STATUS REPORT, FEDERAL REPUBLIC OF GERMANY

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1 STATUS AND TRENDS

1.1 Road accidents in Germany

The total number of police registered road accidents has stagnated for the last 10 years – between 2.2 and 2.4 million road accidents. There were slight increases in single years such as 2004, 2007 or 2010, but as well slight decreases in 2002 or 2011. On the long run, there is an increase since 2000 by 2.7 percent in 2013. The forecast for 2014 thus indicates a decrease in accident figures by roundabout 2 percent (2013: 2.41 million road accidents).
The number of road accidents with personal injury has decreased by 24 % since 2000, resulting in 291,105 road accidents with personal injury in 2013. For 2014 a slight increase of almost 2.5 percent to approximately 298,000 injury accidents is expected.
Casualty figures have also decreased, with lower reductions for slight injuries and higher reductions for severe injuries and fatalities. The total number of casualties has decreased by more than 26 percent from 511,577 in 2000 to 377,481 in 2013. For 2014 the increased number of injury accidents will lead also to an increased number of casualties of approximately 2.5 percent compared to 2013 – to about 387,000 casualties in 2014.
Since 2000, the number of severe injuries has been reduced by nearly 37 percent to 64,057 seriously injured road users in 2013 and the number of slight injuries has been reduced by nearly 23 percent to 310,085 slightly injured road users. Fatalities have decreased by 55 percent from 7,503 fatalities in 2000 to 3,339 fatalities in 2013. A slight increase to approximately 3,360 fatalities has been predicted for 2014.
According to the positive development on the long term, the year 2013 showed the lowest number of fatalities since introduction of accident statistics. And also for the number of injury crashes and casualties the year 2013 was the second best after 2010, when accident figures were even lower than 2013.
But the forecast for 2014 with stagnating or even increasing numbers shows, that the positive development cannot be taken for granted. While many factors concerning e.g. safety behavior or vehicle and infrastructure safety play an important role for the long term development of fatality and crash figures, short-term increases result mainly from changes in mobility and traffic behavior due to different and extreme weather conditions. The year 2014 was characterized by an early and mild spring, resulting in high accident and fatality figures concerning mainly motorized and non-motorized two-wheelers.

1.2 Socio-economic costs due to road traffic accidents in Germany

The Federal Highway Research Institute (BASt) calculates the costs of road accidents on an annual basis. The costs of road traffic accidents to Germany's national economy include personal injuries and damage to goods.
The calculated costs include direct costs (e.g. for medical treatment, vehicle repair/replacement), indirect costs (for police services, the legal system, insurance administration, replacement of employees), lost potential growth (including the shadow economy), lost added value of housework and voluntary work, humanitarian costs, costs of monetised travel time losses due to accidents on motorways. Using the developed calculation model an analysis of very severe injuries and the effect of underreporting on total accident costs could be accomplished.
The calculated total accident costs for 2012 amounted to approximately 32.11 billion Euro.
Furthermore, personal injuries amounted to 13.54 billion Euro. Costs of about 18.57 billion Euro were caused by damage to goods.

The costs per person add up to 1.62 million Euro for a fatality, 116,151 Euro for a severely injured person and 4,829 Euro for a slightly injured person.

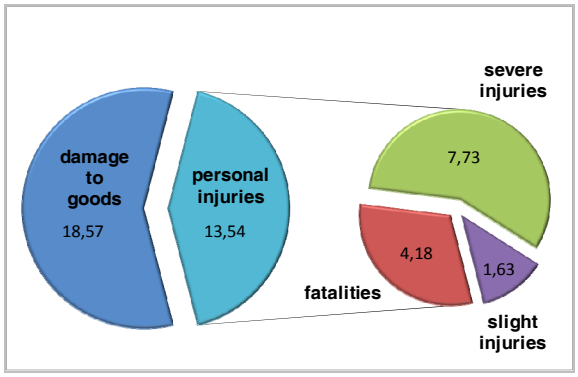

Figure 1: Costs due to road traffic accidents in 2012 (billion Euro)

1.3 German Road Safety Programme

The German Road Safety Program was launched in autumn 2011 and will be running for ten years until 2020. The principal aim of the program is to enable safe, ecologically sensitive and sustainable mobility for all road users in Germany. It comprises a wide range of road safety measures addressing road users, vehicles and the road infrastructure.
The program addresses new challenges (e.g. demographic change and mobility of elderly) and aims at safeguarding the efficiency of the road network. At the same time, it reflects recent technological developments in vehicles such as driver assistance systems, cooperative vehicle systems or new engine concepts. In these latter areas, the main focus lies on ensuring that the development of vehicle technology induces safety gains rather than safety risks. Activities also focus on rural roads and on reducing not only the number of fatalities, but also the number of serious injuries.
For the first time, a quantitative target of -40% for fatalities by the year 2020 was set. The target was defined on the basis of scientific research regarding the expected development of road safety until the year 2020 (R. Maier et al., 2012 a). The monitoring and assessment of road safety measures and the development towards the target is done by the Road Accident Prevention Report, which is prepared every two years and submitted to the German Bundestag. In 2015, a Midterm Report will be launched, taking stock of the first half of the road safety program. Until 2013 the number of fatalities has been reduced by 16,7 % since 2011. On condition of a prolongation of this trend into the coming years Germany is well on its way to achieve the reduction of 40 % by 2020.

