GOVERNMENT STATUS REPORT, SWEDEN 2013

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SWEDISH ROAD SAFETY ORGANISATION

The Ministry of Enterprise, Energy and Communications is responsible for road traffic safety in Sweden. The ministry is limited in size and the Swedish Transport Administration handles much of the practical and operational work. The administration is responsible for the planning, building and operation of roads and railroads. The Swedish Transport Administration also has the overarching role to develop long term plans for all modes of transport. The Transport Administration holds responsibility for research within the fields of mobility, environment and traffic safety. It is also performing in depth studies of fatal crashes within the road traffic system. When co-operation with other actors in society is necessary to effectively achieve its goals the Administration may work together with these actors.

From 2009 the Swedish Transport Agency has overall responsibility for regulations within air, sea, rail road and road traffic. Within the Swedish Transport Agency the Road Traffic Department formulates regulations, examines and grants permits, as well as exercising supervision within the field of road transport over e.g. road traffic, vehicles, driving licences and commercial transport. The agency also conducts analyses of road traffic and supply information about injuries and accidents within the road transport system. Swedish Transport Agency is also holding vehicle and driver licence registers.

The Swedish Transport Administration and the Swedish Transport Agency are both responsible to work towards the transport policy goals set up by the parliament.

In Sweden the main other bodies active in road traffic safety efforts are the police and the local authorities. Other important parties are the National Society for Road Safety (NTF), with its member organisations, and transport industry organisations. The Group for National Road Safety Co-operation (GNS) is a central body that co-ordinates co-operation between the Swedish Transport Administration and Agency, the local authorities the authority for occupational health and safety and the police. The NTF is an additional member of this group, as well as some partners from the private sector.

ROAD TRAFFIC FATALITIES

The Swedish overarching long-term safety objective within the road transport system was settled in 1997, when the Swedish parliament voted for the “Vision Zero”. This vision states that ultimately no one should be killed or seriously injured in the road transport system. The design and function of the system should be adapted to the conditions required to meet this goal.

Since Sweden introduced a visionary goal in the middle of the 1990-ies several jurisdictions have taken the same approach. In some jurisdictions the name has been changed to Safe Systems Approach to avoid the strong focus on the number zero (OECD, 2008).

The Commission of the European Communities has in its White Paper on transports set out the goal “By 2050, move close to zero fatalities in road transport. In line with this goal, the EU aims at halving road casualties by between 2010 and 2020. Make sure that the EU is a world leader in safety and security of transport in all modes of transport” (EC, 2011. Page 10).

Sweden as member of the European Union was part of the union’s target of a 50% reduction of fatalities between 2001 and 2010. For Sweden that target meant a maximum 271 fatalities year 2010.

In the year 2010 the number of fatalities in Sweden was 266. The road toll in Sweden thus did reach the 50% EU target for 2010. Great progress was also made in other countries in the EU. Latvia, Estonia, Lithuania, Spain, Luxembourg, Sweden, France and Slovenia all reached the EU 2010 target. Portugal very nearly made it with a reduction of 49.4%.

With around 300 fatalities per year Sweden is one of the safest countries when it comes to road traffic, with a level of 3.1 fatalities per 100.000 inhabitants in 2012. This is less than half of the European Union risk average (6.1 fatalities per 100 000 inhabitants year 2011). In Sweden fatalities related to distance travelled is 3.2 fatalities per billon vehicles-kilometres (2010) which can be compared with the 6.2 fatalities per billion –vehicle kilometres in USA.

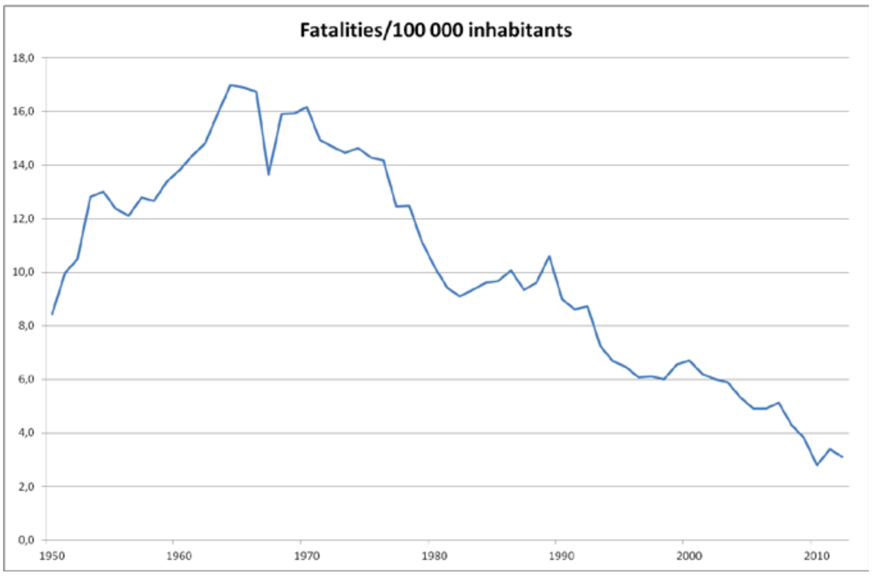

Figure 1. Road fatalities per 100 000 inhabitants in Sweden 1950-2012

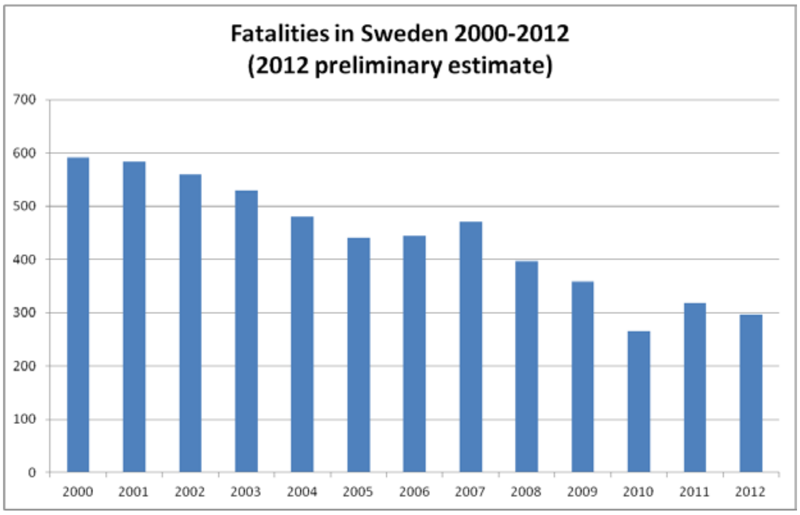

Figure 2. Road fatalities in Sweden 2000 to 2012

INTERIM TRAFFIC SAFETY TARGET FOR 2020

Sweden has a long tradition in setting quantitative road traffic safety targets. In 2009 the Swedish government stated a target of 50% reduction of fatalities and 25 % reduction of severe injuries from 2007 to 2020. This target would demand Sweden to be at a maximum of 220 yearly fatalities in the year 2020. This interim target towards the Vision Zero is a part of an updated continuing road safety operation in collaboration with other stakeholders (The Group for National Road Safety Co-operation, GNS).

After Sweden decided on a target for 2020 the European Union has decided on a 50% fatality reduction between 2010 and 2020. For Sweden this would mean a maximum of 133 fatalities in the year 2020 (because of the good safety performance in 2010). This new ambition is a significantly more demanding target.

The partners of GNS have made an analysis whether the 133 goal could be achieved and what status a set of indicators would have to be at to support the goal. From this analysis it seems that the goal is achievable.

In 2012 the new interim road safety target for 2020 was proposed to the Swedish Government by the Swedish Transport Administration (STA, 2012). One important element in the revision was to predict the benefits of future interventions for road safety in order to facilitate the prioritisation of road safety measures. One way of doing that is to evaluate safety technology with retrospective analysis of crashes. However, by using retro-spective data there is the risk of adapting safety innovations to scenarios irrelevant in the future. Also, challenges arise as safety interventions do not act alone but are rather interacting components in a complex road transport system. Therefore a new method to consider possible impact of safety interventions was developed (Strandroth et al., 2012).

