, axles, wheels and tyres, suspension, chassis, frame and structure, to name just a few examples.

How important this periodic test is, is clear when you look at the results of the vehicle inspections carried out in 2011 (figure 20) in Germany. If you take all the cars together, faults were established in 48 percent according to information from the Federal Motor Transport Authority.

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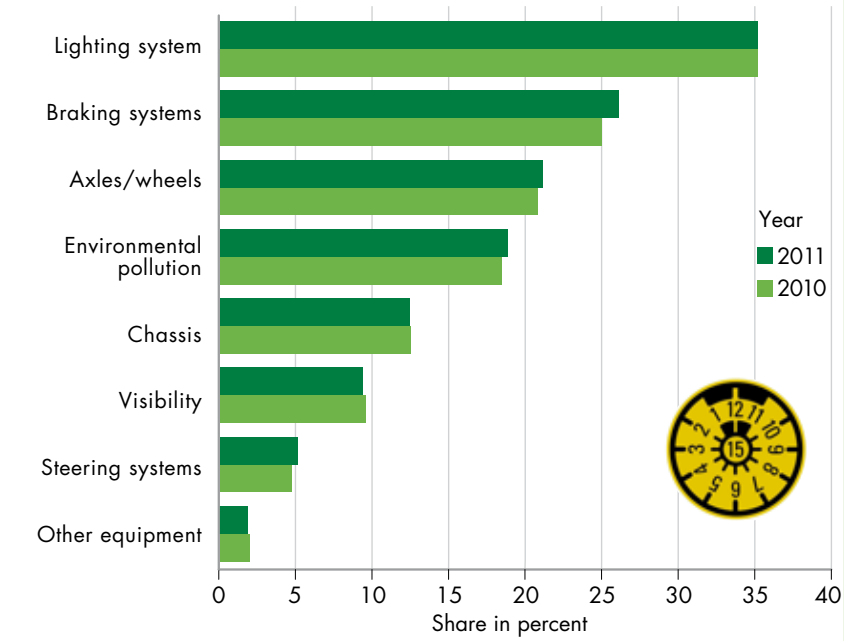
Vehicle inspections 2011: cars based on type of faults



Source: KBA

National programme for better road safety

"Road safety on Poland's roads has significantly improved over the last few years. In 1994, 6,744 people lost their lives in accidents, in 2012 it was "just" 3,557. At the same time the number of vehicles on the roads in 1994 was almost half that in 2012. As well as all the human suffering, huge costs also result from road accidents. These are estimated to be more than 30 billion zloty in Poland alone. The national programme for road safety ("Narodowy Program Bezpieczenstwa Ruchu Drogowego 2013–2020")was initiated with the involvement of the police for all these reasons. DEKRA Polska is also involved in this programme. It has two main aims: firstly to reduce the number of deaths caused by road accidents by at least 50 percent by 2020, secondly to lower the number of serious injuries by at least 40 percent by 2020. These aims are to be achieved by road users behaving more prudently, a safe road infrastructure, adapted speed and an improved emergency rescue system."

Inspector Marek Konkolewski, Advisor at the Office for Road Traffic at the Police Headquarters in Warsaw, Poland

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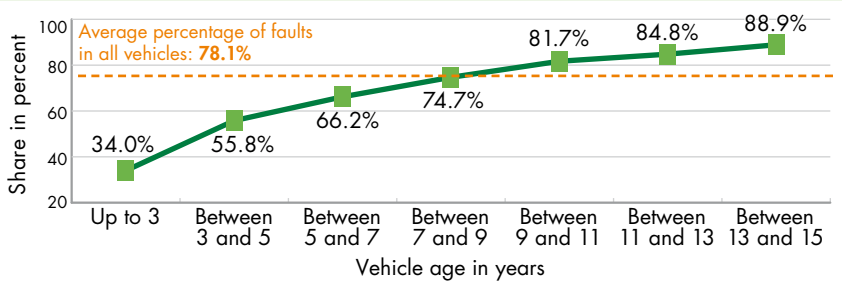
Trend of percentage of faults depending on age of vehicle at SafetyCheck 2012



Source: SafetyCheck 2012 final report

28 percent of vehicles have minor faults, 20 percent even have major faults. Vehicles up to three years old had roughly 17 percent of faults, vehicles over five to seven years old had 41 percent. Vehicles over nine years old came to a failure rate of 68 percent, 30 percent in this group even have major faults.

Lighting systems ranked first among the faults with 35 percent and brakes ranked second with 26 percent. Faults on axles with wheels and tyres also ranked high in this negative ranking list with over 20 percent (figure 21). Whilst experts criticised faults in lighting systems in roughly nine percent of cases with vehicles up to three years old, this percentage increased to 48 percent with vehicles over nine years old. This sharp increase is consistent throughout all assemblies. Which shows: the older the vehicle is, the more faults it has on average.

"SAFETYCHECK" PROVES HIGH FAILURE RATE IN OLDER VEHICLES

The fact that specifically young drivers' cars are still on the road with in part serious safety faults, is also clearly proved by the "SafetyCheck" that has been carried out for years by DEKRA, the Deutsche Verkehrswacht and the German Road Safety Council. Experts had to reject four out of five cars in 2012. Almost 38,000 faults were established on the roughly 15,000 cars tested nationwide. The number of faults per rejected vehicle was 3.3, just under the figure from 2011. The inspected vehicles were 11.3 years old on average and had 130,300 kilometres on the clock on average. The cars were therefore on average 2.8 years older than the

Rural road design and the severity of injuries

Prof. Dietmar Otte, Head of Road Traffic Accident Research at the Medical University of Hannover

"1,575 accidents with personal injury on rural roads were analysed as part of a study from accident records in Hannover. It showed that the road design has a significant impact on the severity of injuries in accidents. On roads with a construction separating lanes, 42 percent of the impact objects were guard rails in single vehicle accidents, although there was a low risk of the car overturning and therefore also a low risk of severe injuries. By contrast, 70 percent of impact objects on single carriageway roads in single vehicle accidents were trees with the consequence of particularly severe injuries.

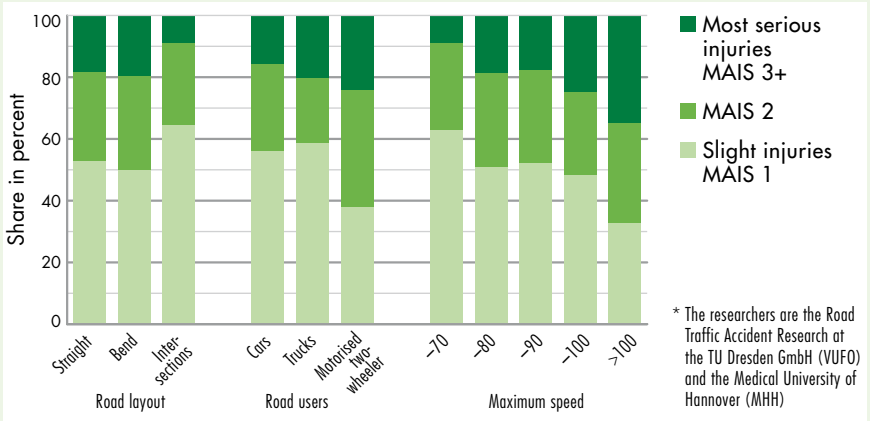
Trees that cars collided with were often right next to the road, 65 percent were up to two metres away from the edge of the road. Only roughly a quarter of accidents on rural roads happened at spots with trees. However, from the people that were killed on rural roads, 35 percent collided with a tree. A ditch at the side of the road proved to be a protection zone, if it did not have a bridge across it. Collisions at the side of the road are basically not as serious if trees or ditch bridges do not suddenly stop the vehicle's exiting movement.

The most serious injuries are always observed when cars collide with each other in oncoming traffic. These are often on single carriageway roads, combined with overtaking manoeuvres. Besides speeding, alcohol is frequently an influential factor in accidents, particularly with accidents in the dark at night.

Human error characterises accidents on rural roads, in particular speeding or inappropriate speed influence accidents, above all in bad weather with wet or icy roads. Accident prevention measures seem to particularly lie in influencing speed when analysing accidents on rural roads. However, these must also consist of psychologically effective measures by road design, for example by changing the appearance of a rural road's layout and environment. As there is clearly a higher level of collision speeds on roads with multiple carriageways and a very straight course.

Accidents on rural roads (n = 2,304)

The Hannover and Dresden accident surveys*, which collect roughly 2,000 road accidents with personal injury using statistical representative sampling design every year as part of the GIDAS (German In-Depth Accident Study) on behalf of the Federal Highway Research Institute and the German Research Association for the Automobile Industry FAT provide a detailed observation of accidents on rural roads.



* The researchers are the Road Traffic Accident Research at the TU Dresden GmbH (VUFO) and the Medical University of Hannover (MHH)

Source: GIDAS

car fleet as a whole in Germany; the average age is currently 8.5 years. 71 percent of young adults arrived at the SafetyCheck in a car that was aged 8 years or older.

50 percent of all vehicles had faults to do with the chassis, wheels/tyres and the car body, 46 percent to do with lights, electrics and electronics, 38 percent to do with braking systems, 33 percent to do with safety and the environment and 18 percent to do with visibility. 2012 once again clearly showed that the percentage of faults rapidly increases the older the vehicles are (figures 22 and 23). For example, the percentage of vehicles with faults in cars aged up to 3 years was 35 percent. With cars aged seven to nine years, it was 75 percent and with cars aged 13 to 15 years it reached an all-time high of 89 percent.

As far as equipment with electronically controlled safety systems, such as ABS, airbags or ESP / ASR is concerned, the younger drivers' older cars are still way behind new vehicles. However, it is evident that the installation rate in vehicles that are brought to the SafetyCheck is increasing from year to year. At first glance this is pleasing. However, to have any real safety benefits, the systems should also work reliably. Eleven percent of the ESP /ASR systems and roughly 3 percent of the airbags and antilock braking systems had to be rejected at the SafetyCheck in 2012 though.

This shows that there is still a significant need for improvement in this area. Raising the awareness of young drivers about the risk of technical faults on their cars therefore still remains an important task. Younger drivers are very frequently on the road in older vehicles mainly due to financial reasons. However, age, wear and a lack of awareness for technical faults as well as saving on repairs and maintenance lead to older cars having major faults considerably more often than newer vehicles. And that can have fatal consequences in serious cases.

It is clear: the condition of the brakes, chassis, tyres and lights are crucial as to whether the occupants arrive at their destination safely in one piece. This particularly applies on rural roads with the risks already mentioned several times, such as higher speeds or differences in speed between various road users, varying quality in road surfaces and oncoming or crossing traffic.

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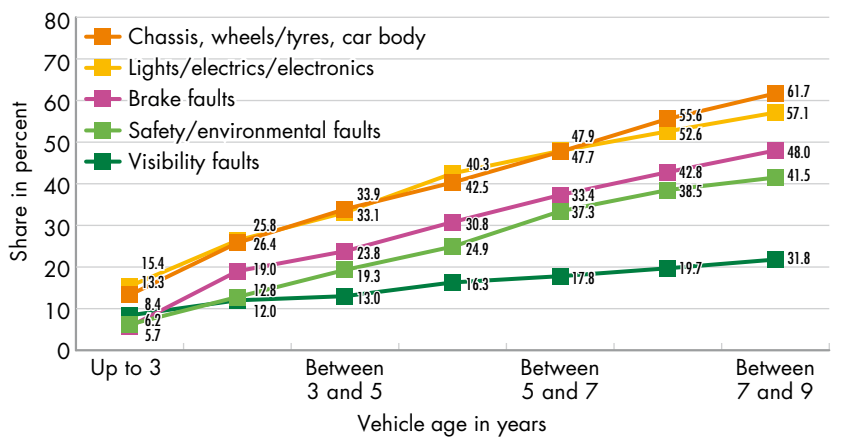
Percentage of faults based on assemblies and age of vehicle at SafetyCheck 2012



Source: SafetyCheck 2012 final report

Accident prevention on rural roads – British Department of Transport advice and guidelines

"The Department of Transport's analysis of collision and casualty data shows that 66% of all fatal road accidents in Great Britain happened on rural roads in 2011, although only around 42% of the distance travelled was on these. With car occupant deaths in particular, it was even 82%. Of all road deaths in Britain, 35% occurred on National Speed Limit rural single carriageway roads. These percentages have remained roughly consistent for historic data back to 2005. Confirmation of the risk on rural roads also comes from the independent assessment of the UK's roads by EuroRAP (European Road Assessment Programme). This shows that the ten roads with the highest risk are all main single carriageway A roads.

The majority of rural roads in Great Britain are under the control of Local Highways Authorities (LHAs) and with this in mind the Department publishes advice and guidance for LHAs. New tools to assist LHAs to improve their road safety are also going online in 2013:

- Various data elements are summarised on the English Local Highways Authority Comparison Site with which LHAs can improve road safety performance (road length, road safety spend, traffic levels and population as well as collision and casualty data). The data is presented in a way that helps them identify where they have outstanding safety performance issues.
- In response to requests from the road safety industry, the Road Safety Observatory publishes an independent source of syntheses of road safety research in a plain English and understandable format. The site's independence from the government will ensure that evidence is presented without any influence from government policy.
- In the Strategic Framework for Road Safety we announced that we would provide a tool to help local authorities to assess the full costs and benefits of proposed schemes.
- The Speed Limit Appraisal Tool, which will be available on the DfT website, is under development.

As new research and evidence informs the road safety community of developments, appropriate changes are made to existing legislation. For example, there is evidence that the 40 mph (roughly 64 km/h) speed limit for heavy goods vehicles (HGVs) on single carriageway roads, brought in to limit the potential damage from an HGV collision, may lead to frustration in those vehicles not subject to that speed limit (maximum speed limit of 60 mph for cars = roughly 97 km/h allowed). This frustration then often manifests itself in dangerous overtaking manoeuvres. The Department therefore currently has an open consultation with a view to seeking opinion about increasing the truck speed limit. The consultation closes on 1st February 2013.

These examples alone demonstrate that the Department recognises the higher risks associated with rural roads and will continue to do all it can to help local highways authorities address those risks."

Department for Transport

Compelling examples of accidents in detail

1 Skid marks from the car that caused the accident

2 Marks in the crash site area

3 Damage to the vehicle that caused the accident

4 Damage to the other vehicle involved in the accident

5 Vehicles in their final accident position

Example 1 – Speeding

DRIVING INTO A MOVING VEHICLE

Accident circumstances:
The accident happened on a well developed main road with regional importance near a long elongated right-hand bend. A secondary rural road merges with an acceleration lane here, the two opposing lanes are marked by beacons in the middle between the two solid dividing lines. The permissible speed is limited to 70 km/h by a road sign in the junction area.

A VW Golf driving on the main road with right of way was approaching at a speed of 140 to 160 km/h and skidded in the bend. As a result of this, the car ended up in the acceleration lane and crashed into an Opel Astra entering the road.

The accident happened during the daytime, the road was dry with a good grip.

Involved parties:
Two cars

Consequences of the accident/injuries:
Both cars overturned in the accident and ended up on their roof. The occupants of both cars were in part seriously injured.

Cause/problem:
With the considerable speeding of the car that caused the accident and without the ESP dynamic driving system, the unstable driving situation that resulted in the bend was no longer in the driver's control.

Prevention options/
approach for road safety measures:
The road layout and junction are clearly marked and easy to see. The lanes for oncoming traffic are clearly marked by a double line as well as beacons set up in-between.

There was no human error established by the driver of the Opel entering the road. The driver of the skidding car would have been able to avoid the accident without any difficulties had they complied with the permissible speed limit. The actual speed was blatantly excessive. However, it is not the cause for the unstable driving situation.

The consequences of sharp steering movements could have been lessened by an ESP dynamic driving system, which would have made a contribution to stabilising the critical driving motion possible.

Example 2 – Lane departure

SKIDDING INTO ONCOMING TRAFFIC

Accident circumstances:
The accident site is on a district road. An 80 metre long bend (radius 225 metres) ends approximately 60 metres before the subsequent crash site. The road surface consists of asphalt concrete that was dry at the time of the accident. The maximum permissible speed is 100 km/h.

A VW ended up on the opposite lane after exiting a long bend and glanced off the rear end of a Suzuki. As a consequence the vehicle started to skid. It then hit the front of an oncoming Smart car in the opposite lane with the right-hand side of its vehicle.