2 RESEARCH

2.1 Finished projects

2.1.1 AsPeCSS

The ASPECSS project (Assessment methodologies for forward looking integrated pedestrian and further extension to cyclists safety systems) focused on passenger cars' forward looking safety systems that are designed to address pedestrian and cyclist accidents. The project's aim was to deliver harmonised test procedures as input for further regulatory and consumer rating activities as well as to develop a methodology to assess the integrated safety systems (benefit of the linkage from both vehicle's active and passive safety systems). Other initiatives that contributed to the definition of test and rating procedures were the AEB (Autonomous Emergency Braking) group and the vFSS (vorausschauende Frontschutzsysteme / advanced forward looking safety systems) group. Final test procedures had been discussed and defined within Euro NCAP, based on input of all of these initiatives. The four final test cases for pedestrian AEB systems had then undergone extensive validation and verification testing by various test labs, and as a result, the test procedure has proven to be able to compare the performance of different types of pedestrian AEB systems.
In parallel to the work done by ASPECSS, AEB group and vFSS, specifications for a propulsion system as well

as for the pedestrian dummy had been defined. A proper combination of propulsion system and dummy is now available for testing. It is expected that testing within Euro NCAP will start as announced by beginning of 2016.

Figure 2: Testing of pedestrian AEB system.

2.1.2 InteractIVe

After almost four years of work, the integrated project interactIVe has reached its completion, marking major progress towards the realisation of advanced safety systems for Intelligent Vehicles.
The main achievement is the creation and evaluation of integrated ADAS (Advanced Driver Assistance Systems), characterised by outstanding capabilities for supporting the driver in varied traffic scenarios, and specifically for avoiding hazardous situations. Several new safety functions have been implemented in six passenger cars and one truck, based on the following pillar concepts: continuous driver support, collision avoidance, and collision mitigation. These vehicles have granted a comprehensive validation in a large set of field trials, in some cases combined with driving simulator experiments. Special attention has been given to low cost solutions for all the vehicle segments.
Multiple integrated functions were developed for continuous driver support, but also for executing active interventions for collision avoidance and collision mitigation purposes are served by an integrated perception layer. The primary objective was to extend the ADAS scenarios range and usability by introducing a unique access point, the so-called perception layer, where not only different fusion approaches will fit into the same concept, but also all applications have an access to sensor-, digital maps- and communication data through a common interface: the Perception Horizon.
Different types of sensors were used ranging from radars, cameras and lidars to GPS receivers for the extraction of the electronic horizon.
In parallel to this, work was also initiated by the development of detailed use-cases. The use-cases describe how the functions in the different demonstrator vehicles should resolve so called target (accident) scenarios. This work led to Information, Warning and Intervention (IWI) strategies. The IWI strategies should be applicable both to the specific demonstrator vehicles in the interactIVe project as well as to ADAS beyond the project.
The general IWI strategies can be seen as Human Factors guidelines or general functional requirements for ADAS. The development of IWI strategies was carried out iteratively. The use-cases and initial requirements from the vertical sub-projects served as a starting point in order to define the functions. Strategies were evaluated in different simulator and test track experiments and updated based on the outcome of the experiments.
The analysis of legal aspects for broad exploitation of the interactIVe applications was carried out. This work clearly identified the current steering system regulation UN-R 79 as being the most relevant hurdle for the introduction of new, more automated ADAS technologies.

2.1.3 Global technical regulation on pedestrian safety

An Informal Working Group on GTR9 Phase 2 chaired by Germany and with intensive contributions of BASt has prepared both, a second phase for a global technical regulation on pedestrian safety as well as the 01 series of amendments of UN regulation 127, both introducing a new flexible pedestrian impactor (FlexPLI), better reflecting the human response and kinematic behaviour of a pedestrian in case of an impact. In the meantime, UN-R 127.01 has been adopted by WP.29 and is being applied by the contracting parties since January 2015.

In parallel, a Task Force of the IWG redefined the bumper area being subjected to tests with the FlexPLI. A proposal of the Task Force, in principle stating the hard structure under the bumper fascia to define the width of the test area, has been already endorsed by GRSP at its December 2014 session.

2.1.4 Pedestrian safety

Within the Euro NCAP consortium, a technical working group updated the pedestrian test and assessment protocols. Amongst other things, the FlexPLI has been introduced and is being assessed against injury criteria and performance limits proposed by BASt. The new upper legform test is now focusing on the injured body region pelvis and femur rather than on the injury causing part. A new test with the child headform impactor against the bonnet leading edge was proposed by BASt and was introduced in 2015 as monitoring test for defined vehicle heights.

2.1.5 Cyclist safety

Cyclists as the second group of vulnerable road users are currently not addressed by provisions of passive safety. Therefore, BASt initiated the development of a test and assessment procedure for passive cyclist safety, revising, where necessary, the pedestrian test procedures by addressing the particularities of vehicle to cyclist accidents in terms of boundary conditions, following real world accident data and impact kinematics.

2.1.6 Motorcycle helmets

The numbers of accidents involving motorcycles with severe or fatal injuries are still on a very high level compared to other traffic participants. Motorcycle helmets are a substantial part of the protection devices in accidents. Requirements for motorcycle helmets are specified in the UN-R 22 with regard to visibility, shock absorption and others.
In order to reduce this high number of seriously injured or killed motorcycle riders a research project was conducted to establish recommendations for an improvement of the UN-R 22 concerning the type of test, test equipment, test criteria and limits.
Therefore, national and in-depth accident data (GIDAS) were analyzed and supplementary computer based FEM simulations were performed to better understand the injury mechanism and injury pattern of helm protected head injuries. In addition, different new head injury criteria and head finite element models were discussed.
The statistics from national accident data have shown that in 2013, 641 riders were killed and 12,034 were seriously injured in a total number of 42,427 PTW (powered-two-weheeler) accidents. The analysis of motorcycle accidents in GIDAS was based on a subgroup of motorcycle drivers with MAIS 3+ injuries (n=199). In most cases, a protective helmet had been used. In 18%, the main injuries were located in the region of the head; in 48%, the victims had no head injuries but serious to critical or fatal injuries to the body. About 10% of the motorcycle riders had no helmet at all or used an absolutely unsuitable helmet.
Recommendations with regard to the type of testing, test velocities, test temperature and test criteria have been made.