The key point was to project the chain of events leading to a crash today into the crashes for a given time in the future. Assumptions on implementation on safety technologies were made and these assumptions were applied on the crashes of today. It was estimated which crashes would be prevented and the residual was analyzed to identify the characteristics of future crashes. The Swedish Transport Administration’s in-depth studies of fatal crashes and hospital admission data translated into risk of permanent medical impairment were used in the calculations.

It was estimated that the number of road fatalities would be reduced with approximately 40 percent from 2010 to 2020 with the current planned interventions for this period. The main part of the reduction originated from the gradual replacement of the vehicle fleet. The analysis also suggested that it would be possible to strengthen the targets to a reduction of the number of fatalities by 50 percent to 133 fatalities between 2010 and 2020. But that would require measures above and beyond those that are included in the prediction. Through this new method not only quantitative estimations were made. But also valuable information regarding the characteristics of future crashes was found. The current Swedish road safety operation is based on a system of management by objectives where cooperation between stakeholders, targets on Safety Performance Indicators (SPI:s), and annual result conferences where road safety developments and targets are followed up. The aim is to create long-term and systematic road safety operation together with the other stakeholders.

The road safety performance indicators that are monitored is speed compliance, sober driving, seat belt use, helmet use, safe vehicles, ABS on motorcycles, safe national roads, safe municipal streets and maintenance standard on municipal streets. These indicators each have a target for 2020 which makes possible to prioritize between measures easier for stakeholders.

DEVELOPMENT TOWARDS THE GOAL 2020

The role of the vehicles to contribute to the target is further discussed later in this paper. However, it is worth noticing that the replacement of the car fleet gave the biggest contribution to the results 2010 and in the near future.

The development towards the target is annually evaluated at a result conference in April. So far there have been two conferences making it possible for all stakeholders to meet and discuss further work towards the interim target and Vision Zero.

ISO-MANAGEMENT SYSTEM FOR ROAD TRAFFIC SAFETY

In the spirit of the Tylösand Declaration, Sweden has been an initiator to get a new work within International Organization for Standardization (ISO). The work is aiming at developing a Road-Traffic Safety Management System standard. (ISO/TC 241 - Project Committee: Road-Traffic Safety Management System). Sweden is through the Swedish Standards Institute (SIS) holding the secretariat.

The vision of the International Management Systems Standard is:

• Elimination of death and serious injury in the road transport system is the overarching goal.

• A voluntary and complimentary tool to legislation, addressing all organizations interacting with road traffic and driven by the needs of interested parties, including market forces.

• An approach to utilize and disseminate ”best practice”.

• Knowledge transfer from Traffic safety experts to the intended user community of the standard.

All requirements of the International Standard are generic and are intended to be applicable to all organizations regardless of type, size, products and services provided.

The standard was delivered in 2012 as ISO 39001 Road traffic safety (RTS) management systems - Requirements with guidance for use.

PENETRATION OF SOME SAFETY SYSTEMS IN SWEDEN

Electronic Stability Control (ESC) has been proven to be very effective in reducing crashes related to loss of control (Erke, 2008, Ferguson, 2007, Lie et al. 2006).

The first studies of the effectiveness of ESC were published in the ESV conference 2003. Several studies followed in 2004 and 2005 establishing a scientific ground for declaring that ESC was effective. A study of fatal crashes in Sweden has shown that ESC is reducing fatal loss-of-control crashes with 74% (Lie. 2012). As these crashes constitute about 36% of all fatal crashes for cars without ESC, the overall effect is around 27% risk reduction. This is higher than previous estimates based on crashes with a lower severity level.

The first mass market car with ESC was introduced late 1998. ESC was from then on gradually implemented on executive mid size and large cars and reached a 15 % new car sales penetration in mid 2003. Sweden has been world leading in getting a high degree of ESC penetration in new car sales. In December 2010, 99% of all new passenger cars were equipped with ESC. Even with this rapid introduction of ESC predictions show that it will be year 2017 before 90% of the traffic will be performed in cars with ESC.

Sweden has been part of Euro NCAP since the start of the organisation. Over the years since Euro NCAP started, the average scores have improved both for occupant protection as well as for pedestrian protection. Swedish Transport Administration has done an evaluation of the relation between Euro NCAP results and the risk of injury and fatality in real life crashes. The study shows a 70% fatality risk reduction between a Euro NCAP 2 star car and a 5 star car (Kullgren et al. 2010). A Swedish study shows the relation between Euro NCAP pedestrian score and real life impairment risks (Strandroth et al. 2011). An approximate 20% reduction of injuries causing permanent medical impairment is estimated for two star pedestrian protection compared to one star cars. The injury reduction grows with higher levels of medical impairment and in lower impact speeds.

In December 2012 almost 98% of the new car sales had a seat belt reminder according to Euro NCAP specification for the driver. 93% had a reminder for the passenger and 61% a system to monitor seat belt use in the rear seat. Seat belt reminders are reducing the number of unbelted driver in city traffic with 80% in Europe (Lie et al. 2008). A Swedish study has shown that seat belt reminders living up to Euro NCAP’s specification is increasing seat belt use in fatal crashes with 80%. (Lie, 2012). This is very promising.

THE CONTRIBUTION OF NEW VEHICLES

With a rapid development of vehicles safety there has been of interest to calculate the yearly benefit of the exchange of the vehicle fleet. With about 160 fatalities in cars every year, the exchange of slightly fewer than 6% of the vehicle fleet results in around 9 “saved” lives in 2012. Out of these about two thirds comes from the better crash protection and one third from the ESC systems.

ABS ON MOTORCYCLES

Anti-lock Brakes (ABS) has been proved by several studies to significantly reduce motorcycle crashes by some 20-50% depending on injury severity (Teoh, 2011; HLDI, 2009; Rizzi et al., 2009). As a consequence, many stakeholders have been encouraging the fitment of ABS on new motorcycles (STA, 2012). In Sweden the fitment rate has increased from approximately 15% in 2008 to 70 % in 2012. According to Bosch Corporation (2012) the installation rate in Europe for ABS in production on motorcycles with engine size larger than 250 cc has increased from 27% in 2007 to 36% in 2010. Since the European Parliament also has voted for a legislation which makes ABS mandatory for all new motorcycles over 125cc from 2016, the fitment rate is likely to increase even more in the years to come.

However, while previous research on ABS has shown impressive effects, earlier studies have focused primarily on heavier motorcycle models. Further research is therefore needed in order to confirm if the results applies to lighter motorcycles, i.e. scooters, as well. Also, it could be useful to expand the ABS effectiveness calculations to include material from countries with different motorcycling habits, i.e. countries in southern Europe were motorcycles are often used for transportation. In 2012 Folksam Research and the Swedish Transport Administration have initiated a study which sets out to calculate the effectiveness of ABS in Sweden, Italy and Spain. An induced exposure approach is used and the material includes more than 10,000 casualty crashes with motorcycles. The preliminary results indicated a reduction of crash involvement with ABS-equipped motorcycle by some 20%, compared with the same models without ABS. The effectiveness was even higher in crashes at intersections and similar results were found for scooters with at least 250cc engine displacement. The full paper is presented at the 2013 ESV Conference.

FFI – STRATEGIC VEHICLE RESEARCH AND INNOVATION

Transport, mobility and accessibility are of major importance for quality of life and growth. If society is to continue its positive development, transport solutions must be safe and environmentally sustainable. Safe electric cars, smarter logistics and resource-efficient production technology are examples of the innovation and renewal which can help the Swedish automotive industry meet this challenge. To drive the development forwards, Sweden's government and industry are investing in a long-term partnership within FFI – Strategic Vehicle Research and Innovation.