Tyre marks running in the VW's direction of travel start from the right-hand lane to the left-hand lane and then go over into the soft shoulder on the left next to the road. From the position of the marks it can clearly be derived that the VW entered the opposite lane after the bend and collided into the two other vehicles there.

Involved parties:
Three cars

Consequences of the accident/injuries:
The occupants of both cars that collided in oncoming traffic were seriously injured.

Cause/problem:
Technical faults relevant to the accident were not established on the VW, there was also no evidence of speeding.

Prevention options/
approach for road safety measures:
Staying in the right-hand lane would have been possible for the driver that caused the accident through concentrated and cautious driving.

Lane departure warning systems (LDW) can contribute to announcing the critical departure from your own lane in good time to initiate countermeasures.

Dividing the lanes would be ideal to counteract collisions in oncoming traffic.

1 Road layout in the area of the accident site
2 Final position the vehicles were found in
3 Rear end damage to the vehicle involved in the accident
4 Impact site on the rear right-hand side of the skidding vehicle
5 Reconstructed accident position

1 Road layout and track marks in the motorcycle's direction of travel
2 Motorcycle's final position in accident between the tree and guard rail
3 Motorcycle damaged in accident

Example 3 – Motorcycle – Tree

SINGLE VEHICLE MOTORCYCLE ACCIDENT

Accident circumstances:
The motorcyclist was travelling in a right-hand bend that follows a left-hand bend after a short straight section on a rural road at about 5 am (dawn). The bitumen surface of the five metre wide lane was dry, there were no visibility problems and the speed was limited to 70 km/h by road signs. Several trees line both sides of the road in the nature of a short avenue, where guard rails are also installed. The motorcyclist braked heavily at the start of the left-hand bend. Tyre marks of varying intensity on the road indicate that the brake was then released several times. The motorcycle tilted to the left. Dark impact marks, which can be allocated to the motorcyclist's left knee, document hitting the road. Subsequently, the motorcycle and motorcyclist slid to the outside of the bend and under the guard rail separately from each other. As a result, the motorcycle crashed into a tree. The motorcyclist impacted against a guard rail post with his helmeted head and was then flung onto the road again where he came to his final position.

Involved parties:
Motorcycle

Consequences of the accident/injuries:
The motorcyclist was fatally injured.

Cause/problem:
Obviously the motorcycle's was speeding so that heavy braking had to be initiated when driving through the combination of bends. Despite interrupting the braking several times, the motorcyclist could not prevent tilting to the left-hand side. This is typical for overbraking the rear wheel with the given road layout.

Prevention options/
approach for road safety measures:
The main cause can clearly be classified as speeding. If the motorcycle had been fitted with ABS, the overbraking of the rear wheel could have been prevented. It can no longer be assessed with a degree of certainty whether the accident could have been avoided then. The guard rail equipment with additional beam (Euskirchen sytem) would have been able to prevent the direct impact of the motorcyclist against the guard rail post. Guard rail post sheathing would have been able to dampen the head impact. Guard rails with additional beams are really the only effective protection for motorcycle accidents with trees at the edge of the road.

Example 4 – Ambulance – Tree

SINGLE VEHICLE AMBULANCE ACCIDENT

Accident circumstances:
The driver of an ambulance was driving on a straight rural road with slight climb following a gentle right-hand bend at about 7.35 am in daylight. The bitumen surface of the 5.3 metre wide lane was dry, there were no visibility problems and the speed was limited to 80 km/h by road signs. In this straight and stable drive, the vehicle gradually drifted from the surfaced road to the left and impacted head on with a tree at the start of an avenue. There were no tyre marks on the road and the tyre marks in the adjacent soft shoulder indicated instantaneous vehicle motion. The vehicle was crushed roughly 1.3 metres deep in the middle on impact.

Involved parties:
Ambulance

Consequences of the accident/injuries:
The driver was seriously injured. A passenger sitting behind the driver in the second row and another passenger sitting in a wheelchair also on the outside left were fatally injured. All occupants were wearing their seat belts or were secured correctly.

Cause/problem:
The slow lane departure without any counter-reaction by braking or steering indicates that the driver was distracted or fell asleep.

Prevention options/
approach for road safety measures:
As the road has a solid dividing line on both sides (sign 295 of the road traffic regulations), a lane departure warning system would definitely have been able to detect the lane departure and warn the driver. Without this kind of assistant system, a profiled dividing line would have been able to produce typical tyre rumbling noises to warn the driver. Guard rails would have definitely been able to prevent the vehicle from leaving the lane. The consequences of the accident would have been more minor without trees at the edge of the road.

1 Road layout in the ambulance's direction of travel
2, 3 Ambulance in its final accident position
4, 5 Damage to the front of the ambulance

1 *Brake marks from the overturned motorcycle*
2 *Run-out area and the motorcycle's final position*
3 *Tree stump that the motorcycle and motorcyclist hit*
4 *Rear wheel brake disc*
5 *Defective braking fluid container*
6 *Oily tyre due to damaged engine case*
7 *Final position of motorcycle at woodpile*

Example 5 – Technical fault

SINGLE VEHICLE MOTORCYCLE ACCIDENT

Accident circumstances:
The accident happened on a main road near a slight climb in front of a hill and left-hand bend. It was daylight, the road was dry with a good grip.

The motorcycle was stopped when entering the bend by the full braking of the rear axle braking system (brake locking mark in the direction of the edge of the road). As a result of this the vehicle slid to the left and left the surfaced road ending up in a green area. It crashed into a tree stump. The motorcyclist and vehicle ended up next to the road.

Involved parties:
Motorcycle

Consequences of the accident/injuries:
The motorcyclist died at the accident site.

Cause/problem:
The accident was caused by a technical fault: the front brake on the motorcycle was defective. The fluid container, which is in the driver's field of vision, was stuck with adhesive tape. The container's lid and the required braking fluid were missing.

Prevention options/
approach for road safety measures:
Refraining from operating a vehicle that is not roadworthy would have prevented the accident. The vehicle condition and technical fault were visible.

Although adapting the speed to the vehicle's technical condition would have prevented braking before the bend, the risk of having to suddenly brake would only have been prevented by repairing the vehicle though.

A guard rail with additional beam would have been able to prevent the lane departure and the violent impact against the tree stump.

Example 6 – Lane departure

FOUR INVOLVED PARTIES

Accident circumstances:
The accident involving four vehicles happened on a well developed main road.

A BMW moved left into the opposite lane and crashed into the oncoming Nissan first and then into the Ford C-Max behind it. The Ford Mondeo, which was driving on the main road in the same direction as the BMW then crashed into this car.

Scratch marks were identified on the road, which could be allocated to the violent impetus events on the opposite lane to the BMW. There were no brake marks relevant to the accident in the area of the accident site.

Involved parties:
Four cars

Consequences of the accident/injuries:
The BMW driver suffered fatal injuries in the accident.

The whole motor/gearbox/exhaust unit was torn out of the BMW. The front left axle and front wheel were torn off the Nissan. The other vehicles also had significant damage..

Cause/problem:
The actual cause for the BMW leaving the left-hand lane is unexplained. There were no faults found on the vehicle that would explain departure into the opposite lane.

Prevention options/
approach for road safety measures:
Lane departure to the left would have been avoided with more attentive driving. The accident was unavoidable for the other vehicle drivers involved.

Lane departure warning systems (LDW) would be ideal to signal lane departure in enough time to initiate countermeasures.

Dividing the lanes would have been able to prevent or at least moderate the collision with oncoming traffic in the event of a loss of control over the BMW.

1 Final positions of the vehicles involved in the accident
2 Nissan with torn off front left axle
3 Frontal damage to the vehicle that entered the accident site last
4 The driver in this vehicle was fatally injured.
5 The second vehicle in oncoming traffic
6 Overturned vehicle which the driver that caused the accident crashed into first Infrastructure

Daimler AG had concrete casts made of the road surface that was in such a poor state at four sections on a rural road in the Greater Stuttgart area between Friolzheim and Heimsheim in autumn 2011. Their aim was to copy every single bump, pothole and crumbling piece of tarmac as accurately as possible. Samples were then made at a ready-mixed concrete plant, which now serve as models for Daimler test tracks.

Efficiently defusing danger spots

Besides safety elements and measures specific to vehicles to reduce the risks resulting from road user error, improving the infrastructure also plays a very significant part in safety on rural roads. What is important here: maintenance and expansion specifically must not fail due to a lack of funds.

Rural roads are roads of diversity. The short link road between two districts in an urban conurbation counts just as much as the straight road over several kilometres, an avenue or mountain road full of bends. Their use is just as diverse as the roads. Besides a route for everyday passenger and goods transport, it is also a tourist attraction, recreational route, commuter route or simply your route for everyday errands. At the same time, a dream route for cyclists and motorcyclists and a nightmare for some truck drivers. The pleasure of cruising in a caravan becomes an annoyance to others who want to get to work quickly.

The diversity is also reflected in the development and condition of the roads though: on the one hand bumpy mogul fields with collections of potholes, cobbled avenues as well as single carriageway roads with few narrow passing places, on the other hand wide roads developed according to state of the art knowledge. Last but not least, there are various climatic influences that may influence the nature of rural roads. From Scandinavian permafrost soil, along Alpine rock faces with snow and rock fall or picturesque Mediterranean coasts with little shade on offer: With this breadth and the resulting specific dangers, the local features must be worked out to derive and implement suitable preventive measures.

Accident commissions, of which there are approx. 500 active nationwide (DVR 2009), can make a very positive contribution to this. The 2009/96/EC Directive on road infrastructure safety management is also aimed in this direction. As a result, the EU Commission sees infrastructure as being an important area of its policy to improve road safety. In doing so, it is not just about new building projects but specifically about the targeted increase in the safety level of existing roads. Accordingly the "2011 Road Safety Programme" from Germany also states: "The provision of a functional and efficient infrastructure is an important foundation to pave the way for safe road traffic. Factors that contribute to accidents must be eliminated by road construction and traffic regulating measures and danger spots must also be defused to the extent that the consequences are as minor as possible in the event of an accident."

DO NOT NEGLECT CONSTRUCTION AND MAINTENANCE MEASURES

In terms of infrastructure there are of course a few basic principles that apply equally to safety on all rural roads despite all the diversity. These concern the condition of the road surface, the predictability of the road layout, the recognisability of lanes, roadside design, lane markings, the design of junctions and intersections and creating possibilities for passing and overtaking.

Incidentally, the poor condition of roads has always been a reason to complain. For example, in the "Sächsischen Archivblatt" (issue 2-2012) there is an interesting article about the development of the Saxon Court's roads. In an electoral action against a Leisnig senior civil servant

in 1699 it says: "As we have to hear with a great amount of displeasure there are complaints almost every day about the terrible roads and paths throughout our electorate and lands and therefore our [...] directives regarding these are irresponsibly not given any priority" (Sächsisches Staatsarchiv, Staatsarchiv Leipzig, 20010 Amt Leisnig, No. 2299, Gazette 1).

Even if hardly any drivers get stuck in the rutted bogs of wet roads or cartwheels do not brake off in their dozens nowadays, the causes of poor roads are still the same: "...irregular road maintenance, unclear responsibilities, a lack of finance for road construction as well as sometimes ignorance towards electoral orders." Of course it is not possible to rebuild every dilapidated road or modernise it from scratch. However, significant safety benefits can be expected if all construction and maintenance works are planned, prioritised and implemented in terms of maximum safety.

An even road surface with good grip, also called a wearing course plays an important part. Inadequate friction values extend braking distances and increase the risk of losing directional control in bends or with swerving manoeuvres and therefore also the risk of skidding. Unevenness can lead to water collecting and thus also increase the risks of aquaplaning and black ice. They also lead to problems when clearing snow. This should also be paid attention to during repair work. For example, the use of bitumen to improve minor damage is effective and comparably cheap but the surface becomes extremely slippery when wet. The exit then quickly becomes a skating rink, especially for motorcyclists and cyclists.

BETTER ORIENTATION THANKS TO CLEARLY VISIBLE LANE MARKINGS

Besides the condition of the road surface, the recognisability of the road layout and individual lanes is very important in a whole range of different light and weather conditions. Classic lane markings, reflectors and marker posts provide guidance. There is a huge variety of design here in Europe, whereby this can also be traced back to local needs and traditions.

Be it yellow or white, lane marking is the most common method of highlighting the right way. Durability and a good grip are guaranteed thanks to its special composition. Visibility is also achieved in darkness and the wet by mixing in reflective elements. The side edge of the road is represented by a solid line, the individual lanes (directions) are separated by different types of lines if the lane width is sufficient for two lanes in one direction. However, over the course of time the lane markings wear out, flake away or have missing sections if road surface areas in need of repair are not remarked.

Despite their simple principle, lane markings are an important safety element on rural roads. They provide drivers with clear orientation. Active safety systems, for example lane keeping assistants, also rely on easily recognisable lane markings. It is therefore very surprising that some road maintenance authorities make cuts when it comes to maintaining these markings.

Road reflectors can be a very good addition to lane markings. These kinds of reflectors are installed directly on the lane marking line and supplemented by grooves, if applicable. The visibility of individual lanes is significantly improved, especially in rain. However, if used near lane dividing lines they can quickly become a dangerous bumpy track for motorcyclists. They are also easily damaged when using snow ploughs. The risk and benefit potential must be analysed here depending on the stretch.

SKIDDING RISK DUE TO DIFFERENCES IN LEVELS AT THE EDGE OF THE ROAD

Marker posts are an important safety device for recognising the road layout. Mounted at the edge of the road and equipped with reflectors, they highlight the road layout far in advance. The major advantages compared to cat's eyes are that they are also visible with a thick blanket of snow and therefore effective, they are damaged less often and do not require any intervention in the road surface. They also make it easier to estimate distances. A pilot project by the Saarland provincial road agency in November 2012, where the marker posts were removed on a six kilometre long stretch of the L 354 to save costs, failed due to objection from the public and road safety organisations and associations. The posts were reinstalled after a very short time.

If a vehicle leaves its lane towards the edge of the road, the quality of the soft or hard shoulder is crucial for the vehicle's further manoeuvrability in many cases. The soft shoulder is the area between the edge line and the actual edge of the road,

Danger spots specific to new drivers

Prof. Dr. Dietmar Sturzbecher, Head of the "Regio-Protect 21" project, University of Potsdam

"The team of the "Regio-Protect 21" project (regionalised protective new driver preparation in the 21st century) has made it its mission to identify regional accident black spots for new drivers (so-called danger spots specific to new drivers) and illustrate these graphically. The aim of the project is to raise the awareness of 18 to 24 year olds in terms of accident causes and risks typical to new drivers. The result should be to contribute to improving the abilities of new drivers to read the road and avoid accidents, before the phase of independent driving.

A number of experts have come together to realise this project jointly funded by the Federal State of Brandenburg's Ministry of Infrastructure and Agriculture and TUV I DEKRA arge tp21. Analysis and the graphical representation of accident data in Brandenburg was done in several work stages: the danger spots specific to new drivers were identified in individual Brandenburg districts and towns and stored with information about the accident causes and accident situations involving new drivers; this was also supplemented by videos. Finally the danger spot directories and teaching material for districts were produced for different target groups (for example, driving instructors, learner drivers, officially recognised experts, accident commissions). In doing so, it became clear that serious accidents involving new drivers predominantly happen outside built-up areas, for example on rural roads and avenues.

in 2012, the MIL commissioned an update and further development of the project content. Cooperation between the project team, representatives of the state accident commission, local accident commissions and Brandenburg's safety auditors was expanded in this context: a regular exchange of experiences and information has been taking place since then.

Looking at the "Regio-Protect 21" project as a whole, it can on the one hand promote the regionally specific, authentic design of driving school training, which teaches new drivers knowledge and attitudes for safe conduct on the road and specifically also on high-risk rural roads. On the other hand there is the possibility of also focusing the practical driving test more on local danger spots."

A sufficiently wide hard shoulder at the same height as the edge of the road ...

... reduces the risk of landing in a ditch in the event of lane departure.

the hard shoulder is the area next to this that does not have a wearing course.

If there is no soft shoulder, the wheels immediately leave the road after crossing the edge line. In doing so, the friction values change, there is also possibly a difference in level between the road surface and in many cases the lower lying hard shoulder. This makes it significantly more difficult to steer back onto the road. There is a major risk that inexperienced drivers will steer in too fast to overcome the difference in level and as soon as the vehicle reaches the road again there is an abrupt change in direction to the side of oncoming traffic, the risk of skidding is also high.