2.1.7 Rear Underrun Protection

UN-R 58 governs the design and installation of rear underrun protection devices on vehicles of categories N2, N3, O3 and O4. Nevertheless, rear end collisions – especially those involving vehicles of category M1 – with the aforementioned categories of commercial vehicles are characterized by a high level of accident severity. Germany thus submitted a proposal to the UNECE suggesting that the regulation be amended. This would include, inter alia, increasing test forces and reducing ground clearance. Using an injury risk model based on German national accident statistics, it is estimated that these measures could reduce the number of fatalities by 53 to 78 % and the number of seriously injured casualties by 27 to 49 % in such accident constellations, which is equivalent to 20 fatalities and 95 seriously injured casualties per year. In monetary terms, the benefit would be 35.7 million euros. The costs for the goods vehicles and trailers affected each year would be between 5 and 20 million euros, depending on how the costs are estimated. Thus, the benefit-cost ratio for the proposed measures is between 1.78 and 7.
Related to relevant accidents at EU 27 level based on a CARE database analysis, the benefit is estimated to be higher than in Germany by at least a factor of 9, whereas fleet-dependent costs would only exhibit a factor of 4. Thus, for the European commercial vehicle fleet and the accidents in which they are involved, it can be estimated that the effectiveness at EU 27 level would be at least as high as in Germany.
Against the background of the problems associated with HGV rear underrunning, the question arises as to whether passenger car emergency braking systems can, in the near future, represent an effective and efficient alternative for improving the situation of rear underrun accidents. For Germany the benefit from introducing an

ideal emergency braking system for all passenger cars would be around 842 million euros per year, while the costs for 3 million newly registered vehicles per year in Germany would be between 489 and 917 million euros. This produces a benefit-cost ratio of 0.9 to 1.7. By comparison, improving the Rear Underrun Protection Regulation would prevent 38 % (20 of 53) of the fatalities theoretically addressed by an emergency braking system but would only cause 2 % of the costs of passenger car emergency braking systems.

2.1.8 Impact of age related changes on injury biomechanics and test tools/procedures

The demographic change results in a higher participation of older people in traffic which leads to increased risk of accidents and injury of this particularly vulnerable group. The passive vehicle safety still shows potential for improvement to address this increasing challenge. BASt is supporting this in particular by contribution to research towards the optimization of test tools and procedures for passive vehicle safety in regulation and consumer testing. To enable this, BASt has been involved in a variety of research projects and regulatory activities in particular addressing to age-related conditions of road users.
E.g. as part of the revision of the UN-R 94 for frontal impact of cars the injury criteria of the Hybrid III dummies were adjusted to take into account the injury tolerance of older car occupants. Further a research project addressing injury biomechanics of elderly was funded by BASt, which was completed in 2014. The aim of this project was to identify age-related anthropometric differences of the bony thorax based on medical imaging methods (Figure 4). The results allow the adaptation of a numerical human model to represents an older vehicle occupant. This model can be used for further simulation-based investigations to improve the passive vehicle safety for elderly occupants.

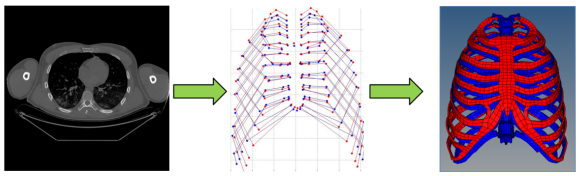

Figure 3: Age-related anthropometric differences of the human bony thorax

On February 12, 2014 the symposium "Trauma biomechanics of older road user - Challenges of Demographic Change" was held at BASt with around 70 participants. The event focused on biomechanical age-related changes of older road users, which may have an effect on accident risk and road safety in general of elderly road users. During the symposium, studies were presented based on current accident data indicating the priorities of the injuries of older road users. In addition, recent biomechanical research results were presented. Furthermore possible technical solutions of vehicle safety systems to take into account biomechanical differences of elderly car occupants were discussed.
BASt will continue to investigate the impact of demographic change on a necessary adaptation of testing and evaluation methods of passive vehicle safety. Specifically, this means a further contribution towards an optimization of wheelchair restraint systems as well as in the development of frontal impact test methods and the frontal impact dummy THOR with corresponding age-related injury criteria. This will be supported by increased use of numerical simulation models of human body.
Some of these research activities including further work on the THOR dummy will take place in the EU funded research project SENIORS (Safety-Enhancing Innovations for Older Road Users). The project will start in June 2015 with a duration of about 3 years under the coordination of BASt. It is based on an integrated approach to improve the safe mobility of older road users in the context of demographic change. All relevant modes of transport are taken into account in the road with a focus on vehicle occupants as well as pedestrians and cyclists.