FFI funds R&D that focuses on climate, environment and safety. The effort is ongoing and includes some €100 million per year, half of which comes from public funds through VINNOVA, the Swedish Transport Administration and the Swedish Energy Agency. An equivalent amount is invested by the four industrial partners: Volvo, FKG (Scandinavian Automotive Suppliers), Scania and Volvo Cars. This collaboration between public bodies, industry, educational establishments and research institutes is intended to provide high-quality results and contribute to positive social development. As a help to focus and to strive for the goals in collaboration the authorities together with industry partners have developed road map defining safety concepts and mile posts for the years 2015, 2020 and 2025. The road maps will be updated as progress is achieved.

FFI funds projects with two thirds of the money going to climate and environment and one third to safety. An FFI board is responsible for setting a balance between targeted projects and more long-term efforts which can deliver groundbreaking results. The board's duties also include promoting constructive cooperation between the various actors in the road traffic system.

The investments in FFI take place through various collaborative programmes. One is vehicle and traffic safety. Sweden is a world leader in traffic safety. The programme will contribute to the continued development of vehicles with active systems to prevent accidents as well as passive ones to mitigate the consequences of those accidents which nevertheless occur. Initiatives have a systemic approach so as to get roads, vehicles and road- users to interact well.

IMPORTANT FIELDS FOR FURTHER RESEARCH

Many fatalities in Sweden as well as globally is related to impaired driving. In Sweden 2011, 18% of killed vehicle drivers had illegal levels of alcohol on their bodies (Swedish Transport Administration 2012). As many other countries Sweden has an alcolock programme for offenders. There is also some 85000 alcolocks used in Sweden in trucks, buses and taxis on a voluntary basis. There are even some installations made in trams, ferries and locomotives. These alcolocks are used on an emerging market for safe transports. Both buyers of transports and suppliers have found these alcolocks attractive to ensure sober drivers. There is an ongoing technology development both in terms of new basic technologies for alcolocks and forms for a reliable and non-intrusive sobriety support systems.

Alcohol consumption is not the only reason for impaired driving. Often fatigue, distraction, legal and illegal drugs as well as alcohol are lumped into the term impaired drivin. Vehicle systems are out on the market that detect distraction and fatigue. These systems are using signals from the vehicle to analyze the state and driving patter for the driver. Already today the cars have an idea about when driving isn't up to standards. The systems as of today have weak feed back to the driver and uses signal lamps of haptic feed back. Not far away in time the vehicle will have a good estimate of the potential impairment of the driver. The question is how a vehicle, on its own, can restrict and guide the driver into a safe driving envelope. The most evident way is to limit the speed of the vehicle and putting safety systems into a more nervous mode. This makes a potential crash avoided and less harmful. There is an evident need in society to research this field and to develop guide lines for a safe shut down sequence.

The layout of infrastructure and the properties of it are becoming important for modern safety technologies. Already today lane departure warning systems are using lane markings as a critical component. In the near future crash avoidance by steering will need even better environmental awareness from lines and other road furniture. More and more cars are reading traffic signs and speed restriction signs are used to help drivers from speeding. As indentified by the European Council, there is an urgent need for better co-operation between vehicle manufacturers and suppliers, and road authorities. Rules, standards and strategies for line painting and road signs could be aligned with the properties of modern vehicle systems to better achieve good functionality and safety.

As traffic is developing into a more automated mode of transport the need for close co-operation between all actors in the field is becoming urgent. Automation in traffic demands co-operation.

Speed management is a key element to achieve good safety. More and more countries are using speed cameras and section control to diminish illegal speeding. In Sweden more than 1000 speed cameras or as it is called in Sweden, “road safety cameras” have been put up the last years. The aim of the camera system in Sweden is to support drivers in making a safe speed choice and, through a change in speed behaviour among a large proportion of the traffic create a new social norm with respect to what is an appropriate speed (Belin et al 2010). This has generated an emerging market demand for support systems helping users not to speed. Already many years ago nomadic SATNAVs indicated the speed limit. The same approach is now entering integrated navigations systems. Some vehicle manufacturers are also using cameras to read speed signs. As an effect of the marker development the consumer crash test program Euro NCAP has developed a protocol to assess Intelligent Speed Assistance systems (ISA) and is using the protocol since January 2013. A better compliance with speed limits will give significant environmental benefits through lower fuels consumption.

Just like vehicle safety and road safety have been two to a large degree separate cultures, vehicle safety and ITS (intelligent Transport System) have been driven by different groups in industry and society. There are high expectations from the ITS side to solve traffic safety problems. Further research is needed in which vehicle safety experts and ITS experts more clearly defines the areas of potential for improved safety. This should be done for the different stages of a driving process leading up to a potential crash. The connected vehicle is probably more important to strategic decisions in the driving than for support in emergency situations. A reasonable balance must be achieved between safety from connectivity, active and passive safety. This balance should be further investigated and communicated.

Although the road traffic injuries is a very complex problem over the years a comprehensive knowledge have been developed about the magnitude of the road safety problem, knowledge about important risk factors and both theoretical knowledge and practice experience about effective road safety strategies and measures . However, we still lacking of systematic knowledge about the way different public authorities, private organizations in different time periods try to tackle this major public health problem. We do not seem to have an adequate understanding and interpretation of the dynamics of the process aimed at formulating and implementing road safety polices and how sound road safety interventions are diffused in the society. Improving road safety requires knowledge about implementation processes, measures known to be effective and how and where in other sectors of society road safety aspects can be mainstreamed and partnerships built. It also requires the ability to choose the strategies and approaches that best fit the specific conditions of different countries Racioppi 2004, Belin 2012).

Vision Zero is a radical policy innovation (Belin et al, 2011) and we need more systematic knowledge of its implementation and diffusion. In May 2010 the Swedish Transport Administration decided to establish the Vision Zero Academy. The role of the Academy is to generate knowledge on how innovation and implementation processes can be made more effective, and furthermore to ensure that this knowledge is transferred to all relevant stakeholders in an open, transparent and inclusive way in order to develop a safe road transport system.

CONCLUSIONS

When it comes to traffic Sweden is one of the safest countries in the world. The Vision Zero approach has further boosted a good safety culture.

The exchange of vehicles in combination with improved vehicle technology is a major contributor to achieve ambitious traffic safety targets. As more than 50% of new sales cars are sold to companies and other non private buyers, active strategies to convince large fleet buyers to choose best safety standard is of outmost importance.

Road users have a responsibility to operate within the safety limits of the road transport system. Vehicle technology can support this. Intelligent seat belt reminders, systems alerting drivers when speeding and alcohol starter interlocks are important systems to further develop and put on the market in large scale.

The ISO 39001 management system standard for traffic safety will give organisations a possibility to work focused with traffic safety.

Vehicle manufacturers and organisations responsible for infrastructure must develop better co-operations to ensure that the modern road offers a useful interface to modern vehicle technology such as lane departure warning and traffic sign recognition.

A safe system is achieved when user capabilities, vehicle safety, road design and speed limits all are in harmony. A holistic perspective on road safety is under development and is important when prioritizing research efforts.

More general information is available at the following pages
http://www.trafikverket.se/eng
http://www.transportstyrelsen.se/en
http://www.vinnova.se/en/ffi/

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UNITED STATES GOVERNMENT STATUS REPORT

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State of Motor Vehicle Safety

In 2011, 32,367 fatalities occurred in the U.S. as a result of motor vehicle crashes. This is the lowest number of deaths since 1949. The number of motor vehicle-related fatalities in 2011 fell 1.9 percent from the 32,999 fatalities in 2010.

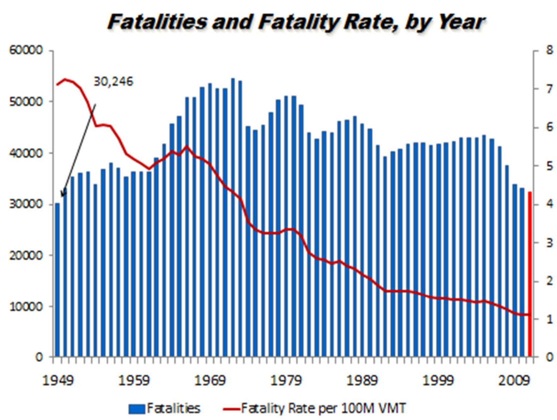

Figure 1. Fatalities and Fatality Rate per 100 Million Vehicle Miles Traveled Between 1949 and 2011.