Wherever possible there should therefore be a soft shoulder width adapted to the speed limit and road layout. The adjacent hard shoulder should be adjusted to the level of the road and surfaced so that it remains at the same level even after longer periods of rainfall and being driven over by trucks.

On rural roads, you continually come across bends whose small radius cannot be recognised in advance, bends whose radius gets smaller and smaller and consecutive bends with significantly different radii. Other safety measures are required, as new construction is in most cases ruled out at least in the short to medium-term. "Dispersed directional signs" have particularly proved themselves. These red and white striped signs show the direction of the bend. A sensible configuration of distances between the individual signs makes the bend radius clear. This positive effect can be significantly enhanced in combination with a guard rail with beam on the outside of the bend. Strong contrasting lane marking is particularly important near bends. The announcement of the bend(s) in good time using suitable information signs supports these measures. An intact hard shoulder is also very important near bends.

ALMOST ONE IN FIVE DEATHS CAUSED BY ROAD ACCIDENTS ARE DUE TO COLLISIONS WITH TREES

The roadside design of rural roads plays an important part in both accident prevention and lessening the consequences of accidents. It provides the driver with initial orientation about how the road layout continues. At the same time, it influences the choice of speed, among other things. Discrepancies between the suggested and real road layout and condition must be avoided at all costs.

A controversial much discussed topic is that of plants at the roadside. An avenue is almost unbeatable in terms of displaying the road layout. However, trees next to the road, regardless of whether they are planted in a row, at the edge of a forest or are planted singly, pose a very high risk for road users in the event of impact. They are also visibility barriers. Wild animals can suddenly run out

The road condition is often fraught with risks on more minor rural roads.

from behind trees onto the road, junctions are seen too late and pedestrians and cyclists as well as other unlit vehicles are only visible much later due to the constant change between bright and dark light conditions. It goes without saying that felling countless trees along rural roads is not possible for various reasons. However, it is incomprehensible that young trees are being planted right next to rural roads time and time again. Such huge potential risks are produced for the aesthetic reasons of landscaping. In addition, the ecological benefits of a tree is in no way measured by the fact that it is right next to the road.

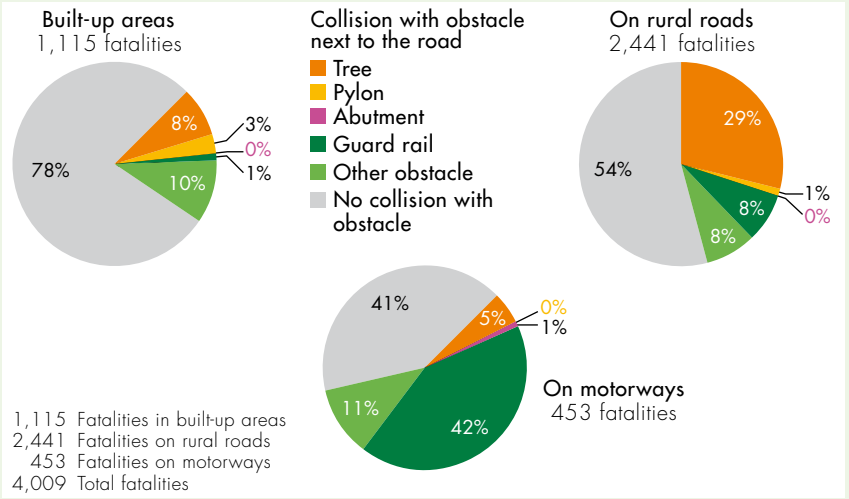
As already stated in the "Accidents" section, 714 people were killed by collisions with trees on rural roads in Germany in 2011 (figures 24 to 26). That is almost 30 percent of all fatalities on rural roads and just under 18 percent of all road users killed in road traffic. By comparison: According to information from the "Observatoire national interministériel de la sécurité routière" (ONISR), 357 people were killed by collision with trees on French rural roads in 2011 (= 12.5 percent of all fatalities on rural roads and nine percent of all road users killed in road traffic).

THE LIMITS AND POTENTIAL OF VEHICLE SAFETY

As far as car occupants are concerned, car body structures, cushioning of the interior and restraint systems, which include statutory seat belts since roughly the mid-1990s and the additional front and side airbags, can offer so-called all-round protection nowadays. However, compared to the front area, the side area of the passenger compartment only has limited possibilities to realise crumple zones to convert kinetic impact energy into deformation energy. Nevertheless, a certain protective effect could be realised through high-strength car body structures and side airbags in the hip, chest and head area of the driver and passengers. In the process, car developers are considering side impact against trees and similar post-like obstacles within the framework of regulations with technical viability at justifiable expense.

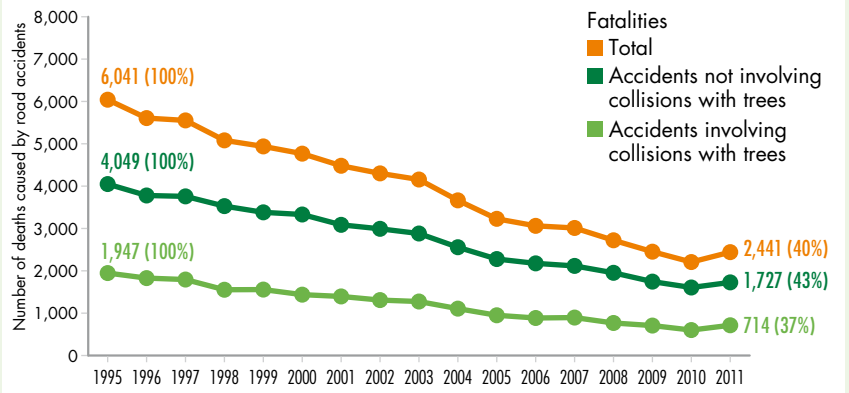
The crash tests carried out in this context include side impact against a fixed solid post with 254 mm diameter at an impact speed of 29 km/h according to Euro NCAP. Using the results of this post impact test, significant developmental progress can be established in current cars in terms of side impact compared to similar vehicle models that were new on the road in the 1980s and 1990s. However, it is to be expected that the limits of passive safety are quickly

24
Deaths caused by road accidents in Germany in 2011 due to collisions with obstacles next to the road, broken down according to locations



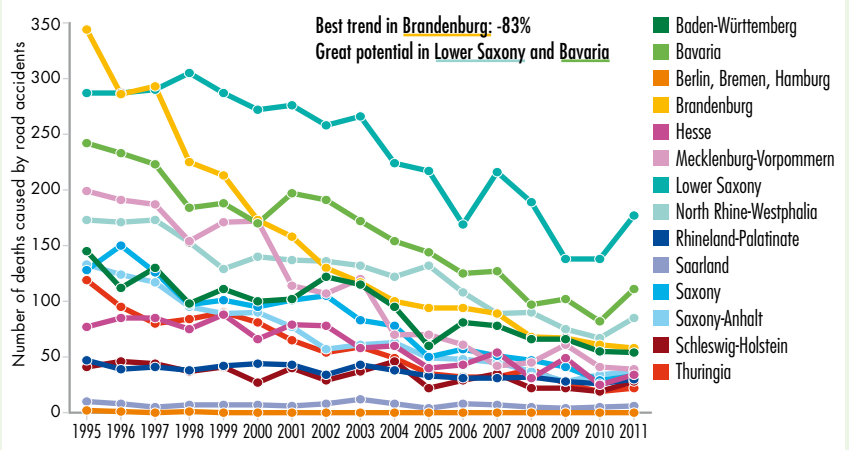
Source: StBA

25
Deaths caused by road accidents in Germany from 1995 to 2011



Source: StBA

26
Deaths caused by road accidents involving collisions with trees next to the road on rural roads in Germany sorted according to federal states from 1995 to 2011



Source: StBA

30 percent of all fatalities on rural roads lost their lives in collisions with trees in 2011.

reached or even significantly exceeded in accidents with side impact against a tree at speeds that are greater than the actual test speed for post impact. This means the potential to protect occupants in serious collisions with trees that frequently happen at much higher impact speeds is limited in terms of cars' passive safety.

Far greater potential to reduce the number and consequences of accidents with impact against trees next to the road is seen today in the context of introducing driver assistant systems. The ESP electronic stability control basically has great potential to prevent accidents caused by lane departure and subsequent side impact against a tree. This system may contribute, for example, to a vehicle not getting into an unstable driving situation when it enters a bend fast and starting to skid from the road, at least not within the limits of driving physics. The accident prevention potential of ESP may be extremely limited or no longer exist, in particular with high speed accidents.

Lane departure as a result of inattentiveness can also be prevented by a lane departure warning system (LDW). Driver assistant systems, which allow obstacles on the road or the road layout in bends to be recognised more clearly, are still helpful to prevent lane departure accidents, for example due to delayed or panicky responses. The systems entering the market with recognition of road signs (speed limits, hazard warnings) provide even more potential. Fortunately, a trend reversal can be detected in some car manufacturers here. For example, state of the art driver assistant systems, such as active cornering lights or lane keeping assistants are now also being offered as standard in small and mid-size cars or at a comparatively low surcharge. These systems should therefore be considered for reasons of your own safety when buying a car.

According to information from the Federal Motor Transport Authority, the average age of licensed cars has increased to 8.5 years as of 1st January 2012. It will therefore take a relatively long time until the latest vehicle safety technology will have an effect on a considerable percentage of cars on the road and those involved in accidents. In terms of reducing the number and severity of accidents involving collisions with trees next to the road further, vehicle safety technology can make even more contributions but these will only contribute to a sustainable reduction in

Car-to-X communication and the simTD project

Dr. Peter E. Rieth, Head of Systems & Technology and Member of the Executive Board at Continental-Division Chassis & Safety

"The series launch of car-to-X communication is an important milestone on the path to accident-free driving. By networking vehicles and the infrastructure electronically, vehicles can exchange information with each other and also with traffic lights and traffic information centres. As a result we can perceive traffic obstructions before we see them and recognise dangers before they become a threat. Road traffic therefore becomes safer, more fuel-efficient and flows better for all road users.

As part of the simTD research project, we have tested out the functionality, practicality and effectiveness of car-to-X communication for the first time under real conditions together with numerous partners and sponsors from the automotive and telecommunications industry, with the local government of Hesse, the city of Frankfurt am Main, different federal ministries as well as renowned universities and research institutes. Last year, 120 vehicles were on the road in Hesse and around Frankfurt am Main, in both city traffic and on rural roads and motorways, in Europe's largest test fleet.

As there are comparatively few communication units, so-called roadside stations, to be found at the edge of the road or at traffic lights on rural roads, we rely even more on vehicle information here: they are particularly important for determining traffic conditions or sending weather information and warnings to the traffic information centres. The cross-traffic and obstruction warning as well as the roadwork information system are applications that can be particularly useful when travelling on rural roads. The functions were implemented as part of simTD, integrated into the whole system and successfully trialled.

As part of simTID, the technical feasibility and practicality were also proved, initial results about its impact on traffic are already available. For example, there are less collisions on rural roads, because a vehicle that brakes suddenly can warn the road users behind it in good time. The majority of the trial drivers also accept the system and rated it as helpful. Detailed results about the driving trials are being presented in the middle of this year."

the number of road traffic casualties in the medium to long-term.

ROAD CONSTRUCTION SOLUTIONS TO PROTECT AGAINST COLLISIONS WITH TREES

Vehicles that forgive mistakes and their equipment can help the driver to master their driving tasks and prevent accidents (active safety) as well as protect the driver and passengers in accidents that still take place (passive safety). As part of a holistic approach, this also applies to the road and surrounding environment, which can be summed up by the phrase "roads that forgive mistakes".

In 2001, DEKRA and Winterthur-Versicherung (AXA Insurance today) carried out an information event on the topic of "Lane departure" in Wildhaus, Switzerland. Collisions with trees were the focus and roads that forgive mistakes were the key challenges. The following technical solutions, some of which can also be found in the "Guidelines for passive safety on roads using vehicle restraint systems" launched in 2010 by the Federal Ministry of Transport, Building and Urban Affairs, are available to realise this.

- When building new roads, a side safety zone should be set up, as is already practised in several Scandinavian countries. Absorption devices such as guard rails or bushes can be accommodated in this open space at the side.
- Guard rails mainly offer protection if they are placed at a sufficiently large distance from the obstacle (tree). Then the guard rail can deform and absorb the energy. However, even if the energy absorption is limited, a guard rail or concrete wall can prevent a car impacting at high speed from mechanically impinging in a relatively small area of its car body so that the structure collapses here and the residual space for occupants is not impaired. Two-wheeler drivers can also be effectively protected using suitable structures.
- Visual traffic guidance equipment on or right next to the road can improve visual guidance as much as (yielding) marker posts with reflective devices.
- Bushes and shrubs can be an ecological and viable version of road design in terms of safety. They stop vehicles relatively gently over a large surface area. A crash test showed that the loads occupants are exposed to when colliding with a bush are roughly eight times less than with a similar collision with a tree. However, as a naturally growing thing bushes and shrubs have inconsistent impact absorbing properties that change over the course of time. Suitable supplementary analysis and maintenance advice would be required here.
- The use of damaged or destroyed trees on the edge of the road should be stopped. If possible, trees should be removed from the edge of roads and replanted at a safe distance from the road. At individual spots with well-known potential for danger caused by trees that cannot be moved, crash absorbers would be one possible measure so that when a vehicle impacts a larger impact surface is provided and additional energy is absorbed by deformation.
- On hazardous stretches of road, speed limits and no overtaking can contribute to improving safety. Checks and controls support compliance with these regulations.

Regardless of which measures are taken in each individual case, there is still need for research in terms of collisions with trees. For example, there is still no scientifically sound data known about which percentage of collisions with trees included in official statistics happen near (worthy of protection) avenues or at the edge of forests or singly planted trees. Using the published federal statistics it also cannot be established what the percentages of vehicle types (cars, trucks, motorised two-wheelers, bicycles) in accidents with collisions with trees next the road are. As far as cars and smaller trucks are concerned it will be interesting to see whether these kinds of accidents will also still happen in a few years when most of these vehicles have ESP electronic stability control and are also fitted with relevant driver assistant systems.

EARLY ANNOUNCEMENT OF DANGER SPOTS

Measures to protect against wildlife are of course also part of roadside design. Grass should be kept short in the hard shoulder area and adjacent bushes should be cut back regularly. However, keeping the view clear is also required to be able to recognise junctions early and be able to carry out overtaking manoeuvres safely. If a steep sloping embankment is next to the hard shoulder, then measures must be

Good experiences with 2+1 roads

Dr. Matts-Åke Belin, Project Manager Vision Zero Academy, Trafikverket (traffic authorities), Sweden

"Since 2002, Sweden has opened over 2,250 kilometres of collision avoidance roads to regular traffic, 200 kilometres of these in 2011 alone and our experiences of them are very good. The number of fatalities on these roads has dropped by more than 70 percent. 2+1 roads can therefore be similarly as safe as motorways, but at significantly lower costs. 2+1 roads also cope with a high volume of traffic. This innovative solution met with great scepticism from the public at the start. According to the annual survey on road safety, 80 percent of Swe-

den nevertheless welcome an expansion of this solution. Therefore, it could also be an option for other countries and legislators to equip their roads with barriers between the lanes. This proposal is a cost-effective way to avoid frontal collisions."

More cash for road infrastructure

Doris Bures, Minister for Infrastructure, Austria

"More than two thirds of all motorcycle accidents happen on rural roads. For this reason, the Austrian Ministry of Transport has provided its states with EUR 1 million incentive funding through the road safety fund to improve the infrastructure at blackspots. This means that if a state invests in making road surfaces have a better grip, marking dangerous bends more clearly or providing crash barriers with a beam, then the Federal Ministry of Traffic, Innovation and Technology (BMVIT) pays half. There are EUR 2 million in total available to make rural roads even safer, as a safe infrastructure prevents human suffering."

Beautiful trees – fatal danger

Dr. Walter Eichendorf, President of the German Road Safety Council

"One in five deaths caused by road accidents can still be traced back to collisions with trees. There are roughly 800 fatalities every year, one person loses their life by crashing into a tree approximately every eleven hours. 80 percent of all single vehicle accidents where control is lost of the vehicle. The accident cause is not just speeding. A brief lapse of concentration, even a minor driving error can have fatal consequences. As trees at the edge of roads do not forgive any mistakes.