2.1.9 Child restraint systems

The work of the UNECE/GRSP Informal Group “Child Safety” deals with the new regulation UNECE R129 for child restraint systems (CRS). A step by step approach is implemented. The Phase 1 dealing with with ISOFix Integral “Universal” CRS (“i-Size”) is finalized. The new regulation includes side impact testing, an updated test bench and the use of the Q-dummies. The weight group system has changed to a standing height based system which is easier to understand by users. Up to an age of 15 month an “i-size” CRS has to be rearward facing. The new regulation gives the possibility to have universal rearward facing CRS with ISOFix anchorages. The use of CRS homologated according to the UNECE R129 is implemented in the German regulation. To support the use of the CRS and explain the new regulation a brochure “Kindersicherheit im Auto” will be published by BASt. The brochure will be also available for download in English (“Child Safety in Cars”).

2.1.10 Smoke and toxicity in bus fires

Bus fires occur frequently but are usually not accompanied with severely injured persons. In most of the cases the fire starts in the engine compartment and does not affect any passengers because they can leave the bus in time. However single accidents, in which the fire enters the passenger compartment, resulted in a high number of fatalities. More dangerous than the fire itself is the toxicity of smoke gases due to burning interior parts made of plastic materials.
BASt therefore initiated a research project with regard to the fire safety performance of buses including smoke development and its toxicity. The study was elaborated by BAM (Bundesanstalt für Materialforschung und -prüfung, Federal Institute for Materials Research and Testing, Germany) and was published recently. Burning behaviour tests were carried out with small specimen of bus interior material, with complete seats and using whole buses in order to examine possibilities to further increase bus fire safety and to determine how far it is possible to transfer and adapt existing rail requirements to buses.
Some of the outcome of the experiments is already incorporated into international legislation. Especially UN-R 107 and 118 cover bus fire safety performance. E. g. fire detection systems in the engine compartment and smoke detection systems in separate interior compartments which turned out to be very useful are already required. Also testing of certain properties of insulation materials to repel fuel or lubricant as well as testing vertical burning rates for vertically mounted parts is specified in the UN regulations.
The most important results of the work concern smoke development and toxicity of smoke gas components which are still not covered by legislation. As demonstrated in the experiments, in case of a fire the air in a passenger compartment of a bus is quickly filled with large amounts of opaque smoke that impair visibility. Requirements limiting smoke density and toxic smoke gas concentrations would help to increase the time of escape for passengers in case of a bus fire so that they are not exposed to the toxic components that are produced when bus parts are burning. It is not sufficient to limit all components together by a weighted sum as in the current rail standard since single gases might be lethal although the sum limit is not exceeded. It is rather recommended to limit concentrations for each single component. The study further recommends that the concept to use fire suppression systems in the engine compartment should be persued further.
The transposition of the recommendations of this study into UN regulations is currently discussed on national level. The report is available for download: http://www.bast.de/DE/FB-F/Publikationen/Download-Publikationen/Downloads/F1-busFireProject.pdf.

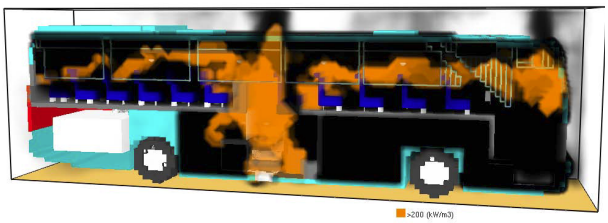

Figure 4: Bus fire simulation (source: BAM)

2.1.11 Periodic Roadworthiness Tests

The current Directive 2009/40/EC includes minimum standards for the periodic roadworthiness tests of motor vehicles (regular vehicle checks required by law) and will be replaced by the Directive 2014/45/EC. The current Directive 2009/40/EC is repealed with effect from 20 May 2018.
The current Directive applies to passenger cars, buses, coaches, light and heavy goods vehicles and their trailers (with more than 3,5 tons maximum authorized mass), but not to scooters, motorbikes, tractors and other smaller trailers.
In the Directive 2014/45/EC (Official journal of the European Union / L127 / 29th of April 2014, Volume 57) the scope of vehicles to be tested is extended to two- or three-wheel vehicles from 1. January 2022 (vehicle categories L3e, L4e, L5e and L7e, with an engine displacement of more than 125 cm) and wheeled tractors of category T5. These two categories of vehicles are currently not compulsory under EU law. Also vehicles of historic interest have now been more precisely defined. Other aspects such as the minimum training of inspectors and the common data exchange are also part of the Directive. The still outstanding implementing acts will cover the verification of the electronic vehicle safety systems, such as Adaptive Cruise Control and the exchange of data between the Member States.
The European Commission contracted a consortium led by CITA including BASt to undertake a project to develop and evaluate roadworthiness inspection methods for the inspection of the functionality and performance of Electronically Controlled Safety Systems (ECSS) and perform a cost benefit analysis for their potential introduction into European legislation.

For this purpose 2,654 tests on electronic systems were performed during field tests. The stored error messages of the tested vehicles cannot be associated with existing defects or are only relating to a low voltage of the vehicle. Therefore those error messages of the electronic systems are not suitable for the purpose of Periodic Technical Inspection at this time. In addition, it has been found, that the reference value method is a suitable additionally method to assess the deceleration and the brake force distribution. The final report was transmitted in July 2014 to the Directorate General MOVE of the European Commission: http://www.cita-vehicleinspection.org/Home/Studies/ECSS/tabid/560/Default.aspx.