Even more impressive, the fatality rate per 100 million Vehicle Miles Travelled (VMT) in 2011 fell to a historic low of 1.10 (see Figure 1). This downward trend is continuing.

The total number of police-reported crashes in the U.S. in 2011 was estimated by the National Automotive Sampling System (NASS) General Estimates System (GES) to be 5.3 million, resulting in 2.22 million persons being injured. In recent years, the estimated number of people injured has decreased. Unfortunately, the injury rate, based on VMT, increased slightly in 2011, rising from 75 to 76 people per 100 million VMT.

These improvements in motor vehicle safety are due in part to the collective efforts of the operating agencies of the Department of Transportation[1], the States, automobile manufacturers, and other private sector organizations. NHTSA's engineering efforts, combined with its educational and enforcement programs to ensure proper compliance with the U.S. regulations, have contributed to this significant achievement in safety.

Table 1 provides a breakdown of all motor vehicle fatalities by person type.

Table 1. 2010-2011 U.S. Fatalities by Person Type.

Motorists and Non-occupants Killed in Traffic Crashes				
Description	2010	2011	Change	% Change
Total*	32,999	32,367	-632	-1.9%
Motorists Killed in				
Passenger Vehicles	22,273	21,253	-1,020	-4.6%
Passenger Cars	12,491	11,981	-510	-4.1%
Light Trucks	9,782	9,272	-510	-5.2%
Large Trucks	530	635	+105	+20%
Motorcycles	4,518	4,612	+94	+2.1%
Non-occupants Killed				
Pedestrians	4,302	4,432	+130	+3.0%
Pedalcyclists	623	677	+54	+8.7%
Other/Unknown	185	198	+13	---

Source: FARS 2010 (Final), 2011 Annual Report File (ARF)
* Total includes occupants of buses and other/unknown vehicles not shown in table

In spite of these hard-fought gains in vehicle safety, motor vehicle crashes continue to be a major public health concern. For example, in 2009, motor vehicle crashes are the number one cause of death in ages 4 and 11 through 27. In addition, because of the young lives lost, in 2009, motor vehicle traffic crashes ranked 5th overall in terms of the years of life lost, behind major causes of death such as cancer, heart diseases, chronic lower respiratory diseases and stroke.

For these reasons, NHTSA remains fully committed to its mission of working with industry and the public to improve motor vehicle safety through a coordinated effort involving research, education, enforcement, and rulemaking.

Data Collection and Analysis

NHTSA conducts a motor vehicle crash data collection program through the National Center for Statistics and Analysis (NCSA). It is composed of: the data collected from the states, including Fatality Analysis Reporting System (FARS) and the State Data Program. In addition, NHTSA also performs detailed crash investigations in the National Automotive Sampling System (NASS)

[1] The National Highway Traffic Safety Administration (NHTSA), the Federal Motor Carrier Safety Administration (FMCSA), the Federal Highway Administration (FHWA), Federal Transit Administration (FTA) the Federal Railroad Administration (FRA) and the Research and Innovative Technology Administration (RITA)

Crashworthiness Data System (CDS) and the Special Crash Investigations (SCI) programs.

In the 1970s, NHTSA devised a method that utilizes a combination of State record and investigation based systems to provide nationally representative traffic crash data. The recoding of police-reported crashes from State record based systems into a uniform format provides counts and trends. The detailed field investigations provide the details required for countermeasure development and evaluation. This sample based approach provides nationally representative data at a small fraction of the cost it would take to collect and manually recode the millions of police-reported crashes into a uniform format.

FARS is a State crash record based system that provides a census of all fatal crashes occurring on public roads in the United States. The NASS is comprised of the General Estimates System (GES) and the Crashworthiness Data System (CDS). The GES is a State crash record based system that provides national estimates calculated from the approximately 50,000 crashes collected annually to provide characteristics of all motor vehicle crashes. The CDS conducts detailed investigations into a nationally representative sample of approximately 4500 crashes involving towed passenger vehicles to investigate injury-causing mechanisms and to evaluate countermeasures.

The NASS infrastructure was utilized in two surveys to collect nationally representative data on the events and factors related to the causation of crashes. The Large Truck Crash Causation Study (LTCCS) was conducted by the National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA) from 2001 to 2003 collecting about 1,000 crashes providing information on the causes or contributing factors for large truck crashes. From 2005-2007, NHTSA conducted the National Motor Vehicle Crash Causation Survey (MMVCCS) which collected about 7,000 crashes providing nationally representative information on the events and factors related to the causation of light motor vehicle traffic crashes. The SCI program provides in-depth data on crashes where emerging issues may be of interest.

The Not-in-Traffic Surveillance (NiTS) system is a virtual data collection system designed to provide counts and details regarding fatalities and injuries that occur in non-traffic crashes and in non-crash incidents related to motor vehicles. The NiTS 2007 system produced an overall annual estimate of 1,747 fatalities and 841,000 injuries in non-traffic crashes and non-crash incidents.

NCSA also conducts key analyses of the collected data and publishes reports, including the Traffic Safety Facts Annual Report and Traffic Safety Fact Sheets. Copies of the most recent reports can be found at NCSA's web site using the following URL: http://www.nhtsa.gov/NCSA.

Status of NHTSA Research Programs

NHTSA research priorities are driven by problem size (as defined by crashes, injuries and fatalities attributable to specific vehicle or driver issues), by technical innovations that present new opportunities for improving safety, and by changing driver behavior and demographics. These technical, market and economic factors are used to develop three-year vehicle safety priority plans, and 5 year and longer term strategic plans. Aligned with DOT and NHTSA goals, Figure 2 illustrates the program development process among NHTSA data collection, research, rulemaking, and enforcement activities. Collectively, planning teams continuously strategize, prioritize and implement research programs, furthering the agency's goals to reduce fatalities and injuries.

Figure 2. NHTSA Research Planning Process.

Strategic program plans and roadmaps are typically developed with outcomes aimed at regulatory decisions and implementations. Current plans and roadmaps include a Motorcoach Safety Plan, Automated Vehicle Research Roadmap, Connected Vehicles and Vehicle-to-Infrastructure Roadmap, Human Factors Roadmap, Distraction Plan, Biomechanics Plan, Alternative Energy Vehicle Safety Plan, Crashworthiness Plan, and Elderly Occupant Plan. Key programs are described in the sections that follow.

The Haddon Matrix is the most commonly used paradigm in the injury prevention field. Developed by William Haddon in 1970, the matrix provides a comparison of factors before, during and after an injury or death. By utilizing this framework, one can think about the relative importance of different factors, interventions, or programs. Figure 3 shows the NHTSA research program areas comprising an expanded Haddon matrix. A fundamental change to the Haddon matrix was adopted, whereby the pre-crash category is now composed of normal driving and crash imminent conditions. The expanded matrix better matches the breadth and scope of our crash avoidance and crashworthiness research programs.

Crashworthiness Research

Low Offset / Oblique Frontal

In September 2009 the National Highway Traffic Safety Administration (NHTSA) published a report that investigated the incidence of fatalities to belted non-ejected occupants with air bags in frontal crashes involving late-model vehicles. The report concluded that after exceedingly severe crashes, the largest number of fatalities occurred in crashes involving poor structural engagement between the vehicle and its collision partner, such as corner impacts, oblique crashes, and impacts with narrow objects.

In response to these findings, NHTSA began researching a test procedure intended to mitigate the risk of injuries and fatalities related to motor vehicle crashes involving poor structural engagement. This research demonstrated that an impact between a "research" moving deformable barrier (RMDB) and a stationary vehicle at a 15 degree angle can reproduce vehicle crush, occupant kinematics, and risk of injury seen in vehicle-to-vehicle crashes. It was also demonstrated that injury risk related to poor structural engagement has not been entirely mitigated in the current fleet, as newly-designed vehicles are still prone to large intrusions and potential injuries to the head, chest, knee/thigh/hip, and lower extremity.