Unfortunately, trees only play a minor role in hazard perception for car drivers and motorcyclists. The main dangers on rural roads are considered to be tight bends, narrow roads or spots with game crossing. There is often the mistaken belief that collisions with trees can be avoided when skidding in avenues by being able to drive between two tree trunks in the case of an emergency. However, trees become a closed wall with lane departures on an avenue.

That is why safety reserves are so crucial. Wherever serious accidents happen, people and trees can be effectively protected, for example with guard rails. An additional beam helps prevent serious motorcycle accidents in tight bends. Admittedly: an avenue does not look quite as beautiful anymore but saving human life should be considerably more important to us. And please only plant new trees with additional safety barriers. So that what is a small tree to start with does not grow into a major hazard in just a few years.

The German Road Safety Council (DVR) has declared the prevention of collisions with trees as a priority measure. The provision of funds for a "National passive safety barriers programme" could make a major contribution to better road safety on rural roads. So that in the spirit of our "Vision Zero" strategy: Nobody dies. Everyone arrives."

taken against a fall or the particularly high risk of overturning. If other construction measures are out of the question, guard rails or concrete sliding walls are also effective safety devices here.

Junctions and intersections also pose a particular risk. Safe solutions can be designed here using construction measures. But traffic light controls or complete retrofits are not always possible. What is important is an early announcement by clear, comprehensible direction signs. For example, drivers are warned about slow, crossing traffic in good time, strangers to the area have enough time to orientate themselves and prepare and announce their own turning off manoeuvre, if applicable. Turning off lanes, in particular for the safe positioning of vehicles turning off left, help to defuse many dangerous situations. An appropriate maximum speed must be specified in good time. Clear priority rules and a clear view of the junction area are essential. It would also be desirable if this area had lighting in the dark.

The roundabout has experienced a renaissance in some European countries. The reduced speed has decreased both the number of accidents and the severity of injuries in the event of an accident. However, roundabouts are not always the best solution and they do not always contribute to improving safety due to creating unfavourable basic conditions. As a result, roundabouts must be announced in good time, the entries and exits must be designed so that they cannot be driven through without reducing your speed and the wide-spread pieces of art in the centre of roundabouts must not constitute a dangerous obstacle or distraction.

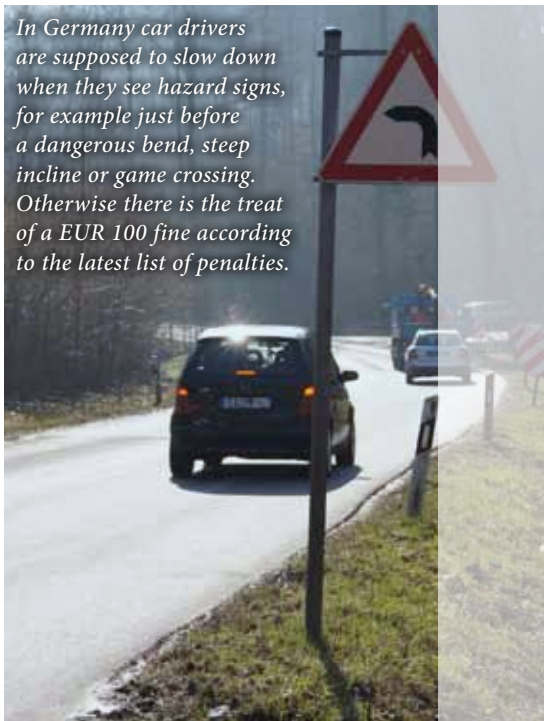
BETTER SAFETY THANKS TO OVERTAKING LANES AND SPEED MONITORING UNITS

Overtaking manoeuvres on rural roads still end in frontal collisions or skidding off the road too often. Poor visibility, misjudging distances and speeds as well as your own impatience are just a few reasons for the often fatal decision to overtake. There are significant differences in speed and the desire of many car drivers to overtake as quickly as possible in particular on rural roads with a high density of trucks. Suitable options must be created here. The ideal solution would be to expand rural roads into four lanes with a construction separating lanes, as practised in Sweden. However, large-scale expansion to four lanes is not possible, on the other hand 2 + 1 lanes can often be realised in sections.

As a current study by the Federal Highway Research Institute (BASt) on the "Improvement of road safety on single carriageway two lane roads outside built-up areas (AOSI)" shows, road safety on rural roads can be significantly improved using overtaking lanes combined with no overtaking in sections. With regards to accidents with personal injury and serious damage to property, this measure could achieve up to 64 percent effectiveness. Furthermore, it could be demonstrated that even short overtaking lanes just 600 metres long are also safe overtaking sections. As part of the study, the BASt also examined the effectiveness of stationary speed checks. The number of accidents on the stretches of road analysed could be reduced by up to 52 percent by using these kinds of speed checks. The effectiveness of both the measures mentioned was analysed using a before/after comparison. The incidence of accidents was observed over a period of three years before and after measures were implemented, the traffic flow and speeds were recorded using double induction loops.

NEW GUIDELINES FOR THE LAYOUT OF RURAL ROADS

Many of the infrastructure measures highlighted would have to be accompanied by traffic control measures. These are specifically speed limits and no overtaking. However, the aim must be self-explanatory roads with roadside design that forgives mistakes. This means: The user intuitively recognises which driving behaviour and speed is required of them from the road design alone. Dangerous spots are recognisable as such. Stretches that look safe are also safe. At the same time, the road offers enough safety reserves so that a driver can quickly regain control of their vehicle after a mistake and it does not result in an accident if possible or the consequences of accidents are less serious.



In Germany car drivers are supposed to slow down when they see hazard signs, for example just before a dangerous bend, steep incline or game crossing. Otherwise there is the treat of a EUR 100 fine according to the latest list of penalties.

Road safety must not be neglected when creating roundabouts.

A large step was taken in this direction with the new "Guidelines for the layout of rural roads" (RAL). These guidelines, which are currently under development, are based on the latest scientific findings and provide for specific measures to raise the level of safety in conspicuous accident situations. Important innovations relevant to road safety in the RAL are for example the design of intersections as well as the creation of enough safe overtaking opportunities. Depending on the road category, four design classes are designed that differentiate between trunk roads, national roads, regional roads and local roads. There is a uniform road design for each design class.

The four classes differ significantly from each other. They can therefore be clearly identified by drivers and the driving style or speed can be adapted accordingly. The overtaking regulation on rural roads is also being revised through the respective design class. The declared aim is to enable greater use of additional overtaking lanes and to largely do away with using the opposite lane. Road safety is given top priority in the definition of new guidelines. However, ecological, economical and regional development aspects are also being included. The information available so far is very promising. It is to be hoped that the content will also be implemented by the responsible road maintenance authorities.

Road safety costs money. And measures to improve the infrastructure in particular often carry a lot of weight here. A reliable and safe infrastructure is the backbone of the European economy though and represents individual mobility and thus quality of life. Long-term planning and a use of funds geared towards safety can save money in the long run though. Anyone who does not plant a tree right next to the road today, does not have to pay for expensive guard rails tomorrow; anyone who modernises the road surface and renews the markings, is acting far more economically than constantly improving damage to the road that just gets deeper and deeper.

Politics is called on to release sufficient funds for road construction. Knee-jerk reactions without any sound risk and impact assessments are generally very cost intensive and damage the image of the responsible groups of people and even whole municipalities, regardless of whether it is the disassembly and subsequent reassembly of marker posts, the planting of trees and felling of them a year later, the installation of works of art on roundabouts with subsequent removal due to residents' protests or the complete reconstruction of a roundabout, which is then rebuilt into a normal junction with traffic lights again after two years.

SOS transmitter onboard – eCall as a lifesaver

In the near future, an automatic emergency call system in cars, which automatically triggers an electronic emergency call via the mobile phone network in the event of an accident, will be added to modern safety engineering in vehicles. The EU Commission is planning to introduce the eCall system through EU legislation for new homologised vehicle types as mandatory by 2015.

The system recognises a serious accident, among other things by the airbag activation signals. The position data of the car involved in the accident is automatically transmitted immediately and a voice connection is made with the car involved in the accident, if possible. The necessary emergency rescue measures can then be initiated very quickly. However, even if there is not a voice connection, the public service answering point can request assistance in future.

The European-wide emergency number 112 is being used for eCall. Geodata is recorded using satellite navigation systems and automatically transmitted via the mobile communications network. This guarantees that the accident site is established quickly. You can also call and talk to an employee at the public service answering point. A national pilot test showed that in 90 percent of all cases a connection was made to the emergency services within 25 seconds, in 97 percent of cases within 45 seconds. Besides implementing eCall in vehicle systems as a so-called in-band modem, there are also thoughts about allowing "retrofit systems", i.e. applications based on smartphone technology. An eCall system for motorcyclists is also being discussed.

Germany has been involved in the implementation process from the start and has taken part in working parties at European level, among other things with the involvement of DEKRA. In this context, DEKRA is also developing proposals for how the safe function of the eCall system can also be simulated as part of the vehicle inspection.

The Federal Ministry of Transport, Building and Urban Affairs (BMVBS) has also established a national eCall implementation platform to coordinate any other necessary measures with those involved in Germany. The aim is to create the basic conditions so that automatic emergency calls can be received and processed by the public safety answering points. One important point is to equip the PSAP (public service answer points = traffic information centres that receive all the emergency calls) with the necessary technology to be able to receive and analyse the incoming data.

A dangerous mix of risks

As is highlighted in the "Accidents" section, human error is the most frequent cause of accidents by far on rural roads too. Whether it be inappropriate speed, driving too close, risky overtaking manoeuvres, turning off errors, ignoring right of way or driving under the influence of alcohol: the person behind the steering wheel is and remains one of the greatest risk factors in road traffic. To effectively counteract this, we must not least work towards a heightened sense of responsibility in all road users.

When it comes to analysing the cause of accidents on German roads, it is generally differentiated between general causes and people-related causes. As the Federal Statistics Office explains, the police can state up to two general accident causes per accident and up to three errors for the first driver or pedestrian involved (main person responsible for accident) as well as for another person involved, therefore a maximum of eight accident causes per accident.

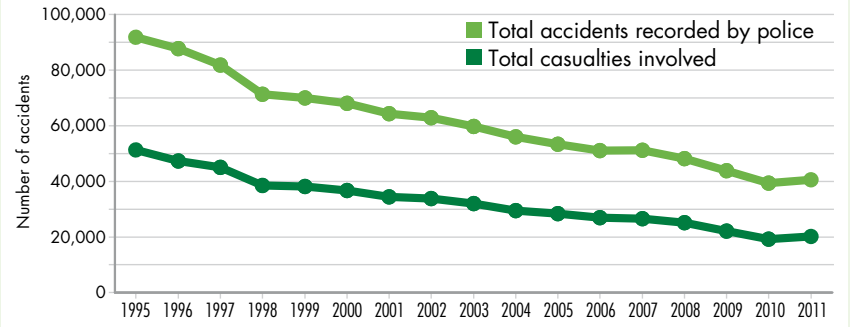
If we look at the year 2011 more closely, a total of 430,000 accident causes were statistically recorded for the roughly 306,300 accidents with personal injury on Germany's roads. The most common accident cause (86.3 percent) was driver error, another 3.7 percent were down to pedestrian error. General causes, which besides the weather and road conditions also include obstacles, such as game on the road, had a share of 8.9 percent of the recorded accident causes. Even if it is only the police's initial assessments within a week of the accident that are included in the respective statistics, the high percentage of human error definitely shows what a huge risk vehicle drivers pose.

ALCOHOL ON RURAL ROADS

An example for human error in road traffic is the irresponsible willingness to get behind the wheel despite the consumption of alcohol. In Germany, approximately 20,000 people were injured or killed in drink driving accidents in 2011. 16,731 accidents under the influence of drugs in Germany resulted in personal injury (Federal Statistics Office, 2012).

The particular danger of drink driving can be evidenced using accident statistics, among other things. In 2011, alcohol was established as the accident cause in "just"

27 Accident cause drink driving in Germany for 2011



Source: Federal Statistics Office

1.7 percent of all accidents recorded by police, that's 40,000 accidents (figure 27). However, these accidents end fatally or with serious injuries more frequently. Roughly ten percent of fatalities were the casualties of drink driving (Federal Statistics Office, 2012). Although the number of accidents caused by drink driving has constantly decreased over the last few years, there was another increase in accident figures after 2010. This must be seen as a clear sign that road safety work on drink driving is still a long way from being adequate or finished.

The statistics prove in turn that drink driving also makes up a large percentage of accidents on rural roads. Although, the accident figures for drink driving have dropped on rural roads over the last few years, there were still approximately 9,000 accidents under the influence of alcohol, 2,396 of these with personal injury (figure 28) in 2011. If you look at the age of those involved in drink driving accidents, it is noticeable that there is a really wide spread of age groups from young to middle age (figure 29). It is therefore not just new drivers who drink drive but also drivers aged between 25 to 55 years.

VARIOUS DEFICITS CAUSED BY ALCOHOL

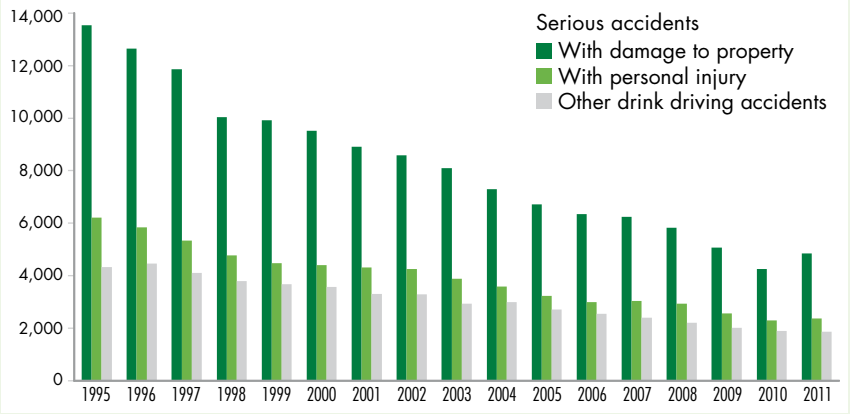
One possible cause for the comparatively low percentage of young people involved in drink driving accidents is the alcohol ban for new drivers that has been valid since 1st August 1997. The evaluation of the alcohol ban for new drivers (Holte et al.; 2010) was able to prove the success of this measure. In the first twelve months after the introduction of the alcohol ban, the number of new drivers involved in drink driving accidents dropped by 15 percent compared to the same period the previous year. In the following years, drink driving offences among young drivers under 21 years of age decreased by 17 percent compared to drivers over 21 years old. A 2.5 percent decrease in drink driving offences was established in this group. What is particularly impressive in this evaluation, is the 95% high acceptance of the measure among the new drivers concerned.

The high risk of accidents under the influence of alcohol is explained by various deficits that alcohol causes in people. When consuming alcohol, it is not just a psycho-functional area that is impaired, for example visual performance. There are in fact a range of different performance deficits. For example, an analysis of literature shows that 97 percent of all deficits occurred with a blood alcohol level of 1.1 in the 129 studies analysed. These deficits could be evidenced in various psycho-functional areas that are shown in figure 30 (Mattern et al., 2009).