Figure 5: scan tool used in ECSS

2.1.12 EVERSAFE

The objective for EVERSAFE was to provide safety requirements for electrically propelled vehicles, thus answering the current need for standardization within the area. This was achieved through the investigation of potential safety issues of electric vehicles and further complemented with a study of user safety concerns. This allowed for the identification of real and perceived safety risks which were needed to be addressed by the developed safety requirements. Under the scope of the EVERSAFE project, safety issues were categorized in two groups:

• Active/Primary Safety: Under this topic vehicle stability was addressed under fault conditions which would not arise in a conventional vehicle, i.e. failures in wheel hub motors, faulty regenerative braking systems.

• Passive/Secondary Safety: Within this area, the focus was set on the fields of crash compatibility (conventional fleet meets electric fleet) and Energy Storage Systems behaviour under and after crash loads (focusing on Li-ion batteries). Major results were recommendations for the safe testing of electric vehicles and/or their main components in regulations and standards as well as an updated safe handling procedure for rescue services to be considered in case of a severely damaged electric vehicle in crash.

To mitigate the safety issues identified by EVERSAFE, the delivered safety recommendations also revealed needs for further research efforts and comprised suggestions for standardization to be implemented by both industry and legislation.

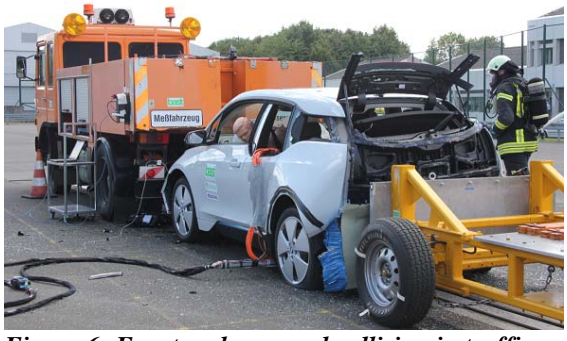

Figure 6: Front and rear-end collision in traffic congestion scenario

2.2 Ongoing research

2.2.1 Turning Assist Systems for trucks

Accidents between right turning trucks and straight riding cyclists often show massive consequences. Accident severity is much higher than in other accidents. The situation is critical especially due to the fact that, in spite of the mirrors that are mandatory for ensuring the field of view for the truck drivers, cyclists in some situations

cannot be seen or are not seen by the driver. Either the cyclist is overlooked or is in a blind spot area that results from the turning manoeuvre of the truck and its articulation if it is a truck trailer or truck semitrailer combination.
At present driver assistance systems are discussed that can support the driver in the turning situation by giving a warning when cyclists are riding parallel to the truck just before or in the turning manoeuvre. Such systems would generally bear a high potential to avoid accidents of right turning trucks and cyclists no matter if they ride on the road or on a parallel bicycle path. However, performance requirements for such turning assist systems or even test procedures do not exist yet.
BASt therefore carries out a research project in order to develop a testing method and elaborate requirements for turning assist systems for trucks. In-depth accident data was evaluated case by case in order to find out which are representative critical situations. These findings served to determine characteristic parameters (e.g. boundary conditions, trajectories of truck and cyclist, speeds during the critical situation, impact points). Based on these parameters and technical feasibility by current sensor and actuator technology, representative test scenarios and pass/fail-criteria are defined.
After having fixed the set of test cases and parameters a validation phase has to follow. For that purpose trucks equipped with turning assist system will be used. It will be examined if the system is able to inform the driver when necessary and how far it is still annoying due to possibly given false warnings.
It can be expected that a turning assist system that fulfils the requirements and tests elaborated in this study will have a very positive influence on accident figures concerning right turning trucks and cyclists. The test procedure is meant to be the basis for an international discussion on introducing turning assist systems in vehicle regulations at UNECE level.

2.2.2. Study on Camera-Monitor-Systems

Within the automotive context camera monitor systems (CMS) can be used to present views of the traffic situation behind the vehicle to the driver via a monitor mounted inside the cabin. This offers the opportunity to replace classical outside and inside rear-view mirrors and therefore to implement new design concepts, aerodynamically optimized vehicle shapes and to reduce the width of the vehicle. Further, the use of a CMS offers the potential to implement functionalities like warnings or situation-adaptive fields of view that are not feasible with conventional rear-view mirrors. Despite these potential advantages, it is important to consider the possible technical constraints of this technology and its effect on driver perception and behavior. On the technical side besides the field of view and the robustness of the system, aspects as its functionality at day and night as well as under varying weather conditions were object to a scientific investigation conducted by BASt. Concerning human machine interaction the perception of velocities and distances of approaching vehicles were considered as they might be different for CMS as compared to conventional rear-view mirrors. Potential influencing factors as the position of the display or drivers' age were taken into account. Within the BASt study CMS was tested under controlled conditions as well as in real traffic for passenger cars and heavy goods vehicles.
In general, it was shown that it is possible to display the indirect rear view sufficiently for the driver, both for cars and trucks, using CMS which meet specific quality criteria. Depending on the design, it is even possible to receive more information about the rear space from a CMS than is possible with mirror systems. It was also shown that the change from mirrors to CMS requires a certain period of familiarisation. However, this period is relatively short and does not necessarily result in safety-critical situations.
Currently the UN-R 46 (Devices for indirect vision) is under revision by an informal group on Camera-Monitor Systems, in which above mentioned results are considered.