Current research will test additional high sales volume vehicles to evaluate a larger portion of the current and future fleet performance using the Oblique test procedure. This research also includes oblique impacts to the right side of the vehicle and evaluates occupant kinematics on the far or opposite side of the impact.

Heavy Truck Safety

As mandated by the Moving Ahead for Progress in the 21st Century Act (MAP-21), P.L. 112-141, NHTSA research will evaluate the need for crashworthiness standards in heavy vehicles. This research focusses on crash characteristics, occupant injury types and their origin. Additional research will evaluate possible countermeasures to mitigate occupant injuries.

	Crash Avoidance		Crashworthiness	
	NORMAL DRIVING	CRASH IMMINENT	CRASH EVENT	POST-CRASH
PASSENGER CARS/TRUCKS	• Driver Distraction • Driver Support Systems • Blind Spot Detection • Alcohol Detection • Drowsy Driver Detection •Crash Warning Interfaces •…	•Forward Crash Warning •Lane Departure Warning •Automatic Braking •Lane Keeping •V2V & V2I •Crash Warning Interfaces •….	• Advanced Airbags •Dynamic Rollover • Oblique/Off-set Frontal • Adaptive Restraints • Child Side Impact • Elderly Occupants • ….	• Auto Crash Notification (ACN) • Advanced ACN • Medical Outcome (CIREN) • First Responder Safety
HEAVY VEHICLES - Truck/Bus	• Driver Distraction • Drowsy Driver Detection • Enhanced Vision Systems • Blind Spot Detection •Crash Warning Interfaces	• ESC/RSC •Forward Collision Warning •Lane Change Warning •V2V & V2I •Crash Warning Interfaces	• Underride	• Electronic Data Recorders • ACN?
MOTORCYCLES	• Conspicuity	• ABS/CBS • V2V	• Helmet Use • Airbags	• ACN?
PEDESTRIANS	• Quiet Car Detection • Lighting Systems for Pedestrians	• Pedestrian Warning • Automatic Braking • P2V	• GTR Hoods/Bumpers	•ACN?
BATTERY ELECTRIC VEHICLES	• Charging Safety • Lithium Ion Battery	• Shut-Down Strategies	• Lithium Ion Battery • Electrical Isolation	• First Responder Safety
ELECTRONICS RELIABILITY & SECURITY	• Fail-Safe Strategies • Software Reliability • Fault Detection & Reporting & Driver Vehicle Interface	• Control System Management Strategies & Driver Vehicle Interface	• Control System Management Strategies	• Electronic Data Recorders

Figure 3. Expanded Haddon Matrix describes NHTSA Crash Avoidance and Crashworthiness programs.

NHTSA has released a report analyzing all 2008 fatal truck under ride crashes reported in the Trucks in Fatal Accidents database (TIFA) (Blower, 2012). This study found that a third of the heavy vehicles struck were single unit trucks and the other two thirds were nearly all tractor trailer combinations. Of the 539 fatal crashes, 72% of the striking vehicles were light vehicles, 20% were heavy vehicles and 8% were motorcycles.

The second report, in progress, includes a review of 2009 TIFA under ride data as well as estimates of relative speeds between vehicles for a portion of the 2008-2009 TIFA dataset. A significant portion of fatalities involving trailers with rear impact guards include vehicle under ride extending to the windshield and beyond. From the relative speed study, it was determined that 50% of rear end crashes occurred with relative speeds of 44 mph or higher between light and heavy vehicles. As the data indicate that the safety performance of the rear impact guards could be improved, the agency is considering upgrades to trailer rear impact guard requirements.

Dynamic Rollover Protection

A Dynamic Rollover Test System (DRoTS) is under development. Its capability has been optimized through numerous vehicle tests and refinement. This development work demonstrates good dynamic performance and repeatability. DRoTS fixture performance for various initial test conditions has been confirmed and adapts to a range of vehicle sizes.

Current focus for this test fixture is to evaluate occupant kinematics and injury potential for a range of rollover and vehicle conditions. Parametric studies will evaluate test dummy and cadaveric kinematics for a range of restraint and rollover conditions. Additional 2013 testing will incorporate a roof installed on the rollover buck to evaluate test dummy and cadaveric roof contact and injury predictions. The roof of the rollover buck can be quickly replaced to allow study of rollover dynamics, vehicle structure, restraint design, and their effects on occupant kinematics and ATD injury prediction.

Child Passenger Safety

Using NHTSA's Fatality Analysis Reporting System (FARS) data files for the years 2007-2011, the agency estimated that 34 % of fatalities among child (3 and under) rear seat passenger vehicle occupants in motor vehicle crashes were in frontal crashes while 32 % were in side impact crashes. Side impacts are less common than frontal impacts yet they result in a comparable amount of fatalities. From NASS-CDS(2003 to 2008) data files it was determined that 55% of AIS2+ injuries in 0-12 year old children were to the head and face, while 28% of AIS2+ injuries were to the torso.

NHTSA has been conducting research on the protection of children in side impact crashes. Much of that research has focused on developing a test procedure to evaluate CRS performance in side impact crashes. A side impact sled test procedure, replicating a near-side impact, is currently being evaluated for repeatability and reproducibility. Sled buck test parameters are being refined. Children can strike side structures and other interior surfaces of the vehicle. Thus, research efforts are also underway to investigate the injuries from contact with lower door sections and vehicle interior components to see if there is need to increase the protection for rear occupants.

The agency is also reviewing the current FMVSS No. 213 test procedure to determine the viability or advisability of increasing the simulated frontal impact speed from 30 mph to 35 mph, updating the existing test seat fixture and assessing high-weight rated CRSs.

Child seat manufacturers have begun to increase the upper weight limits on many of their CRS models as a result of consumers' needs and state laws that require children to be in some form of child restraint until 6-8 years of age. Consequently, the American Academy of Pediatrics and NHTSA issued updated guidelines in 2011 encouraging parents/caregivers to keep children rear-facing to the allowable extent of the child restraint system. Thus, the agency is undertaking efforts to develop test procedures to evaluate the safety performance, including the structural integrity of these higher weight rated rear facing CRS models. In addition to higher weight usage limits, the CRS themselves tend to be heavier than the lower rated models. The agency is conducting research to assess the performance capability of the Lower Anchorages and Tethers for Children (LATCH) systems when used with these higher weight rated CRS models.

Lithium Ion Battery Safety

NHTSA's safety research program for electrically propelled vehicles will focus on lithium ion based Rechargeable Energy Storage Systems (RESS). NHTSA has awarded two contracts for RESS research to develop baseline test procedures and performance metrics. These awards were to SAE and Ford Motor Company. Both contracts are two years in duration and are intended to build upon current industry practices and voluntary standards to help codify minimum vehicle level performance standards for lithium ion battery systems. These best practices shall encompass normal driving, charging, crash and post-crash conditions. NHTSA has also entered into a research program with Argonne National Laboratories to investigate common post incident RESS diagnosis and stranded energy removal. Procedures and devices will be developed to maintain safety by developing and integrating safety assessment algorithms that monitor and maintain RESS stability. NHTSA has also partnered with Sandia National Laboratories to investigate functional cycling test procedures for evaluating post-test RESS. Finally, NHTSA has initiated a program to examine the safe performance of RESS battery management systems.

Nathaniel Beuse

Countermeasures for "Lightweighted" Vehicles

NHTSA recently released new Corporate Average Fuel Economy (CAFE) requirements for 2017 and beyond. As part of this effort, NHTSA investigated cost and safety implications for future light-weighted vehicle designs. On the safety side, NHTSA is investigating the crash response and potential safety impact of introducing light-weighted fuel efficient vehicles into the US fleet. Finite element models have been developed for various light-weighted vehicle designs and crash simulations will be conducted to study the crash safety performance for these designs in both single vehicle crashes and vehicle-to-vehicle crashes. These simulations will also be used to study potential safety countermeasures to maintain or improve the crash performance for future light-weighted vehicle designs.