A similar result could also be evidenced in a meta-analysis of 450 studies between 1954 and 2007 (Schnabel, 2011). A functional impairment was calculated to estimate the effects of alcohol depending on the blood alcohol content. According to this, 30 percent of the findings from

28

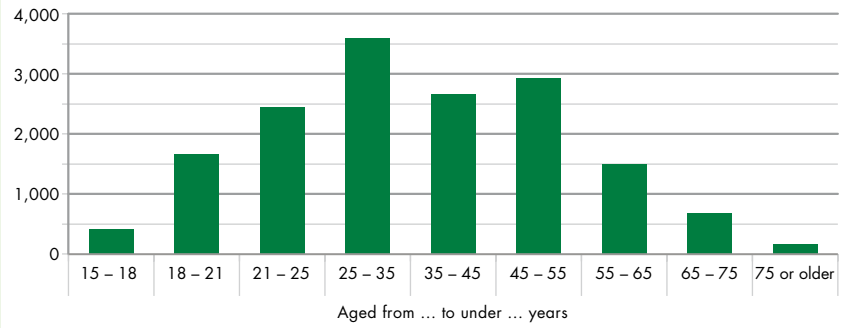
Accident cause drink driving on rural roads in Germany for 2011



Source: Federal Statistics Office

29

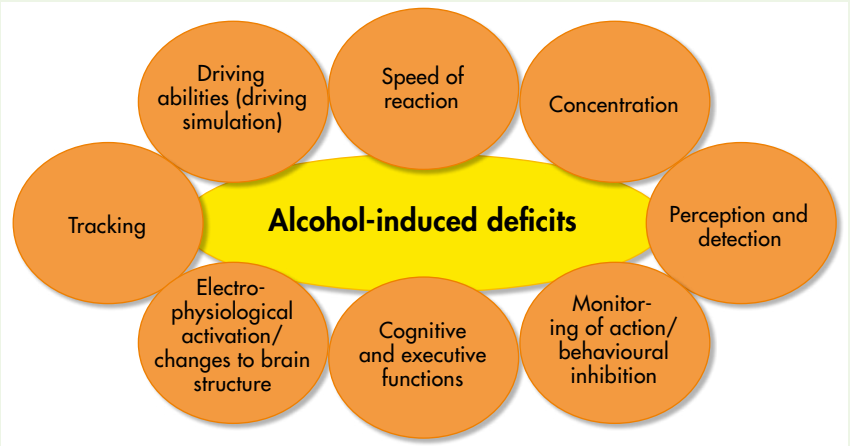
Road users under the influence of alcohol in accidents with personal injury in Germany in 2011



Source: Federal Statistics Office

30

Alcohol-induced deficits



Source: Mattern et al., 2009

31

Summary of results of three analyses of literature on alcohol-induced deficits

An analysis by **Moskowitz and Robinson (1988),** which included 177 studies from the years 1940 to 1985, was able to prove an **alcohol-induced drop** in performance:

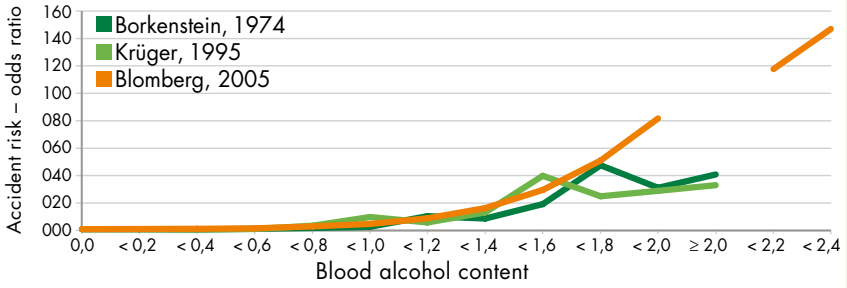
- From 0.4% in 21% of studies
- From 0.5% in 34% of studies
- From 0.8% in 66% of studies
- **From 1.0% in almost all studies**

An analysis of literature by **Moskowitz and Fiorentino (2000),** which included 112 articles from 1981 to 1997, showed that **deficits** were evidenced from a BAC of **0.5%** in the majority of studies. **From a BAC of 0.8%** there were deficits caused by alcohol **in 94% of studies.**

In a qualitative and quantitative analysis by **Stewin (2010)** of 129 published articles it was established that **97%** of studies showed **deficits** (for example, concentration, vision, tracking, speed of reaction) from a blood alcohol content of **1.1%.**

32

Accident risk on the roads depending on blood alcohol level according to three studies in odds ratio*



*OR = 2 means that the risk of having an accident has doubled

Sources: Borkenstein et al., 1974; Krüger, 1995; Blomberg et al., 2005

the studies analysed are significant with a blood alcohol content (BAC) of 0.5. The functional impairment runs linearly. This means that the higher the blood alcohol content is, the more significant findings or evidenced deficits occur. What is also interesting in this context are the results of three analyses of literature on alcohol-induced deficits (figure 31).

GREATLY INCREASED ACCIDENT RISK

The devastating effect of alcohol on performance and thus also on road safety is shown in the calculations on accident risk depending on the blood alcohol content (figure 32). Krüger (1995) analysed the accident risk under the influence of alcohol using a sample of approximately 20,000 drivers and 5,144 accidents in the German-speaking region. There are also the results of a study by Borkenstein (1974) from the USA. They come to the conclusion that the risk of causing an accident under the influence of alcohol is already three times higher with a blood alcohol level of 0.8 compared to sober drivers. The risk of causing an accident is ten times higher with a blood alcohol level of 1.0. A more current study from the USA (Blomberg et al., 2005) also calculated risk values for particularly high alcohol levels. For example, the accident risk with a blood alcohol content of 2.2 is almost 120 times higher compared to road users not under the influence of alcohol. Krüger (1995) and Borkenstein (1974) summarised the results over a blood alcohol level of 2.0, whereas Blomberg et al. (2005) state precise values. With a blood alcohol content of 0.8 the accident risk is two to four times higher and rises to ten times higher with 1.0.

The epidemiological risk of driver injuries depending on the blood alcohol level was calculated in the EU project DRUID (Driving under the Influence of Drugs, Alcohol and Medicines) with Belgian, Danish, Lithuanian and Dutch data sets. The result clearly showed that a roughly 3.5 times higher risk of injury with a blood alcohol content of 0.5 to 0.8. The risk of injury is thirteen times higher with an increase in blood alcohol level up to 1.2. An increased risk of 60 times higher was calculated at over 1.2 (Hargutt, Krüger & Knoche, 2011). As part of this DRUID study, the risk of having a fatal road traffic accident was also ascertained as follows using data from Poland, Finland and Norway:

- The risk increases three to nine times with a BAC of 0.1 to 0.5.
- The risk increases eighteen to forty times with a BAC of 0.5 to 1.2.
- The risk increases 137 to 2,123 times with a BAC of over 1.2.

Using the presented statistics it can be clearly shown that alcohol in road traffic is still a major source of danger. One possibility for counteracting this danger, alongside many others such as media campaigns, is the use of alcohol interlocks, which prevent a motor vehicle from being started by a driver who has been consuming alcohol (Schubert & Nickel, 2012). This would result in new possibilities to maintain mobility and therefore participate in a social life following the creation of a legal basis to carry out these kinds of studies before they are applied in practice. A driver who has committed an alcohol-related offence is not only protected against drink driving by using an alcohol interlock device but can also continue to take part in a social and working life with an appropriate legal basis that is still to be created.

From a professional and scientific point of view, drunk drivers with a blood alcohol level of 1.1 or more are a high risk group. The medical, toxicological and psychological study results show that a driving suitability assessment of this at-risk group of people is indicated from a blood alcohol level of 1.1. It is now a political decision what (accident) risk the state is prepared to take.

In terms of the state's duty to protect and the political decisions derived from this, the following are listed in the EU Convention for the Protection of Human Rights and Fundamental Freedoms:

- Article 1 – Duty to observe human rights: "The High Contracting Parties shall secure to everyone within their jurisdiction the rights and freedoms defined in Section I."
- Section 1 Article 2 Item 1: "Everyone's right to life shall be protected by law."
- Section 1 Article 8 Item 2: "There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disor-

Perception can be very quickly clouded in road traffic due to the consumption of alcohol or drugs.

der or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others."

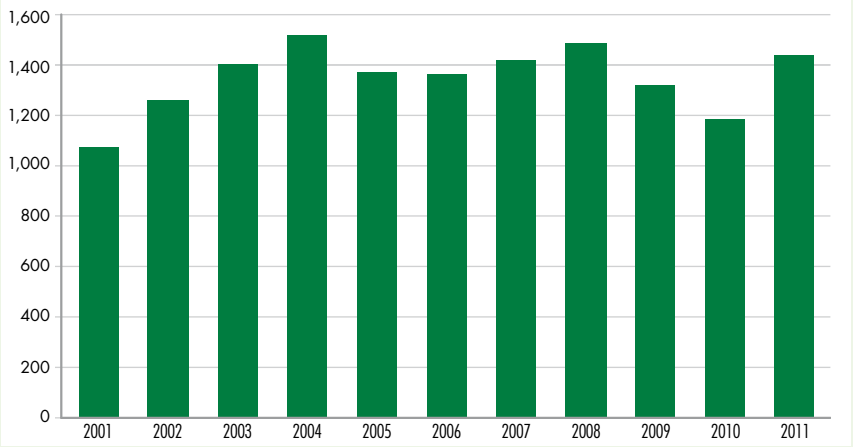
The legal situation in Germany is in line with this. In the German Constitution 1 Article 2 Item 2 it states: "Everyone has the basic right to life and physical integrity. The rights of the individual are inviolable. These rights may only be infringed as the result of a law." The state makes sure of vehicle drivers and vehicles' suitability for approval to travel on public roads itself. In terms of road traffic this means that the protection of the general public from unsuitable drivers has a socially higher value than the right to individual automotive mobility.

DRUGS ON RURAL ROADS

Road traffic accidents under the influence of drugs are currently taking a critical turn. Despite a drop in the figures overall, the number of accidents with personal injury under the influence of medicines and drugs has been at the same constant level for years (figure 33). According to the Federal Statistics Office, 570 people were seriously injured as a result in 2011. This means an increase of 41 percent compared to the previous year.

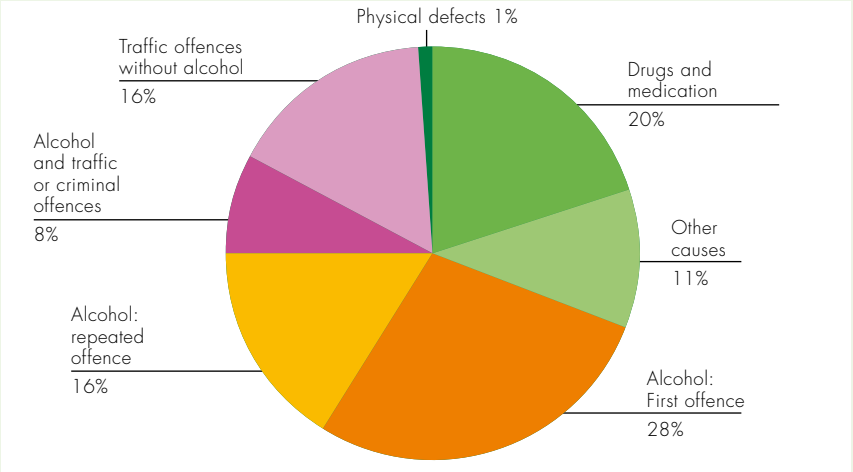
The accident statistics for drug-related traffic incidents very clearly prove that drugs are on the rise in road traffic. This trend can also be seen in medical/psychological examinations (figure 34), where there is an increase in examinations for "drugs" compared to the previous year. As a result of poor statistics on medical reports that can also be ordered after driving under the influence of drugs,

33 Accidents under the influence of intoxicating substances with personal injury



Source: Federal Statistics Office

34 Distribution of causes for medical/psychological examinations in 2011



Source: Albrecht, 2012

Increased checks were able to reduce the number of drink driving accidents even more.

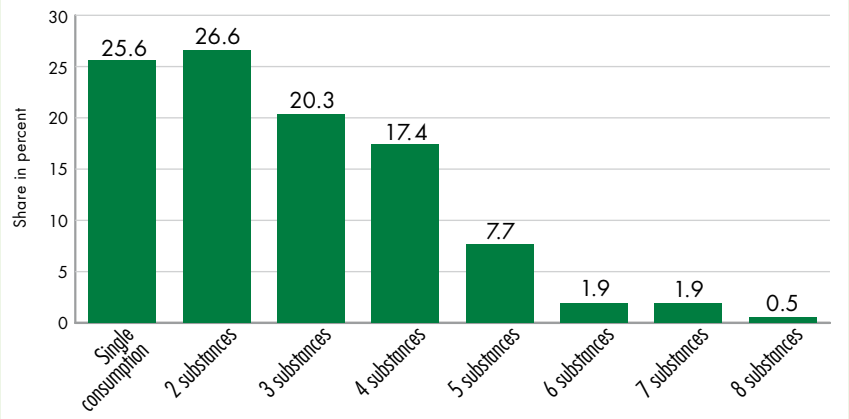
the data on drug offences cannot be analysed at the Assessment Centre for Driving Suitability. It is therefore even more important to stress that particularly because of the rising number of road traffic accidents involving drugs and associated more frequent driving suitability assessments screening must be done according to assessment criteria (Schubert & Mattern, 2009). With so-called hard drugs (for example, heroine and amphetamines), evidence of abstinence is required.

Drivers under the influence of drugs is a particularly explosive issue due to the frequent mixing of different intoxicating substances. Based on an investigation by the Forensic Toxicology Centre of Munich (Sachs, 2012), the consumption of just one substance tends to be the exception (figure 35). In a sample of 287 test subjects from the first half-year of 2007, the record was 18 different intoxicating substances in just one sample. These included cocaine, heroin, morphine and amphetamine.

In the process, it is particularly critical that you can generally only look for certain substances in the samples taken. The type of substances is specified in the list of intoxicating substances according to the Appendix to Section 24 a) of the road traffic regulations. They include:

Intoxicating substances	Substances
Cannabis	Tetrahydrocannabinol (THC)
Heroin	Morphine
Morphine	Morphine
Cocaine	Cocaine
Cocaine	Benzoylecgonine
Amphetamine	Amphetamine
Designer amphetamine	Methylenedioxyamphetamine (MDA)
Designer amphetamine	Methylenedioxyethylamphetamine (MDE)
Designer amphetamine	Methylenedioxymetamphetamine (MDMA)
Metamphetamine	Metamphetamine

35 Percentage of mixed consumption according to number of substances found in sample



Source: Sachs & Schubert, 2011

If the person being examined has taken a substance that is not included on this list, for example because it is completely new to the market, then toxicology analysis also cannot be carried out at this time. This not only poses toxicology but also the prosecution with a specific problem. The high consumption of mixed substances clearly proves the importance of polytoxicology drug screening in driving suitability assessments as well as checking for a possible cross-addiction.

DISCREPANCY BETWEEN ACTION TIME AND DETECTION TIME

Whilst there is extensive research into impairments in the field of alcohol, this does not exist yet in the field of drugs. One rea-

son for this can certainly be seen in ethical concerns, which go hand in hand with the experimental administration of drugs. However, this lack of verified findings makes it considerably difficult to compare alcohol-related and drug-related impairments. This is very difficult to support in so far as "former drug dependency" and "former alcohol dependency" were put on an equal legal footing with the fourth amendment to the Driving Licence Directive and other statutory road traffic regulations (4. FeVuaÄndV).

However, the current equal treatment of alcohol and drugs as part of the driver suitability assessment still leads to the unfavourable treatment of drivers who have committed drug offences, as they are considered for the driver suitability assessment regardless of the dosage of intoxicating substances evidenced in the body, whereas a drunk driver is only ordered to a driving suitability assessment from a blood alcohol content of 1.6 upwards.

A related problem with the use of drugs is the discrepancy between action time and detection time. The Federal Constitutional Court specified the following on this: "Whilst it is true that the driving ban mentioned in Article 24 a Clause 2 of the road traffic regulations should refer to the time of actual negative impact on performance and cases are conceivable where the amount of active substances is only/still so small that an impact on performance cannot or can no longer be measured or does not in any case go beyond what road traffic law accepts as consequences of a whole variety of indispositions and irritations. The limit that a vehicle driver exceeds "under the effect" of drugs is reached though once the blood active ingredient content is so high that reliable blood analysis evidence is possible." (BVerfG, 1 BvR 2652/03). The Federal Constitutional Court did not follow the legislator's adoption of the identity of the action time and detection time for drugs.

The comparison between alcohol and drugs is also made more difficult as a result of technical content issues. The following risks result with drugs consumption in comparison to alcohol consumption:

- Unknown forms of application
- Lack of controllability of effect
- Dosage of active ingredients taken unclear
- Intoxication does not depend on dosage
- Atypical intoxication
- Consumption of a mixture of different substances
- Overlapping of distribution phase(s)/ elimination
- Differences between occasional and habitual consumption as well as
- Inter-individual and intra-individual fluctuations between effect and concentration.

Therefore there is currently a great need for research in this field to be able to recommend scientifically-based and empirically proved limits to the legislator.