2.2.3 Study on winter tyres

Winter tyre use for passenger cars is mandatory in Germany if there is snow or ice on the road. Commercial vehicles are required to have tyres with winter characteristics only fitted to their driven axles, and no specific limits for tyre wear and age are set for any vehicles' winter tyres.
Since wear and age of tyres might have a considerable effect on their friction coefficients, BASt was asked to perform an extensive study on winterly road surfaces to identify reasonable limits. In general, passenger car tyre properties decrease substantially with profile depths below 4 mm, but not with age. This effect had not been found with commercial vehicle tyres.
Theoretical considerations suggest that specific winter tyres on trailer and steering axles might contribute to better braking behavior of commercial vehicles. The steering axle has a large influence on empty truck-and-trailer combinations, while the trailer axles have a high effect on fully loaden vehicles. The current regulation on tyres UN-R 117 does not define any tests or winter requirements for steering axle or trailer tyres, so no robust estimation on the improvement of traffic safety can be done.

It seems that a situational requirement to fit belt chains to driven axles could improve the climbing ability of commercial vehicles in specific situations. Since a large amount of traffic jams on German highways in winterly conditions is due to trucks being stuck, this could in fact improve winterly traffic flow.

2.2.4 Accessibility in long distance buses

In order to deregulate passenger transport, German long-distance bus operators are now allowed to compete against one another and against rail transport. To meet the requirements of all passenger groups in the light of inclusion, their buses will have to provide two wheelchair spaces by 2020 (by 2016 for vehicles first registrations). These requirements build not only towards the German wide aspiration to reduce accessibility barriers, but also towards the goal to avoid barriers systematically in the future. So far, it is not clear if other specifications for equipment going beyond those accessibility requirements in long-distance buses are needed to ensure an appropriate degree of accessibility. For that purpose BASt initiated a research project carried out by Human Factors Consult, Berlin. After having defined accessibility in this context, the main goal of the research project is to derive recommendations for measures to be taken when designing and building accessible long distance buses as a basis for international discussion on harmonised regulations. The project therefore includes two subordinate tasks: first to gather stakeholder requirements and define accessibility which is both done using questionnaires and workshops and second to compose recommendations for respective measures. Different kinds and degrees of disabilities have to be regarded. The measures shall focus on the vehicle itself, the operation of the long-distance buses and on operation personnel. Road infrastructure issues shall be demonstrated using examples for best practice. Deriving measures shall also take into account the state of the art technology for barrier free access and examples coming from the rail sector. In the end also costs, feasibility (technical limits) and practicability have to be considered when assessing the measures proposed.
First intermediate and preliminary results show that for the technical requirements for the bus UN-R 107 Annex 8 can serve as a good basis which might be amended. It turned out and should be paid attention to that accessibility in the view of disabled people often can be reached by the use of support addressing at least two sensory channels. It seems equally important to consider needs and requirements of different user groups (individuals differently challenged and unchallenged in kind and degree (of impairment), senior citizens, children, parents, etc.) in a design for everyone and to focus not only on the accessibility of the vehicles but equally on a barrier-free travel chain as a whole.
The project is planned to be finished in the course of the year 2015.

2.2.5 GTR on head restraints

For several years, work is in progress with regard to develop an improved regulatory dynamic test procedure for head restraints with the aim of mitigation of neck injuries. The dynamic test option in the current GTR No. 7 on head restraints foresees the use of a Hybrid III dummy using the test pulse as described in FMVSS 202a. According to several studies like those from EEVC, the Hybrid III is lacking biofidelity under rear impact conditions and is not humanlike enough for seat or head restraint testing. In consumer test programs like Euro NCAP or IIHS, the BioRID is used for many years for the dynamic assessment of seat performance under rear impact conditions. However, several concerns have been raised about the repeatability and reproducibility of the BioRID. As the anthropometric test device (ATD) is the crucial factor in a dynamic test a suitable dummy needs to be defined for use in regulation. Several studies have shown that out of the available dummies (Hybrid III, THOR, RID3D, BioRID) the BioRID seems to be the best dummy for low speed rear impact seat testing.
Within the framework of the Informal Working Group on a GTR No. 7 on head restraints phase 2 a BioRID Technical Evaluation Group (TEG) has been given the task to improve the BioRID and to develop the necessary specifications and documentation for regulatory purposes. The BioRID TEG started its work in January 2010 and most of the meetings are hold as WebEx meetings with some joint face to face meetings with the GTR No. 7 group. The BioRID TEG is chaired by BASt. The TEG has made significant progress and quite a lot of issues have been discussed, investigated further and addressed in the meantime e.g. by technical bulletins released by the dummy manufacturer (Humanetics). A drawing package is now available on the UNECE website as well as an improved certification procedure; a built level check list has been published as well as a PADI (Procedures for Assembly, Disassembly and Inspection). Work is ongoing with the aim of reducing the response corridors during certification and refining the certification procedure. A new certification test (GEN-X test) has been developed and some further refinements are ongoing. The improvements developed and proposed by the TEG and the new certification procedures are indented to be used by Euro NCAP and IIHS, too. The aim is a worldwide harmonized BioRID for testing under rear impact conditions for regulatory purposes as well as consumer testing. A really challenging task of the GTR No. 7 group and the BioRID TEG is the development of validated injury or seat performance criteria addressing the risk of cervical spine distorsions. In September 2014 a special GTR No. 7 / BioRID TEG Group of Experts Whiplash Injury Criteria Meeting was chaired by BASt.

The group recommended a set of potential injury criteria for regulatory purposes. However, those injury criteria are still under discussion and further research.