Advanced Restraints

NHTSA has recently awarded a contract for the development of prototype adaptive occupant protection systems. This research should develop a system to address a range of occupant sizes and positions and test conditions to emphasize the system adaptability for variable high speed crashes. This research effort was awarded to Takata and should complete in early 2015.

In recent years, advanced restraint technologies have become widely available in front outboard seating positions, but are infrequently available in the rear seat environment, particularly in high volume vehicles. Although previous field data analyses have estimated that rear-seat occupants are at lower risk of serious injury and fatality than front-seat occupants in motor-vehicle crashes, some recent studies have shown that front seats may provide better protection, especially for elderly occupants, than rear seats in newer vehicle models. NHTSA has recently initiated a research project with UMTRI and TRW to design, optimize, fabricate, test, and demonstrate prototype advanced restraint systems for protecting rear-seat occupants. This project will consider a range of body sizes, ages, and multiple frontal crash conditions. This project will establish the baseline performance of a non-advanced restraint system and demonstrate the occupant safety improvements offered by the advanced restraint systems. This project will complete in early 2015.

NHTSA is also conducting sled tests for currently available rear seat restraint systems. These systems include inflatable belts, load limiters, and pre-tensioners, for improving protection for adults.

Motorcoach Research

NHTSA has studied the issue of motorcoach occupant safety for several years. On average, motorcoach crashes cause 19 deaths annually. Ejection from the motorcoach is common to both frontal and rollover type crashes accounting for about half of all motorcoach passenger fatalities. Ejection is particularly harmful in fatal crashes, with rollover accounting for 75 percent of those fatalities.

The agency is continuing its research into ejection through window openings. Component tests using a guided impactor are being carried out to evaluate the performance of various window glazing and latch designs. The agency also plans to conduct tests to assess interior impact protection and compartmentalization, pursuant to MAP-21 requirements.

The agency recently initiated a two year contract to develop and evaluate test procedures to assess fire detection, suppression and flammability of exterior materials for motorcoaches. This research project, headed by Southwest Research Institute, will focus on engine and wheel well fires.

Biomechanics Research

NHTSA's Human Injury Research and Applied Biomechanics Divisions have led NHTSA's biomechanics research efforts over the past 35+ years. Many of the current research efforts are documented in the Biomechanics Research Plan (NHTSA, 2011c), which is available on the NHTSA Research website. The plan includes numerous projects that support NHTSA's rulemaking initiatives (NHTSA, 2011a).

Injury Response/Tolerance

Research continues to focus on injury outcomes / mechanisms and the development of new and improved devices (e.g., anthropomorphic test devices or ATDs) to address the continuing issues observed in frontal, side, rear, and rollover crashes. Head/brain and thoracic injuries continue to be focus areas for the adult occupant as supported by real-world data.

Efforts include the analysis of traumatic brain injuries and the criteria that may be used to assess them. Continued collection and analysis of laboratory and full scale crash data using SIMon (**S**imulated **I**njury **Mon**itor) and other head/brain models is supporting the continued development and assessment of a rotational brain injury criterion (BRIC) that will utilize angular kinematics of the head derived from

ATD instrumentation to predict the risk of brain injury (Takhounts et al., 2011). Related research, including the analysis of football player head impacts, axonal strain related to diffuse axonal injury, and age related changes to brain anatomy and injury tolerance, will allow for further enhancements of finite element head models and for development of improved brain injury criteria.

Ongoing efforts in the area of thoracic response and injury tolerance include the application of standardized sled test conditions for assessing frontal ATD bio-fidelity. Other thoracic research includes testing to support the development of a multi-point thoracic injury criterion and efforts aimed at assessing thoracic response and injury tolerance under oblique loading.

Anthropomorphic Test Devices (ATD)

NHTSA's research efforts have focused on numerous ATD development, evaluation, and federalization projects. In the area of adult dummies, significant efforts continue with regards to the THOR 50th percentile male and 5th percentile female ATDs. Among other issues, current efforts are focusing on completing bio-fidelity assessments/comparisons, injury criteria, and technical documentation to support a 2013 NHTSA agency decision regarding next steps for the THOR 50th male dummy. The THOR 5th percentile will incorporate the updates that have been made to the 50th male. An agency decision on next steps for the THOR 5th is planned for 2014.

NHTSA has completed an assessment of WorldSID (50th percentile male) relative to bio-fidelity and crash test capability. The WorldSID 50th male shows improved bio-fidelity over existing side impact dummy designs and has performed well in current Agency side impact tests. Similar efforts are being done with the WorldSID 5th female to compare bio-fidelity versus existing ATDs.

A test series to determine the bio-fidelity of rear impact dummies, including the 50th percentile male BioRID dummy, has been completed and analysis is in progress. The Human Injury Research and Applied Biomechanics Divisions will assess the test results to determine potential injury criteria and calibration and certification procedures for these dummies and continue to work with the international vehicle safety community to complete the analysis.

Finally, NHTSA is completing efforts in support of child ATD development. First, NHTSA has supported the implementation of a revised neck, thorax and pelvis for the Q3s, 3-year-old side impact child dummy. The updated Q3s recently underwent evaluations for bio-fidelity, repeatability, reproducibility, and durability. Additionally, work continues to assess other child dummies such as the Hybrid III 6- and 10-year-old to include in future regulation as well as research to enhance the response of these dummies.

Vulnerable Occupants

NHTSA is completing research to address unique concerns related to vulnerable occupants, which include children, elderly, obese, and pregnant occupants.

Field data analyses of real-world crashes, together with census data projections for ongoing long-term increases in the population of those 65 and older, supports the need for research focused on the injury tolerance/response of older vehicle occupants. NHTSA is supporting research describing differences in geometry (e.g., brain, rib cage), material properties (bone, soft tissue), and other factors that may contribute to changes in fragility and frailty of older occupants. In particular, research focused on the brain and thorax is in process that will enable the development of improved, age-specific tools such as computer models and injury criteria. Improved models and criteria will facilitate the development of enhanced restraint system designs that account for the reduced injury tolerance and changing anthropometry/geometry of the aging vehicle occupant.

With regard to children, NHTSA leads a multi-center research effort to collect and document new child anthropometry, injury criteria and response data that together can be used in the development of advanced child dummies. Areas of study included the head, neck, shoulder, thorax, and abdomen.

Crash Injury Research and Engineering Network (CIREN)

CIREN continues to utilize its unique multidisciplinary approach for crash injury investigation and research to improve the agreement between laboratory research and real world crash results. Complete access to medical documentation and radiologic images allows CIREN an improved understanding of how occupants sustain injury in modern passenger vehicles. This greater awareness aids NHTSA in identifying new injury mechanisms that are not currently monitored by the vehicle safety standards or vehicle crash testing. CIREN has the unique capability of collecting and assigning contributing factors for injury causation and severity. The influence of health conditions such as osteoporosis, obesity, brain atrophy and age are reviewed and assigned accordingly in CIREN cases. CIREN will be increasing data access in 2013 with public release of case data in flat file form.

Advanced Automatic Collision Notification (AACN)

NHTSA is researching many aspects of AACN. These efforts include pilot studies of data transmission and data collection, data utility and injury prediction assessments, development of system specifications and evaluation protocols, and collection of end-user feedback. An agency decision on next steps is planned for 2013 (NHTSA, 2011a).

Crash Avoidance and Electronic Controls Research

Crash avoidance research is largely defined by data, including problem size estimates from crash data that are collected, reduced, and maintained by the National Center for Statistics and Analysis (NCSA). Data are also provided through driver performance and vehicle functional studies, test track evaluations of countermeasure technologies, naturalistic and simulator studies, and objective test procedures. Figure 6 illustrates the vulnerable areas around a vehicle that can be addressed by crash avoidance technologies.