AGGRESSION IN ROAD TRAFFIC

In the field of psychology, aggression is understood to be a behaviour that entails the deliberate harming of another person. A distinction must be drawn with the term violence, which is understood as a subset of physical aggression. However, aggression also includes psychological components, for example in terms of threats and/ or insults. There are two types of aggression. With instrumental aggression, aggressive behaviour is used to achieve certain goals, for example money. In doing so, harming a person or thing is not the main aim but is acceptable to achieve the ultimate aim (Selg. et al., 1997). With emotional or impulsive aggression, damaging behaviour is used to harm someone out of irritation or anger. A person's disposition to aggressive behaviour is called aggression.

According to the Driving Licence Directive (FeV) Section 11 (3) Clause 7, a medical psychological examination must be ordered "...with offences related to driving suitability, especially if there are indications of a high potential for aggression." The term potential for aggression is inopportune in this sense as an enduring willingness toward aggressive behaviour is not made directly clear by this. However, that is precisely what is meant in the context of

Confiscated hashish is examined and weighed in the lab of the LKA (State Criminal Police Office) Düsseldorf.

Taking a stand against intoxicating substances in road traffic

"Alcohol and drugs are still one of the greatest sources of danger in road traffic. Although the effects and deficits that are caused by alcohol or drug consumption have in the meantime been scientifically well investigated, there still has not been a legal specification of limits, which are based on expert scientific findings. New designer drugs come onto the market every week in Germany, which cannot be included in the list of intoxicating substances according to the Appendix to Section 24 a of the road traffic regulations at such short notice. Furthermore, specific analysis methods must be provided that can evidence the drug's active ingredients depending on the appearance of new drugs on the market. Drivers under the influence of alcohol and drugs are a high-risk group, who willingly accept psychological deficits and the associated high potential for an accident. They require special observation. The legislator can take a stand against intoxicating substances in road traffic using a general ban on drugs.

Prof. Dr. Wolfgang Schubert, President of the German Society for Traffic Psychology

The equal treatment of alcohol and drugs called for in the Driving Licence Directive has not been successfully implemented yet as the knowledge about the effect of drugs needs to be further improved."

the Driving Licence Directive. Therefore, we do not talk about potential for aggression from a psychological point of view but aggressiveness.

There are many examples for aggressive behaviour in road traffic. An aggressive driving style for example includes driving too close to the car in front, flashing your lights, cutting in and approaching at excessive speed. However, aggressive behaviour can also be observed in road traffic that does not have anything to do with driving style directly. This includes for example insults and aggressive gestures. In an analysis by Maxwell and colleagues (2005), three percent of male drivers admitted to having got out of their car once to physically threaten another person. Many accidents on rural roads, which are the result of speeding, for example, can also be seen as an expression of aggressive behaviour. They can be traced back to the driver's behaviour. A summary of the different forms of aggressive behaviour in road traffic can be found in figure 36.

What does aggressive behaviour in road traffic lead to? On the one hand, a range of studies proves that there is a link between aggressive behaviour and accidents (Herzog & Schlag, 2006). On the other hand, there are even more links between aggressive behaviour and aggressive driving style, the number of traffic offences (warnings and fines) as well as number of points. When analysing these links though it must be considered that as a rule there is not only one cause for an accident happening. Consequently, aggressiveness is considered to be a possible cause for traffic offences or accidents.

There are different causes and influential factors for aggressive behaviour in road traffic. It is well-known from studies that situational road traffic influences, for example noise or loud music, increase physiological agitation (e.g. Hennessy et al., 2003). Circumstances that happen just before a journey, for example stress at work, can also lead to increased agitation. Other factors such as a lack of space, minimal options for communication and time pressure lead to people expressing increased aggression (Herzberg, 2004). Added to this are the fleetingness of encounters and the low concentration of prosecution. Road traffic is the ideal environment as it were to live out their aggressiveness, from the point of view of those involved. In other areas of life, this behaviour would be immediately sanctioned by the environment.

TENDENCY TO DISREGARD SOCIAL AND LEGAL RULES

The latest development in Swiss legislation shows how severely aggressive behaviour, for example speeding, can be punished. A law came into force there on 1st January 2013, which even provides a prison sentence for speeding. In Section 90 Clause 2 of the Swiss road traffic regulations it states: "Anyone who takes the high risk of an accident with serious injuries or fatalities by intentionally breaching elementary road traffic regulations, namely by gross disregard of the maximum permissible speed limit, reckless overtaking or participating in an unauthorised race with motor vehicles shall be punished with a prison sentence of one to four years." Regardless of this it should be noted that it is professionally important not just to punish those concerned but offer help from traffic psychologists to modify their behaviour to achieve a permanent change in the behaviour of those concerned.

As authorities can order a medical psychological examination according to Section 11 of the Driving Licence Directive if a driver commits offences that imply a "high potential for aggression", i.e. a disposition toward aggressive behaviour, it is necessary to consider the link between offences and driving behaviour.

The driving licence authorities do not have any information about drivers' personality traits but they do have information about traffic offences on file and criminal acts. Can doubt about driving suitability therefore also be empirically substantiated as a result of criminal acts?

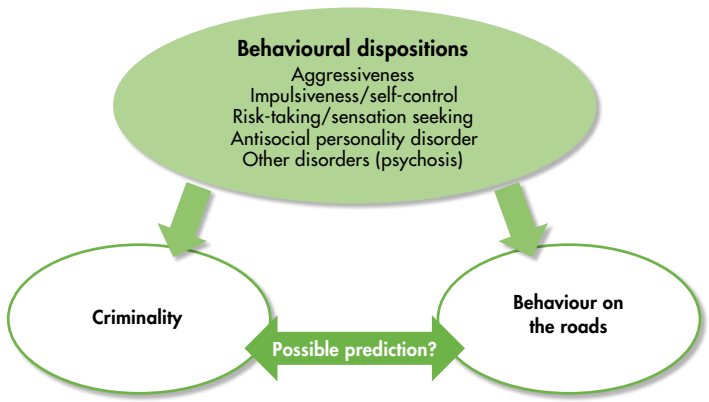
Aggressive behaviour generally exists together with other problematic behaviour. This includes among other things, impulsiveness, a lack of self-control and self-regulation, antisocial behaviour, alcohol and substance abuse and depend-

36
Types of aggressive behaviour in road traffic

Undue care and attention on motorways	Undue care and attention on rural roads	Undue care and attention in built-up areas
• Driving too close to car in front • Blocking the left-hand lane • Overtaking on the inside • Lane hopping • Unwillingness to practise the zipper principle • Inappropriate speed • Pulling out to the left • Pulling in sharply • Overtaking just before an exit	• Risky overtaking • Driving too fast	• Undue care and attention towards weaker people • Driving too fast • Car parking conflicts (2nd row, pavement, cycle paths) • Sounding the horn at traffic lights • Unwillingness to allow others to merge into flowing traffic • Changing lanes/lane hopping

Source: Ellinghaus, 1986

37
Link between aggressive/antisocial behaviour, criminality and behaviour on the roads



Source: According to Banse, 2012

A great deal of attention is particularly required by all road users at intersections on rural roads.

ency as well as psychological disorders (Banse, 2012).

A whole variety of different behaviours combined is antisocial behaviour, i.e. a general tendency to disregard social and legal rules. Aggressiveness can be seen as an indication of antisocial behaviour. The question of whether aggressive or antisocial behaviour therefore predicts criminal acts and problematic behaviour on the roads independently of each other, or whether criminal acts and traffic offences have to be classified as symptoms of the same problem is important. If the latter is the case then any traffic offences committed would make it possible to predict criminal acts and vice versa.

The link between criminal acts and behaviour on the roads was analysed in a Dutch study (Junger et al., 2001). The results showed that the commitment of criminal acts allowed for the prediction of road accidents (figure 38). The risk of a road traffic accident increased by 2.4 times with people who had committed an act of violence before. The fact that there is also a link between road accidents and non-violent property offences suggests that accidents were an expression of an antisocial or aggressive pattern of behaviour.

PSYCHOLOGICAL ASPECTS OF DESIGNING "RURAL ROADS"

There are two types of accidents on rural roads. On the one hand, a third of accidents were caused by losing control of the

38 Odds ratio that people who have committed a criminal offence were also involved in an accident

Criminal offences	Odds ratio for road accidents
One property offence	2.0
Two or more property offences	4.0
Violent offence within the last year	1.8
Committed one violent offence before	2.4

OR = 2 means that the risk of having an accident has doubled

Source: According to Junger et al., 2001

Criminal acts and behaviour on the roads

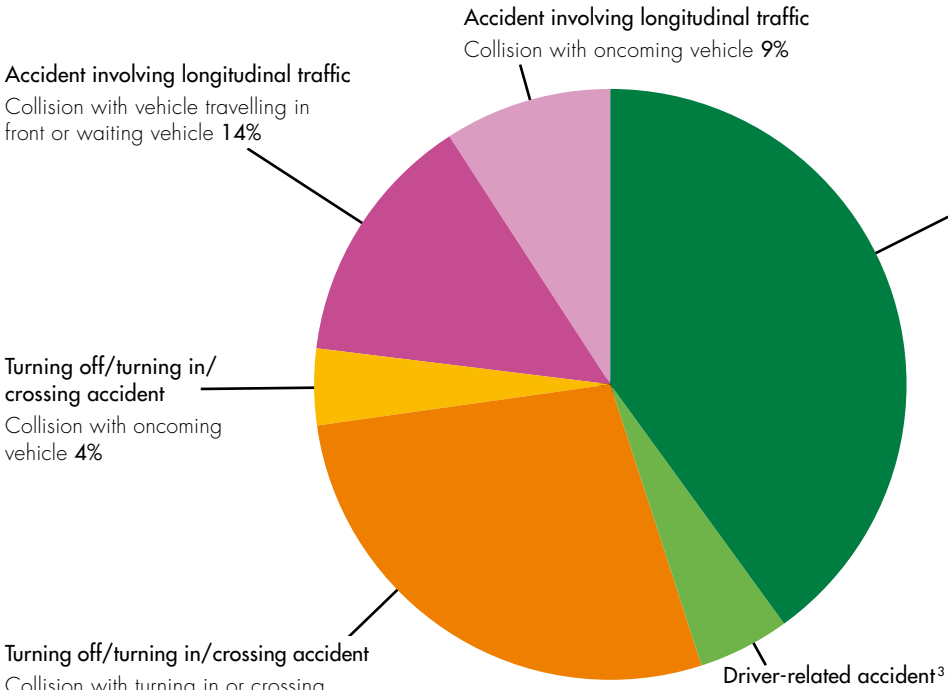
Prof. Dr. Rainer Banse, Chair of the Institute for Psychology University of Bonn, Social and Legal Psychology Department

"The results of several empirical studies in the Netherlands suggest that offenders who were convicted of a violent or property offence have a significantly higher risk for traffic offences and accidents. A marked antisocial pattern of behaviour is also expressed in road traffic. Consequently, the question arises whether the danger of drivers who have committed offences is currently being classified correctly by legislation. As a result of the low number of meaningful studies in Germany, further research is required in this field. Nevertheless it can be noted that criminal behaviour (also regardless of the road traffic!) may justify official doubt in driving suitability. The drivers concerned must however be given the chance to take up specific rehabilitation measures to be able to organise the treatment of antisocial and aggressive behavioural dispositions more promisingly. The prospect of obtaining their driving license again can be an important motivation to change behaviour, especially for antisocial or aggressive people as they are more receptive to rewards than to punishments."

A great deal of attention is particularly required by all road users at intersections on rural roads.

39

Accident constellations based on accident type[1]/accident nature[2] for accidents where car drivers were the main cause in Germany in 2007



[1] **Accident type:** Conflict situation that led to the accident

[2] **Nature of accident:** describes the actual collision

[3] **Driver-related accident:** accident triggered by losing control of the vehicle, without any other road users having contributed to this

Source: According to Federal Statistics Office

Source: According to Heinrich et al., 2010

Accompanied driving at 17 in Germany

The first young people had the chance to take part in so-called accompanied driving at 17 from April 2004. This has been possible in all federal states since 2008. Two major random samples were analysed in order to check the impact of this measure on road safety: former accompanied driving at 17 drivers and drivers, who had acquired their driving licence at the age of 18. The results show that there were 17 percent less accidents and 15 percent less traffic offences in the first year of independent driving with the former accompanied driving at 17 road users compared to drivers of the same age who acquired their driving licence the standard way (Schade & Heinzmann, 2011). The decrease in accidents and traffic offences is four percent higher if the driving performance is taken as the basis (23 percent accidents, 22 percent traffic offences). This result was successfully replicated in an independent sample. As a result, accompanied driving at 17 prevented roughly 1,700 accidents with personal injury in 2009. However, there is also evidence that although the positive effects of accompanied driving do impact on the second year of independent driving, they then weaken and ultimately lose their effect (Schade & Heinzmann, 2011).

vehicle, on the other hand the accidents happened in longitudinal traffic (Heinrich et al., 2010). There was often a collision with a turning in or crossing vehicle (approximately 20 percent of all accidents on rural roads). A third of vehicles left the lane. In 14 percent of accidents, there was a collision with oncoming vehicles, which are characterised by a particularly high mortality rate (figure 39).

The majority of accidents on rural roads are caused by car drivers. Driver-related accidents caused by car drivers are often accompanied by lane departure (83 percent of driver-related accidents) or by collision with an oncoming vehicle (11 percent of accidents). The most frequent accident causes for lane departure with car drivers are not adapting their speed (69 percent) and driving under the influence of alcohol (15 percent). Lane departure frequently leads to collisions with trees on rural roads. With other driver-related accidents (collision with oncoming vehicle) besides speeding, faults in street lighting are also significant as accident causes (Heinrich et al., 2010).

When it comes to improving road safety on rural roads, you first have to ask how you want to measure the effect of the measure. It is frequently the case that a measure to increase road safety is considered to be successful once the number of accidents has decreased at an accident blackspot. However, this view obstructs a preventative approach, which stops an accident blackspot from arising in the first place. It is often the case that serious accidents can be avoided in the long-term through construction measures. However, compared to short-term effective monitoring measures these are very expensive. Therefore a cost/benefits analysis must be called for not just for monetary aspects but also in terms of (long-term) effectiveness.

As already stated, lane departure is the most frequent type of accident on rural roads. Besides the accident causes mentioned, the probability of driver error also increases when the road layout is a problem. This includes among other things:

- A lack of line markings (for example, restricted vision of road due to layout)
- Narrow road cross-sections (for example, unsafe parking of broken down vehicles)
- Poor visibility (for example, hidden obstructions due to hills and shrubs)
- Too tight bends (for example, after a long straight stretch).

These shortcomings can generally only be eliminated on stretches using costly structural alterations, which is not straightforward on existing roads though. These problems and possible solutions are dealt with in detail in the "Infrastructure" section. The driver's behaviour on the roads must also be understood and considered when designing traffic routes. The following factors must be observed in the process (Fastenmeier et al., 2007):

- Perception
- Expectation, (risk) attitude
- Stress and strain as well as
- (Cognitive) capacity.

POSSIBLE MEASURES TO IMPROVE ROAD SAFETY ON RURAL ROADS FROM A PSYCHOLOGICAL PERSPECTIVE

In order to cope with a driving task, the traffic environment (traffic flow, road construction features, signposting etc.) conveys information to the driver that has to be interpreted and analysed with the help of experience. Expectations are formed about the traffic flow. Therefore when traffic planning it must also be observed that it is not only the structural condition of a traffic route that determines a driver's behaviour but also their experiences as well as driving motives and needs. In order to meet these factors in-

Take time to survive

Peter Glowalla
1. Vice Chair of the Bundesvereinigung der Fahrlehrerverbände e.V.

"Accidents on rural roads are regrettably among the typical accidents for new drivers. They frequently end with serious injuries and even fatally, in particular because rural roads are often lined by trees. Even in driving schools, each learner driver is carefully familiarised with these dangers towards the end of their driving course with five 45 minute cross-country trips. In the subsequent driving test, driving outside built-up areas on rural roads is also part of the important test content. So why do the most horrific accidents still happen on these roads in particular? Rural roads have their perils. Besides weather, visibility and road conditions, dealing with traffic travelling in the same direction, oncoming traffic and crossing traffic makes any kind of driving more difficult. Added to this there are information signs, instructions and restrictions. Overseeing all this and interpreting it correctly not only has to be learnt but also has to be able to be applied properly. New drivers are well trained but they do not have any experience on the roads yet. Experience has to be experienced and above all survived. For example, a new driver has to know that even slightly leaving their lane may have serious consequences and this kind of lane departure is promoted by distraction. The chosen speed and lane behaviour that has not been developed yet also specifically play a major part here. The knowledge of facts, for example that glancing at a passenger, mobile phone, even the speedometer generally takes two seconds and in this time just under 60 metres are covered "blind" at 100 km/h, are important props for inexperienced new drivers."

herent in the driver, the "Expectation congruence" design principle was created, in which it is ensured that the driver's expectations and anticipations about traffic flow are met (Fastenmeier et al., 2007).