2.2.6 Child restraint systems

BASt is further supporting the work of the UNECE/GRSP Informal Group "Child Safety" in the development of Phase 2 of the new regulation UN-R 129. This phase deals with the implementation of universal booster seats (with and without backrest), were the child is secured by the vehicle 3-point belt, in the regulation. This will also include the stature based system and will be connected to the standing height of the child. After finalization of Phase 2, the group will work on other CRS types in a third phase.
In addition BASt is participating in the "Chest and Abdomen Injury Criteria Task Force", dealing with the Q-dummies. This work includes the reconstruction of accidents with children involved as car occupants The Task Force will give input for the UNECE/GRSP Informal Group "Child Safety" and the Euro NCAP Child Safety Working Group.
After the implementation of the CRS-car interface compatibility assessment protocol, Euro NCAP now works on the replacement of the dummies representing smaller children by dummies representing older children in the dynamic test. BASt is involved in the development of the new protocol which will include the Q6 and the Q10 dummies as rear seat occupants in dynamic ODB and side impact tests. The aim is to improve the protection of larger children respectively small adults on rear seats.

2.2.7 Urban Space: User oriented assistance systems and network management

Together with 30 partners including automobile and electronics manufacturers, suppliers, communication technology and software companies as well as research institutes and cities BASt has joined the national project UR:BAN[1] which started in 2012 running for a four-years-term until April 2016. The project is funded by the Federal Ministry of Economics and Technology. UR:BAN focuses on the development of advanced driver assistance and traffic management systems for cities and pays special attention to the human being in all aspects of mobility and traffic.
UR:BAN also covers the evaluation and prediction of vulnerable road users´ (pedestrians and cyclists) behaviour and movements. With regard to the complexity of urban traffic UR:BAN aims at supporting the driver in performing maneuvers such as driving in narrow or obstructed streets, resolving conflicts with opposing traffic and performing lane changes. By means of novel panoramic sensing and prediction capabilities collisions can be avoided by automatic braking and/or swerving. BASt is involved here with legal expertise since the legal implications of the functions developed in UR:BAN – such as functions performing automated swerving manoeuvres in critical traffic situations – have to be identified and examined.
Furthermore, UR:BAN takes the human being into account by incorporating adaptive support into the design of vehicle controls and displays. BASt is involved in the examination of the aspect of controllability of new driver assistance systems with psychological and legal expertise.

2.2.8 AdaptIVe

Automated driving systems as defined in the EU-project AdaptIVe accomplish surplus operations compared to Advanced Driver Assistance Systems currently in use. They automatically take over operational manoeuvres and "drive" the vehicle longitudinally and cross-ways. Depending on level of automation they differ in terms of tasks still allocated to the driver.
AdaptIVe has the vision of a widespread application of automated driving to improve road safety and address inefficiency in traffic flow. The project approved by the European commission involves 29 research institutes, suppliers and industrial partners. The project develops new and integrated automated functions to improve traffic safety by minimizing the effects of human errors. The general objective of AdaptIVe is to develop new functionalities provided by partially-automated and highly-automated vehicles. Major AdaptIVe-functions are foreseen for different settings, namely highways, urban traffic, and specific close-range manoeuvres. Continuously automated systems like Adaptive Cruise Control and/or Lane-keeping Systems are well established in the market for Driver Assistance Systems today. In combination of these systems, for example the motorway chauffeur, the driver would additionally not required to constantly monitor the "drive" by the function any longer. In legal terms the question is being raised whether legislation is keeping pace with these technological advancements.
Therefore, in addition to the technological aspects, AdaptIVe will address important legal issues that might have impact on the market introduction of automated systems. It will identify the legal implications for manufacturers and drivers and identify boundaries lying in current regulation. Today's legal framework was developed based

[1] www.urban-online.org

on the concept that safe driving is a task of the driver only. Consequently it is likewise a basic legal assumption as well as requirement that the driver must be able to control his vehicle at all times. With a move to automated driving, the driver might temporarily, under certain conditions no longer be needed permanently in this role. Contradictions of such a development with the current legal situation need to be identified.
The main goal of this project is to collect and summarise the important aspects from legislation for different EU-member states on this technology. The secondary objective, from a legal perspective, is to foster mutual understanding and identify the possibly necessary harmonization within the EU member states. This objective shall be achieved by a comprehensive review of the current legal framework regarding automated systems. The review shall cover regulatory law (e.g. national road traffic law), the Vienna Convention on Road Traffic and road traffic liability (of the driver/ vehicle owner). If possible, corresponding aspects of criminal law (specific for the field of road traffic) and administrative offences can be investigated.
Another contribution of BASt is to provide input on impact analysis methology with focus on accident data from the CARE and GIDAS database.

2.2.9 KO-HAF

In 2015 a new research project concerning cooperative, highly automated driving (Ko-HAF) starts. BASt joins a national consortium with automobile and electronics manufacturers, suppliers, communication technology and software companies, research institutes and road administrations. The project aims on development of cooperative, highly automated driving on motorways, i.e. for high speed ranges on well constructed road infrastructure. This includes a significant improvement of forecasts for environmental detection in addition to the automation of the longitudinal and lateral control of vehicles.
The driver can not be taken entirely out of the loop during highly automated driving. Therefore, the readmission of the driving task by the human within a certain lead time will be researched in Ko-HAF as well. Several test vehicles will be constructed for testing and demonstration of highly automated driving under normal conditions and in case of system failure. The new vehicle operation will take place on test tracks and on public roads.
Key activities of BASt – in an academic part – are the evaluation of usability of external data for the highly automated driving, the design of data exchange with third parties and the evaluation of data protection issues.
In a practical part, BASt will conduct driving tests to determine the effect of different levels of automation on the driver's fatigue by EEG (electroencephalography) brain wave measurement and test the effectiveness of possible countermeasures in a second step.