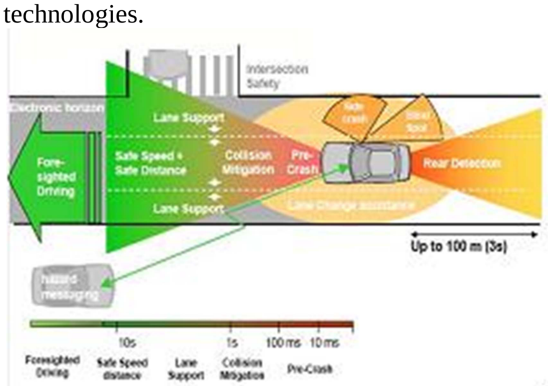

Figure 6. Vulnerable Areas Addressed by Crash Avoidance Technologies.

The major crash avoidance and electronic controls programs are: (1) Light Vehicle Crash Avoidance-Vehicle-based Systems; (2) Vehicle Safety Communications; (3) Heavy Vehicle Research; (4) Human Factors; and (5) Electronic System Safety (Cybersecurity, Reliability, and Automated Vehicle Research).

Light Vehicle Crash Avoidance Research: Vehicle-based Systems

For the past 15 years NHTSA has been engaged in research related to on-board crash warning systems that detect potential crash situations and warn the driver to take appropriate action. Such systems include forward collision warning (FCW); lane departure warning (LDW); and blind spot monitoring (BSM). Past research has included evaluations of prototype systems in both controlled settings (test track and simulators), and through field testing. NHTSA's work in crash warning systems continues, and the Agency is currently launching a large, 2,100 vehicle field study involving production crash warning systems from leading vehicle manufacturers. NHTSA will monitor the operation and driver use of these systems for a 1 year period to help better understand safety potential, driver acceptance and technology reliability issues. NHTSA is also engaged in considerable research related to evaluating effectiveness of alterative collision warning interface designs and implementations, as well as procedures for gauging such effectiveness—see Human Factors Research section for additional discussion).

Crash Avoidance technology has continued to progress, and NHTSA is aggressively pursuing research related to technologies that, in addition to warning drivers of a collision threat, can take active control of the vehicle to help mitigate or avoid the crash (if warnings are not heeded by the driver, or the driver's reaction is insufficient to avoid the crash). In particular, NHTSA is focusing its efforts on dynamic brake system (DBS) and collision imminent braking (CIB) technologies being offered by light vehicle OEMs. Such systems employ radar, camera, lidar and other sensor technologies to detect and track vehicles, pedestrians or objects in the forward path.

DBS technology serves to increase braking effort initiated by the driver during collision imminent situations if the driver's response is determined (by the system) to be insufficient to avoid the collision. CIB systems will operate to automatically energize the brakes in crash imminent situation if the driver does not respond at all to the warnings. NHTSA is currently evaluating the performance of such systems in a variety of crash scenarios and under controlled test conditions. We are also developing objective test procedures and associated test equipment including a strikeable "surrogate" target vehicle to simulate an actual in-path lead vehicle. While the majority of our research efforts to date have been focused on DBS and CIB systems that detect and react to other vehicles and objects, NHTSA is also pursuing research related to advanced systems that are also capable of pedestrian detection and automatic emergency braking.

Estimating the safety benefits of crash avoidance systems is also an important on-going research area for NHTSA. NHTSA has been working with industry partners to develop leading-edge modeling and analytical techniques to improve reliability of estimates—and forecast how changes in system performance attributes may affect safety benefits. In 2009 NHTSA completed four projects with teams led by automobile manufacturers which focused on estimating the safety benefits of technologies that address frontal crash mitigation (primarily rear-end crashes), back-over prevention, and lane departure warning. In June 2011, NHTSA completed two remaining projects with teams led by automobile manufacturers, which focused on technologies that address head-on crash mitigation, lane departure prevention, and blind spot detection.

In July 2012, the agency published a Request for Comments seeking feedback on our observations about these technologies as well as consideration of test protocols that could be used to test their effectiveness. NHTSA is in the process of evaluating industry and public feedback while advancing our research in the other areas listed above.

Vehicle Safety Communications (VSC)

As previously described, NHTSA has conducted extensive research on the effectiveness of vehicle-based collision countermeasures for rear-end, road departure, and lane-change crashes. Such systems use a variety of sensors (radar, camera, lidar, infrared, ultrasonic and others) to detect other in-path vehicles (and pedestrians). However, the systems have inherent limitations as they estimate the presence, intent, and pathways of nearby vehicles and pedestrians—but are subject to inaccuracies which may be induced by poor visibility, environmental conditions, or even roadway markings. Vehicle-based radio communications (based on 5.9 GHz Dedicated Short Range Communications (DSRC), paired with accurate GPS-based relative vehicle positioning, may overcome these shortcomings and improve safety system effectiveness by complementing or, in some instances, providing alternative approaches to autonomous safety equipment. NHTSA is exploring how both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications can enable improved effectiveness of active safety systems.

NHTSA is conducting a collaborative research effort with a consortium of automobile manufacturers to facilitate the development and deployment of effective V2V communication safety systems. Figure 7 illustrates the V2V concept. This project is developing safety applications, addressing interoperability issues and evaluating safety benefits.

Figure 7. Vehicle-to-Vehicle Communications.

In summer, 2012, USDOT kicked-off the Safety Pilot Program. The Safety Pilot is intended to establish a real world model deployment test site for enabling wireless communications among vehicles. The deployment site encompasses vehicles of various types that include a mix of integrated, retrofit, and aftermarket vehicle safety systems.

The goals of the Safety Pilot Program are to:

- Supplement benefits analysis in support of NHTSA 2013 Agency Decision on V2V Communications through the use of real world field data.
- Demonstrate V2V and V2I safety applications, interoperability, and scalability in a data rich environment.
- Create public awareness and determine user acceptance.

Anticipated outcomes include:

- Obtaining empirical data for estimating benefits and user acceptance in support of future federal policy actions.
- Establishing a public database of archived road network data for supporting development of additional safety, mobility, and environmental applications.
- Establishing multiple supplier sources for safety devices and roadside infrastructure.
- Develop a better understanding of the operational policy issues associated with the deployment of V2V and V2I applications

Heavy Vehicle Research

NHTSA's heavy vehicle research program is targeted at examining the functionality, performance, and safety benefits of a variety of advanced crash avoidance and mitigation technologies for heavy vehicles. The heavy vehicle research program addresses safety technologies that are both commercialized but perhaps not widely deployed, as well as prototype and next generation safety systems. The program encompasses multiple vehicle platforms including tractor-trailers or combination vehicles, straight trucks, buses, and motorcoaches. Also, it is important to note that much of the research (described elsewhere in this paper) in areas such as human factors, autonomous crash avoidance systems, and vehicle safety communications, also include elements to address those same issues on heavy vehicle trucks and buses.

Electronic Stability Control for Heavy Vehicles

In the area of crash avoidance, NHTSA's heavy vehicle program is evaluating the performance benefits of electronic stability control (ESC). ESC systems are designed to reduce untripped rollovers and mitigate severe understeer and oversteer conditions that lead to loss of control, by using automatic computer-controlled braking and reducing engine torque output. (Figure 8).

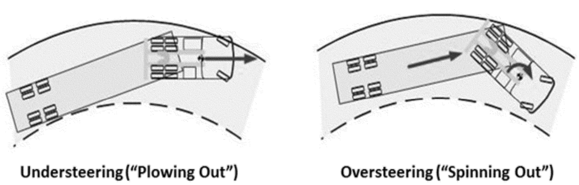

Figure 8. Loss of Control Conditions

Testing at NHTSA's Vehicle Research and Test Center in Ohio has been conducted to develop objective tests and performance measures to evaluate the test track performance of these systems. We also completed safety benefit studies using hardware-in-the-loop simulations, and clinical analyses of large truck crash reconstruction data to determine the effectiveness of stability control systems over a wide range of conditions. The agency published a Notice of Proposed Rulemaking on this issue in 2012.