When planning rural roads, current findings from psychology can be used to design the road layout so that as few danger spots as possible result. In a baseline study on behalf of the Federal Highway Research Institute, the most important psychological aspects for designing rural roads were compiled (Becher et al., 2006), which are summarised in figure 40.

The authors (Becher et al., 2006) come to the conclusion that the research results can be applied to different areas of planning rural roads. On the one hand, stretches with horizontal alignment, i.e. consecutive bends with harmonious radiuses, have the effect that more steady speeds are driven as the curvature generally has a major influence on driving behaviour. Drivers need three to five seconds time to prepare for a bend. The corresponding fields of vision must be guaranteed by plants at the roadside or traffic guidance equipment. Roads that are too narrow over challenge drivers, roads that are too wide under challenge drivers. It is not just markings that increase the visibility of the road layout but also elements such as marker posts. So-called rumble strips on the hard shoulders have a positive impact on accident figures.

The particular need for action to improve road safety on rural roads has also been recognised by the federal government and the "AußerOrtsSicherheit" (AOSI) project group led by the Federal Highway Research Institute (BASt) was initiated to develop suitable measures (Deutscher Bundestag, 2012). In addition, the further development of technical specifications for road design according to regulations for the layout of rural roads, the use of passive vehicle restraint systems for obstacle-free or passively protected roadside areas and the use of rumble strips on rural roads are also provided for by the federal government.

However, does it make sense to simplify traffic routing so much that the driver is distracted by as little information or stimulation as possible? The idea behind this says that a driver can concentrate well on driving if they are distracted by as little external stimulation as possible (Stephan, 2011). However, scientific studies have shown that drivers turn to internal stimulation (for example, feelings) if the outside world does not provide enough stimulation. Added to this, there is the information processing capacity in people, where a person invests more energy in processing a task when interesting stimuli also have an effect (Stephan, 2011). If the driving environment is designed with very little stimulation it may trigger sleepiness in road users (Krüger & Hargutt, 2005).

An interview study (figure 41) with roughly 300 drivers also shows that people are motivated to relieve the growing monotony whilst driving themselves with additional tasks (Huemer & Vollrath, 2012). 80 percent of the drivers surveyed admitted having carried out one to three activities unrelated to driving in the last half hour, whereby the majority of these were operating non-vehicle equipment. 10 to 20 percent of drivers admitted that the activity had actually distracted them. The drivers reported that in principle it was clear to them that these activities unrelat-

40 Examples of psychological aspects for designing rural roads

Research subject	Research findings
The design of bends (radius, length, transition curve, set of bends) influences driving behaviour.	• Speed is particularly heavily influenced by the bend radius in the lower radius range (up to roughly 150 metres). • The sequence of radiuses and curvature are also significant when choosing speed. • Straights between bends have an accelerating effect. • Drivers use the available information to anticipate the curvature of the bend. If the bend is misjudged though, the speed and steering angle is no longer corrected before the bend but in it. • Drivers use the lane edge marking for guidance in a bend and drive further to the left in their own lane, regardless of the width of the road.
Driving behaviour (above all lane behaviour) is influenced by visual guidance features (lane marking, traffic guidance equipment).	• The marking of previously unmarked stretches does not increase the number of accidents. • Innovative equipment that is based on psychological theories, optical braking (e.g. lane markings), haptic lane narrowing (markings made from rough material, which cause unpleasant vehicle vibrations when driven over at high speed), retro-reflective material, show impressive results but they still rank behind speed checks.
Roadside design (above all using plants) plays a part in driving behaviour.	• Drivers do not take the accident risk caused by trees on the roadside into account in their driving behaviour. • Speed checks in avenues lead to a reduction in the speeds driven.
Geometric dimensions influence driving behaviour more than range of vision.	• Drivers only respond to a reduced range of vision when they exceed the permissible speed limit. • There is far too little adapting of speed. • Drivers have learnt that stationary obstacles only rarely appear on rural roads. • It is not the speed driven but the driver's reaction time that is influenced by reduced visibility.
How the driver characterises the road influences driving behaviour.	• Drivers have formed categories for certain stretches of rural roads that determine the speed driven. • The driver's categorisation of the road does not necessarily match the actual road category and resulting maximum speed.

Source according to Becher et al., 2006

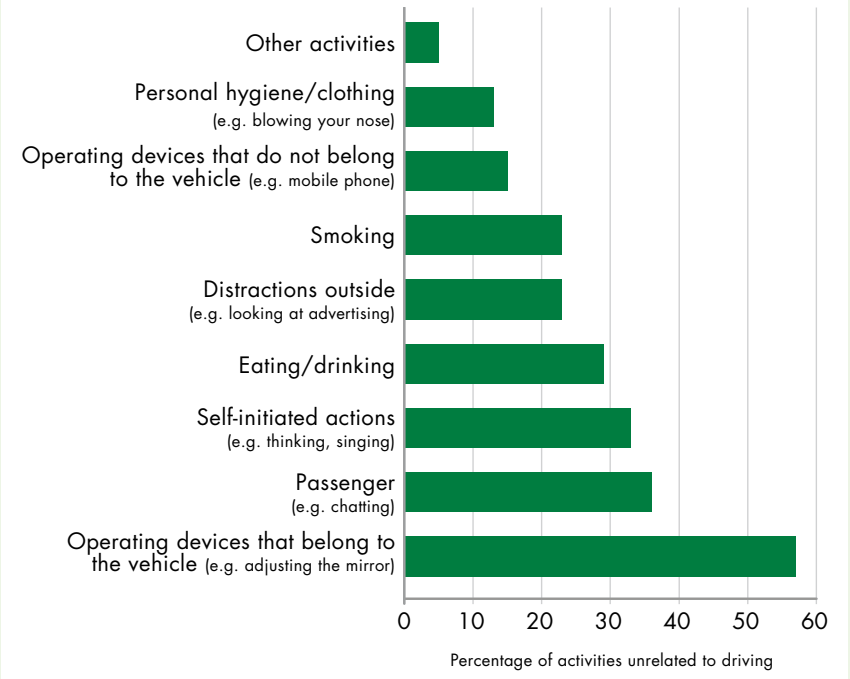
Distraction, among other things by navigation devices and mobile phones, is an accident risk that should not be underestimated.

ed to driving are dangerous. However, in the specific situation this did not apply to them. The results of an analysis of literature (Huemer & Vollrath, 2012) indicate that activities unrelated to driving happen frequently in traffic and are also associated with accidents, although the accident risk caused by this is difficult to estimate.

The problem areas listed show: prevention measures to improve road safety must not be restricted to the vehicle or road construction. Many accident's on Europe's roads can be prevented above all by responsible behaviour, judging your own abilities accurately and accepting rules. It is not without good reason that the "2011 Road Safety Programme" from Germany also states: "Everyone has a responsibility, everyone is being addressed and called upon to prevent accidents and injuries. The requirement for considerate behaviour is imperative particularly in road traffic. The deliberate disregard of traffic regulations is not a minor offence. Every individual has the duty and responsibility to behave in such a way in road traffic that no other people are endangered or harmed."

41

Percentage of activities unrelated to driving with the last half hour at the time of the survey



Source: Huemer & Vollrath, 2012

Rural roads must be made even safer

There is a need for action in many areas to permanently increase road safety on Europe's rural roads. These include measures in terms of the road infrastructure and vehicle engineering, as well as an increased awareness of risks in all road users, plus compliance with regulations and safety standards.

In light of the human suffering and costs associated with road accidents for society, the EU Commission for example estimated costs of approximately EUR 130 billion for accidents on roads in the European Union for 2009, increasing road safety has already been a declared target for years at all levels. Be it by the EU Commission, governments for example in Germany, France, Italy, Austria and Poland or at municipal level: guidelines are being formulated and road safety programmes are being issued everywhere that should contribute to reducing the number of fatalities and people injured in road accidents. The most prominent example are the "Guidelines on Road Safety 2011–2020" published by the EU Commission in March 2011 which sets out the aim of reducing the number of annual fatalities on Europe's roads by half again in the next ten years.

Great importance is attached to rural roads in almost all the programmes. The facts and figures mentioned in the reports in the previous sections highlight why rural roads in particular are the focus of various measures. As on average roughly 60 percent of people killed on roads lose their lives here. This high percentage gains even more importance when you consider that only roughly a quarter of all accidents with personal injury happened on German rural roads in 2011.

The relevance of the topic of rural roads can also be seen at the same time in a wide range of research projects. At this point, just a few projects from the Federal Highway Research Institute are mentioned. For example, the "Recommendations to prevent collisions with oncoming traffic", the "Safety testing of at grade intersection elements", the "Impact, acceptance and durability of elements to separate driving directions" or the "Impacts of cross-section design and longitudinally arranged markings on driving behaviour".

Even though the number of people who died on rural roads EU-wide has significantly decreased over the last few years, the all clear certainly cannot be given on this issue. The potential risk on rural roads is still very high compared to motorways or traffic in built-up areas. In order to achieve sustainable improvement for the future, the accident prevention potential on offer must be used more consistently in the various fields of action.

Besides vehicle-specific safety elements, for example driver assistance and headlamp systems, the road infrastructure in particular also plays an important role in increasing road safety on rural roads. The partially poor condition of rural roads is without a doubt jointly responsible for a large number of accidents, especially when risk increasing factors such as speeding or distraction are added to the mix. Here is just one example on the subject of distraction: If a car is travelling on a rural road within the maximum speed limit of 100 km/h but the driver is distracted for just five seconds, for example by operating the navigation device or glancing at a text message received on their mobile phone, the vehicle covers an uncontrolled distance of almost 140 metres in this time.

However, let's get back to the road infrastructure: The need to specifically invest in the maintenance of roads is also a matter of priority at the highest political level. Structural maintenance is one of the prime objectives in the basic concept on the "Federal Transport Infrastructure Plans 2015" presented by

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DEKRA's demands for greater road safety on rural roads

Road user behaviour

- All road users must be more aware of their responsibility towards themselves and others in road traffic and behave accordingly. Besides greater acceptance of the rules, it is also necessary to obtain information about any new traffic regulations and regularly update your knowledge.
- As the number one lifesaver, the safety belt must always be worn in the front and back seats and children must always be secured.
- To prevent glare for oncoming traffic and road users in front it must be ensured that the headlamps are working properly and are correctly aligned and dipped in good time.

Clarification of regulations and monitoring of compliance with them

- The police and municipalities must carry out more targeted controls at potential danger spots on rural roads to establish the number of offences against traffic regulations relevant to safety (alcohol or drugs at the wheel, speeding, too small a safety distance etc.) and effectively reduce them, if applicable.
- The indication for driving suitability assessment for drivers who have committed an alcohol-related offence must be adjusted to a blood alcohol level of 1.1 to increase road safety. Aggressive behaviour with no direct reference to road traffic also justifies official doubt about driving suitability, as aggressiveness (or increased potential for aggression) makes those concerned a high-risk group.

Infrastructure

- On hazardous stretches of roads, the expansion of sections with a third lane in direction changes must be promoted to enable safe overtaking. If announced in good time, these 2+1 sections can reduce the number of risky overtaking manoeuvres.
- More no overtaking must be introduced and enforced on critical stretches of roads. As prohibition signs on the edge of the road can also be overlooked, they should be consistently supplemented by a solid line on the road (Section 41 Clause 3 of the road traffic regulations – sign 295).
- The speed limit on rural roads must be adapted to the road quality and risk. On well developed stretches of roads, the applicable speed limit for trucks could be increased from 60 to 80 km/h, if application with corresponding amendment to the road traffic regulations. The general principle is: Speed limits must be understandable for drivers. This is the only way that they are accepted.
- Dynamic signage (variable message signs) can also be a real safety benefit on particularly dangerous stretches in order to provide early warnings about temporary hazards, such as fog or icy roads.
- In light of accidents involving impact with an obstacle (tree, post etc.), which usually result in serious injuries or end fatally, roadsides should be protected passively using effective safety barriers or obstacles should be removed, if possible. It must be ensured that there is an adequate safety distance when planting trees next to the road.
- The road layout must be foreseeable and recognisable at all times. Regular maintenance or renewal of lane markings and marker posts is essential for this purpose.
- Sufficient funds and investments are required for an intact road infrastructure (maintenance, expansion and rebuilding of roads). Speed limits because of poor road conditions can also be a temporary emergency measure.
- When building new roads or modernising roads, a preventative and interdisciplinary approach is essential in order to not allow accident blackspots to arise in the first place. For example, it must be standard, among other things, to build a continuous, sufficiently wide and well surfaced hard shoulder and consequently maintain it accordingly.
- Roundabouts are good but they could be better in many places. For example, it should be ensured that the roundabout centre is designed safely. Roundabouts must also be announced in good time and must not suddenly appear as an unforeseeable obstacle. Early, clear recognition is necessary at night, for example by good signage, adequate lighting and retro-reflective marking.
- Intersections, such as junctions or crossroads, must be announced in good time and be clearly visible.
- As motorcyclists make up the second largest percentage of fatalities on rural roads in almost all EU states behind car occupants, the level of guard rail equipment near bends should be increased by covering dangerous mounting brackets with protectors, or even better still by attaching a continuous beam. The "Euskirchen Plus" system developed on behalf of BASt by DEKRA, for example, offers impacting motorcyclists significantly better protection.

Vehicle technology

- Driver assistant systems such as ESP, emergency braking assistants, lane departure warning systems, camera-based active lighting systems or night vision assistants offer great accident prevention potential, especially on rural roads. Greater market penetration would therefore be desirable with these systems.
- It must be guaranteed that mechanical and electronic vehicle safety system components work properly throughout the vehicle's whole life.
- "eCall" is a sensible addition to modern safety engineering in vehicles as an automatic emergency call system, which automatically triggers an electronic emergency call via the mobile phone network in the event of an accident. However, for the efficiency required the system needs technology that works flawlessly in traffic information centres to be able to receive and analyse the incoming data. It is also important that the mobile phone networks are able to internationally process the functions associated with the emergency call.

the Federal Ministry of Transport, Building and Urban Affairs. Additional impetus for greater road safety should also result from the "Guidelines for the layout of rural roads", which are currently still under development. Key innovations in the RAL are, for example, the design of intersections as well as the creation of enough safe overtaking opportunities.

With all the measures regarding even more efficient vehicle technology and better road infrastructure, the person at the wheel is always the one who has the greatest influence on an accident happening and this has also been repeated often in the DEKRA road safety reports in previous years. Vehicle technology and road infrastructure can indeed contribute to not allowing high-risk situations to arise in the first place or lessen their consequences. However, to achieve the target of halving the number of annual deaths caused by road accidents in the EU again by 2020, responsible behaviour, correctly judging their own abilities and a high degree of acceptance of rules is also essential by all road users as well.

Any questions?

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Albrecht, M. (2012). Begutachtung der Fahreignung 2011. Bundesanstalt für Fahreignung. Bergisch Gladbach.

Allgemeiner Deutscher Automobil-Club e. V. (2012). Sichere Landstraßen in Deutschland: Analyse und Bewertung, Kennziffern, Maßnahmen und Handlungsfelder. München.

AXA Konzern AG (2012). AXA Verkehrssicherheitsreport. Eine Studie zum Verhalten der Deutschen im Straßenverkehr. Köln.

Banse, R. (2012). Aggressivität, Straftaten und Fahreignung: Empirische Zusammenhänge und Implikationen für die Fahreignungsbegutachtung. Zeitschrift für Verkehrssicherheit, 58(3), Seite 119–123.

Becher, T., Baier, M. M., Steinauer, B., Scheuchenpflug, R., & Krüger, H.-P. (2006). Berücksichtigung psychologischer Aspekte beim Entwurf von Landstraßen: Grundlagenstudie. Verkehrstechnik, Heft V 148. Bergisch Gladbach.