2.2.10 aFAS

The project "aFAS" is funded by the Federal Ministry of Economics and Technology. Following the successful introduction of assisted driving funktions (up to level 2 of the BASt definitions) the next major step will be the integration of innovative driving functions in high and full automated levels. Against this background, the project „aFAS" was built by a consortium of eight partners. The name stands for a driverless mobile warning truck in case of temporary road works. Temporary road works present a danger for employees of road maintenance services. Accidents often occur because motor vehicles crash into the contruction site. The focus is therefore to build a driverless fully automated truck to improve safety for the employees of road maintenance services. The prototype of "aFAS" will be tested on the hard shoulder of the freeway in real traffic. A particular challenge in this project is to meet the requirements of functional sefety and quality of the steering system and the brake system. Also the sensor system has strict quality standards. BASt is involved with legal expertise in respect to driverless automation. Furthermore, BASt is involved in the application for a special license needed for the driverless vehicle. The limited speeds required for road maintenance provide ideal conditions for the first technical realization of driverless driving.

2.2.11 Frontal Impact

With regard to impact direction the frontal impact is still the most relevant one in terms of injury causation for passenger vehicles. Accident data has shown that the stability of passenger compartments has been improved substantially in recent years, even for lighter vehicles. However, the performance of the restraint system becomes now even more important because vehicles are getting stiffer which is leading to a higher deceleration pulse. Additionally, in real-world car-to-car impacts the lighter of the two vehicles has to withstand higher loadings than the heavier vehicle due to the principle of linear momentum.
Therefore, a research project is ongoing to investigate different types of frontal impact test procedures. The objectives are focused on restraint system tests and include tests with a mobile deformable barrier as well. Different anthropomorphic test devices are used to evaluate the protection capability of occupant restraint systems in particular with regard to the prevention of thoracic injuries.

Furthermore, the benefit of different frontal test procedures will be estimated based on real world accident data.

Figure 7: Comparison of two full width frontal impact tests.

2.3 Perspective

As the finished studies show, vehicle safety research is an international issue. Therefore BASt participated in applying for calls of the European framework research programme “Horizon 2020”. In addition national projects complement the work addressing specific research topics. BASt was successful with regard to the projects mentioned below.

2.3.1 SENIORS

Given the demographical change today’s society is facing, a european funded research project named SENIORS (Safety-ENhancing Innovations for Older Road userS) under the HORIZON 2020 framework programme will investigate the safety need for combining different transport modes being used by the elderly as the most vulnerable road users. The consortium consists of a governmental entity, Euro NCAP laboratories, research institutes, dummy manufacturers, OEMs and vehicle suppliers. The project with kick-off on 1 June 2015 has a running time of 36 months. BASt acts as project coordinator.

2.3.2 PROSPECT

Several vehicles that are currently on the market feature automatic emergency braking (AEB) systems either as standard or optional fitment. Assessment procedures for these systems are under development or already available. Their expected positive effect on accident figures is taken into account in consumer testing.
However, current systems suffer from a few limitations. Their intervention in critical driving situations occurs shortly before this event - at a time when the vehicle driver has almost no chance to avoid the accident by itself. As a consequence, this late reaction time makes it difficult for the AEB system to avoid (e.g. vehicle comes to a full stop just in front of the threat), in particular in high speed scenarios and scenarios with obscured pedestrians. If the braking intervention would start too early, there would be plenty of false activations in regular traffic, even in perfectly normal situations - which is not acceptable for traffic flow, from a safety perspective, and last but not least for the driver. Also, current systems only have access to vehicle braking systems. There's no automatic steering system in production (some prototypes are available).
Proactive safety systems especially for pedestrians and cyclists can be more effective, if they tune their intervention timing better to the traffic situation and driver fatigue, and if they use steering intervention additionally to braking intervention.
This is where the PROSPECT (Proactive Safety for Pedestrians and Cyclists) project comes in: PROSPECT will develop advanced Human-Machine Interfaces (HMI) as well as advanced vehicle control strategies for combined steering and braking. The advanced HMI will monitor the driver's directional attention and for instance intervene earlier in cases where the threat is out of the driver's focus. The control systems will make use

of a tremendously increased radial sensor range to find the optimal combination of steering and braking, and advanced sensor interpretation systems will allow to better judge the intention of pedestrians along the vehicle route with respect to their direction of movement.
To estimate the benefit for these new functions, advanced testing and validation methods need to be developed. Current validation of automatic brake systems is carried out on a test track, without irritating objects, road clutter, road signs or lines; thus, in rather artificial surroundings. PROSPECT will not only introduce novel realistic surrogate targets, but also perform testing in realistic surroundings including other moved objects, infrastructural facilities, clutter and the like.
Final output of PROSPECT will be three vehicle demonstrators, to be tested in detail using state-of-the art surrogate targets for pedestrians and newly developed surrogate targets for bicycles and their riders.

2.3.3 CODECS

The deployment preparation of Cooperative Intelligent Transport Systems (C-ITS) involves many stakeholders, including the automotive industry, National Road Authorities and road operators (including their suppliers), automobile clubs and organisations promoting ITS as a tool to safer, smarter and more environmental friendly mobility. COoperative ITS DEployment Coordination Support is a 36 month support action (kick off 1 June 2015) where core stakeholders support the deployment coordination activities on European scale (Amsterdam Group, EC C-ITS Deployment Platform). Beyond elements of aligning deployment roadmaps and of strategy coordination one important planned output will consist in the profiling of standards which are relevant for C-ITS services with infrastructure involvement. This technically important output for ensuring interoperability represents the focus of the BASt involvement in the CODECS support action.