Berg, A. (2007). Langzeitentwicklung der Fußgängerunfälle. Statistische Analysen – Einfluss der Fahrzeugentwicklung. Tagungsband VKU-Konferenz Fußgängerunfälle und Fußgängerschutz, Interdisziplinärer Kongress, 7. und 8. Dezember 2007, Aachen.

Berg, A., Ahlgrimm, J. (2010). Baumunfälle – nach wie vor Handlungs- und Forschungsbedarf. Verkehrsunfall und Fahrzeugtechnik, April 2010, Seite 118–126.

Berg, A., König, J. (2008). Accident Involvement of Motorcycles – Description of the Current Situation in Germany Using Data from Federal Statistics and In-Depth-Studies. Proceedings 3rd International Conference ESAR Expert Symposium on Accident Research, September 5–6, 2008, Hannover.

Blomberg, R. D., Peck R. C., Moskowitz, H., Burns, M., Fiorentino, D. (2005). Crash Risk of Alcohol Involved Driving: A Case-Control Study. Stamford.

Borkenstein, R. F., Crowther, R. F., Shumate, R. P., Ziel, W. B., & Zylman, R. (1974). The role of the drinking driver in traffic accidents (The Grand Rapids Study). Blutalkohol, 11.

Bundesverfassungsgericht, 1 BvR 2652/03.

Bundesministerium für Verkehr, Bau und Stadtentwicklung (2011). Verkehrssicherheitsprogramm 2011. Berlin.

Bundesministerium für Verkehr, Bau und Stadtentwicklung, Bundesanstalt für Straßenwesen (2012). Straße im 21. Jahrhundert. Innovativer Straßenbau in Deutschland. Berlin, Bergisch Gladbach.

Bundesministerium für Verkehr, Bau und Stadtentwicklung (2012). Grundkonzeption für den Bundesverkehrswegeplan 2015, Entwurf. Berlin.

Bundesministerium für Verkehr, Innovation und Technologie (2011). Österreichisches Verkehrssicherheitsprogramm 2011–2020. Wien.

Deutscher Bundestag (2012). Unterrichtung durch die Bundesregierung: Bericht über Maßnahmen auf dem Gebiet der Unfallverhütung im Straßenverkehr 2010 und 2011. Drucksache 17/10600.

DEKRA, AXA Winterthur Versicherungen (2009). Landstraßen – wie sicher sind sie wirklich? Zahlen und Fakten zum Medien- und Gästetag der Crashtests in Wildhaus (Schweiz) am 18. Juni 2009.

DEKRA, Deutscher Verkehrssicherheitsrat, Deutsche Verkehrswacht (2012). Abschlussbericht SafetyCheck 2012. Stuttgart.

Eid, V., Ellinghaus, D., Funck, Ph., Koch, H., Manssen, G., Meewes, V., Neumann, K., Peters, J. (2005). Schutz von Mensch und Baum. Empfehlungen zum Schutz vor Unfällen mit Aufprall auf Bäume (ESAB). Gesamtverband der Deutschen Versicherungswirtschaft e. V., Verkehrstechnisches Institut der Deutschen Versicherer, Berlin.

Ellinghaus, D. (1986). Rücksichtslosigkeit und Partnerschaft: Eine sozialpsychologische Untersuchung über den Umgang unter Kraftfahrern im Straßenverkehr. Köln: IFAPLAN, Ges. für Angewandte Sozialforschung und Planung.

Fastenmeier, W., Pfafferott, I., Risser, R., Schneider, W. (2007). Ergonomische Ansätze der Verkehrspsychologie – Verkehrspsychologische Grundlagen für die menschengerechte Verkehrsraum- und Fahrzeuggestaltung. Straßenverkehrstechnik 11/2007.

Grundgesetz für die Bundesrepublik Deutschland, vom 23.05.1949 (BGBl. I S. 1), zuletzt geändert durch Gesetz vom 11.07.2012 (BGBl. I S. 1478).

Hargutt, V., Krüger, H.-P., Knoche, A. Driving under the influence of alcohol, illicit drugs and medicines. Risk estimations from different methodological approaches. DRUID Deliverable (1.3.1).

Heinrich, S., Pöppel-Decker, M., Schönebeck, S., Ulitzsch, M. (2010). Unfallgeschehen auf Landstraßen: Eine Auswertung der amtlichen Straßenverkehrsunfallstatistik. Mensch und Sicherheit, Heft M 209. Bergisch Gladbach.

Hennessy, D. A., Wiesenthal, D. L., Totten, B. (2003). The influence of music on mild driver aggression. Transportation Reseach Part F, 6, Seite 125–134.

Herzberg, P. Y. (2004). Aggression im Straßenverkehr. In B. Schlag (Ed.), Verkehrspsychologie. Mobilität – Sicherheit – Fahrerassistenz (pp. 177–196). Lengerich: Pabst Science.

Herzberg, P. Y., Schlag, B. (2006). Aggression und Aggressivität im Straßenverkehr. Zeitschrift für Sozialpsychologie, 37(2), Seite 73–86.

Holte, H., Assing, K., Pöppel-Decker, M., & Schönebeck, S. (2010). Alkoholverbot für Fahranfänger: Evaluation der Wirksamkeit (Mensch und Sicherheit, Heft M 211). Bergisch Gladbach.

Huemer, A. K. & Vollrath, M. (2012). Ablenkung durch fahrtremde Tätigkeiten: Machbarkeitsstudie (Mensch und Sicherheit, Heft M 225). Bergisch Gladbach.

Istituto Nazionale di Statistica (2012). Incidenti stradali 2011. Rom.

Jährig, Th. (2012). Wirksamkeit von Maßnahmen zur Verbesserung der Verkehrssicherheit auf einbahnigen Landstraßen. Dissertation, Fakultät Verkehrswissenschaften „Friedrich List" der Technischen Universität Dresden.

Junger, M., Keane, C.,van der Heijden, P. M. G. (2001). Interrelated Harms: Examing the associations among victimization, accidental injuries, and criminal offending. Injury Control and Safety Promotion, 8, Seite 13–28.

Krüger, H.-P. (1995). Das Unfallrisiko unter Alkohol: Analyse, Konsequenzen, Maßnahmen. Stuttgart: G. Fischer.

Krüger, H.-P., Hargutt, V. (2005). Vigilanzminderung, Ermüdung, Müdigkeit: Ursachen, Erkennung und Gegenmaßnahmen. In B. Madea (Ed.), Kongressbericht der Deutschen Gesellschaft für Verkehrsmedizin e. V. Bonn. 10. bis 12. März 2005. Bremerhaven: Wirtschaftsverlag NW.

Kühn, M., Bakaba, E. (2009). Bekämpfung von Baumunfällen auf Landstraßen. Verkehrsunfall und Fahrzeugtechnik Heft 12, Dezember 2009, Seite 374–380.

Lippold, Chr., Weise, G., Jährig, Th. (2012). Verbesserung der Verkehrssicherheit auf einbahnig zweistreifigen Außerortsstraßen (AOSI). Berichte der Bundesanstalt für Straßenwesen, Verkehrstechnik Heft V 216. Wirtschaftsverlag NW, Verlag für neue Wissenschaft GmbH, Bremerhaven.

Mader, H.-J. (1999). Bedeutung und Entwicklungspotenzial der landschaftsprägenden Alleen. Kompendium zur 3. Verkehrssicherheitskonferenz des Landes Brandenburg, April 1999. Herausgeber: Ministerium für Stadtentwicklung, Wohnen und Verkehr des Landes Brandenburg, Referat Öffentlichkeitsarbeit, Potsdam.

Mattern, R., Schubert, W., Kaufmann, T., Schmitt, G., Stewin, C., Weinmann, W. (2010). Indikation zur Überprüfung der Fahreignung bei schädlichem Alkoholkonsum. In W. Schubert & V. Dittmann (Eds.), Faktor Mensch – Zwischen Eignung, Befähigung und Technik. Tagungsband des 5. Gemeinsamen Symposiums der DGVP und DGVM. Bonn: Kirschbaum Verlag.

Maxwell, J. P., Grant, S., Lipkin, S. (2005). Further validation of the propensity for angry driving scale in British drivers. Personality and Individual Differences, 89, Seite 213–244.

Moskowitz, H., Fiorentino, D. (2000). A review of the literature on the effects of low doses of alcohol on driving-related skills (Report no. DOT HS 809 028). Washington, DC: US National Highway Traffic Safety Administration.

Moskowitz, H., Robinson, C.D. (1988). Effects of low doses of alcohol on driving-related skills: A review of the evidence (Report no. DOT HS 807 280) Washington, DC: US National Highway Traffic Safety Administration.

Nickel, W.-R., Schubert, W. (Eds.) (2012). Best Practice Alkohol-Interlock: Erforschung alkoholsensitiver Wegfahrsperren für alkoholauffällige Kraftfahrer. Literaturstudie, Bewertung und Designperspektiven. Bonn: Kirschbaum Verlag.

Niewöhner, M., Siupka, O., Ritter, S. (2012). Ermittlung von Gurtanlegequoten in Deutschland, Mai 2012. DEKRA Technology Center, Unfallforschung, Stuttgart.

Observatoire national interministériel de sécurité routiere (2012). La sécurité routière en France 2011. Paris.

Otte, D. (2000). Charakteristika von Unfällen auf Landstraßen, Berichte BAST Mensch und Sicherheit Heft M 122.

Sachs, H. & Schubert, W. (2011). Abstinenzprogramm – Drogen – Alkohol. 12. Forum Arbeitsmedizin. 6.–8. Juli 2011 in Deggendorf

Schade, F.-D., Heinzmann, H.-J. (2011). Sicherheitswirksamkeit des Begleiteten Fahrens ab 17: Summative Evaluation (Mensch und Sicherheit, Heft M 218). Bergisch Gladbach.

Schlag, B. (Ed.) (2004). Verkehrspsychologie: Mobilität – Sicherheit – Fahrerassistenz. Lengerich: Pabst Science.

Schindler, V., Kühn, M., Siegler, H. (2004). Intelligente Rückhaltesysteme. Berichte der Bundesanstalt für Straßenwesen, Fahrzeugtechnik Heft F 52. Wirtschaftsverlag NW, Verlag für neue Wissenschaft GmbH, Bremerhaven.

Schnabel, E. (2011). Alcohol and driving-related performance – A comprehensive meta-analysis focusing the significance of the non-significant (Dissertation). Julius-Maximilian-Universität Würzburg.

Schubert, W., & Mattern, R. (2009). Urteilsbildung in der medizinisch-psychologischen Fahreignungsdiagnostik: Beurteilungskriterien (Erweiterte und überarbeitete 2. Auflage). Schriftenreihe Fahreignung. Bonn: Kirschbaum Verlag.

Selg, H., Mees, U., Berg, D. (1997). Psychologie der Aggressivität. Göttingen: Hogrefe.

Statistisches Bundesamt (2012). Verkehrsunfälle 2011. Wiesbaden.

Statistisches Bundesamt (2012). Unfälle unter dem Einfluss von Alkohol oder anderen berauschenden Mitteln im Straßenverkehr 2011. Wiesbaden.

Stephan, E. (2011). Die Gestaltung von Autobahnen im Spannungsfeld von Ablenkung und Monotonie. In B. Wilhelm, E. Stephan, V. Dittmann (Eds.), Tagesschläfrigkeit. Gefahren und Konsequenzen für den Straßenverkehr. 6. Gemeinsames Symposium der DGVM und DGVP am 1./2. Oktober 2010 in Tübingen, Seite 40–49). Bonn: Kirschbaum Verlag.

Stewin, C. (2010). Indikation zur Fahreignungsbegutachtung bei schädlichem Alkoholkonsum aus psychologischer Sicht (Diplomarbeit). Humboldt-Universität zu Berlin.

Straßenverkehrsgesetz in der Fassung der Bekanntmachung vom 5. März 2003 (BGBl. I S. 310, 919), das zuletzt durch Artikel 2 Absatz 118 des Gesetzes vom 22. Dezember 2011 (BGBl. I S. 3044) geändert worden ist.

United Nations (2011). Global Plan for the Decade of Action for Road Safety 2011–2020.

Voß, H. (2007). Unfallhäufungen mit Wildunfällen. Modellversuch im Oberbergischen Kreis. Gesamtverband der Deutschen Versicherungswirtschaft e. V., Unfallforschung der Versicherer. Berlin.

Wallner, B. (2013). Untersuchungen zum aktuellen Unfallgeschehen mit Anprall an Bäumen neben der Fahrbahn. Studienarbeit am Institut für Fahrzeugsicherheit der Technischen Universität Graz.

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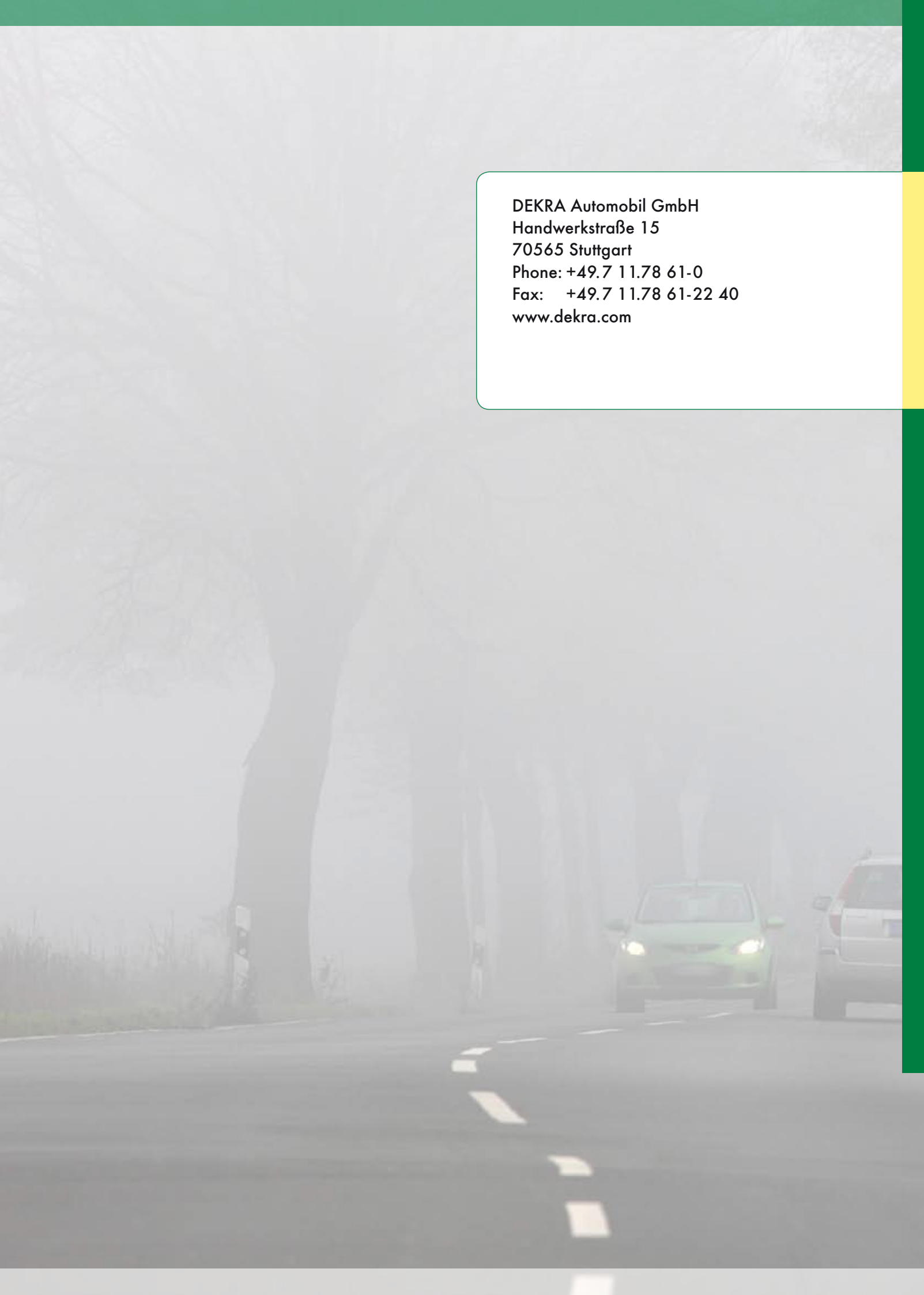

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