Collision Imminent Braking-Heavy Vehicles

NHTSA has been evaluating performance and operational characteristics of warning-only crash avoidance systems for heavy vehicles for over 10 years—with a focus on forward collision warning (FCW). More recently NHTSA has been engaged in research focused on technology that combines FCW with collision imminent braking (CIB). Such systems employ radar and/or camera-based sensors to detect and track other vehicles in the forward path of the subject vehicle. If a collision threat is determined to exist (based on closure range, range-rate and other kinematic conditions), an audible/visual warning is first issued. If the threat persists or worsens, then the foundation brakes are automatically applied to mitigate or avoid the crash.

NHTSA is currently engaged in the following FCW/CIB research:

- documenting the performance of production FCW/CIB systems in a variety of pre-crash scenarios, and under controlled test track conditions (Figure 9),
- evaluating the performance of prototype "next generation" systems that combine radar and optical sensors to improve object recognition, reduce "nuisance" warnings, and enhance braking performance,
- developing objective test procedures for the technology, and
- developing advanced modeling and simulation methods to help understand the safety benefits of FCW/CIB systems as applied to heavy vehicles.

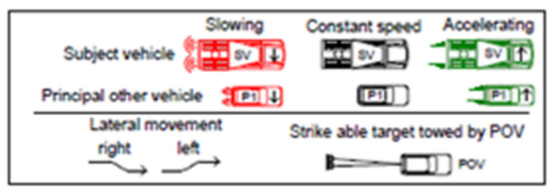

Figure 9. Examples of Pre-crash Scenarios.

To determine how such systems perform in real-world conditions, NHTSA is also launching a Field Operational Test which will target latest generation FCW/CIB production systems to be operated in a variety of fleet types and service environments. Operational, reliability and driver usage profiles will be monitored on approximately 150 trucks for a 1 year period. Results will be used to help assess customer satisfaction as well as safety benefits.

Lane Departure Warning for Heavy Vehicles

Lane departure warning (LDW) systems utilize digital camera technology to track the lateral position of the truck within lane markings, and/or the position of the truck relative to the roadway edge. These systems warn the driver of unintentional drifting out of their travel lane and/or off the edge of the roadway (i.e., roadway departure). NHTSA is currently engaged in evaluating the performance of latest generation systems from truck OEM suppliers (based on controlled track testing), and in developing objective test procedures. NHTSA is also examining the real-world performance of such systems through a 150-vehicle Field Operational Test.

Vehicle Safety Communications for Heavy Vehicles

For several years NHTSA has been working with light-duty passenger vehicle manufacturers to develop and test innovative wireless communication technologies that would allow vehicles to have enhanced “situational awareness” by continuously broadcasting their position and heading at a rapid rate. This information is then received and interpreted by other vehicles. Warnings are presented to drivers if a crash situation is developing or imminent.

NHTSA is now extending this research to include heavy trucks and buses, and is aggressively tailoring the technology and applications as needed to work in the unique operating environment characteristic of heavy vehicles. NHTSA is working with commercial vehicle partners to research and test the use of DSRC based vehicle-to-vehicle communications as a means of enhancing the performance of existing collision avoidance systems (such as FCW and LDW), but also enabling new collision avoidance applications for heavy vehicles such as intersection movement assist (IMA). Heavy vehicle trucks are an integral part of the Safety Pilot Model Deployment (see Vehicle Safety Communications section).

Human Factors Research

NHTSA’s human factors research examines the interaction of driver, vehicle, and environment in order to improve driver-vehicle performance. The research supports Federal Motor Vehicle Safety Standards, safety defects investigations, consumer information, and the advancement of knowledge about driver behaviors and performance. Findings are applied to the development of vehicle technologies, which are compatible with driver abilities and limitations. Main focus areas of the Human Factors program include: (1) Reducing unsafe driving behaviors by addressing driver distraction and driver impairment (alcohol, drowsy driving), (2) Improving the driver-interface (DVI) design of Crash Warning Systems, (3) addressing vulnerable populations, such as blind pedestrians by developing human factors requirements for quiet cars, and (4) human factors for connected, and (5) automated vehicles.

Driver Distraction

NHTSA’s mission is to “save lives, prevent injuries, and reduce economic costs due to road traffic crashes.” One focus of this mission is the prevention of road traffic crashes for which driver distraction is a contributing factor.

In April, 2010 NHTSA released an Overview of the National Highway Traffic Safety Administration’s Driver Distraction Program which summarized steps that NHTSA intends to take to help in its long-term goal of eliminating a specific category of crashes- those attributable to driver distraction (NHTSA 2010b). NHTSA’s Driver Distraction Program consists of four initiatives as illustrated in Figure 10, and described below.

Figure 10. NHTSA Driver Distraction Initiatives

Of the areas described in the plan, the Human Factors program supports initiatives 1-3, which are:

1. *Improve the understanding of the extent and nature of the distraction problem*. This includes improving the quality of data NHTSA collects about distraction-related crashes along with better analysis techniques.
2. *Reduce the driver workload associated with performing tasks using both built-in and portable in-vehicle devices by improving the designs of device interfaces*. Better device interfaces will help to minimize the amount of time and effort involved in a driver performing a task using the device. Minimizing the workload associated with performing non-driving, or “*secondary,*” tasks with a device will permit the driver to maximize the attention they focus toward the *primary* task of driving.
3. *Keep drivers safe through the introduction of crash avoidance technologies.* These include the use of crash warning systems to re-focus the attention of distracted drivers as well as vehicle

initiated braking and steering to prevent or mitigate distracted driver crashes.

Distraction Guidelines

Of the projects listed under Initiatives, 1-3, a main focus is to develop a set of Distraction Guidelines in support of Initiative 2 – Reduce Workload from Interfaces. As discussed in NHTSA's Driver Distraction Program, NHTSA's intent is to "develop voluntary guidelines for minimizing the distraction potential of in-vehicle and portable devices."

Drivers perform secondary tasks (communications, entertainment, informational, and navigation tasks not required to drive) using in-vehicle electronic devices by interacting with them through their user interfaces. The user interfaces of these devices can be designed to accommodate interactions that are visual-manual, auditory-vocal, or a combination of the two. Some devices may allow a driver to perform a task through either manual control manipulation with visual feedback, or through voice command with auditory feedback to the driver.

In general there are two functional categories based upon the mode of interaction: visual-manual and auditory-vocal. Visual-manual interactions involve the driver making inputs to the device by hand (e.g., pressing a button, rotating a knob) and visual feedback being provided to the driver. Auditory-vocal interactions involve the driver controlling the device functions through voice commands and receiving auditory feedback from the device. Note that a single device's driver interface could accommodate both visual-manual and auditory vocal interactions.

In 2012, NHTSA published draft Visual-Manual Driver Distraction Guidelines for In-Vehicle Electronic Devices for public comment. These guidelines are intended for application to in-vehicle device tasks that are performed by the driver through visual-manual means. The goal of the NHTSA Guidelines is to encourage the design of in-vehicle device interfaces that minimize driver distraction associated with secondary task performance. The Guidelines specify criteria and a test method for assessing whether a secondary task performed using an in-vehicle device may be acceptable for performance while driving. The Guidelines also seek to identify secondary tasks which interfere too much with a driver's ability to safely control their vehicle and to categorize those tasks as ones that are not acceptable for performance by the driver while driving. NHTSA is also currently developing the second phase of these guidelines that will focus on Portable Aftermarket Devices, as well as the third phase, which will focus on voice-based auditory interfaces.

Alcohol Detection Research: Driver Alcohol Detection System for Safety (DADSS)

Since 1997, about a third of all fatally-injured passenger vehicle drivers had blood alcohol concentrations at or above the legal limit. In order to address this problem, NHTSA entered into a five year cooperative agreement with the Automotive Coalition for Traffic Safety (ACTS) aimed at developing alcohol detection technologies with broad deployment potential. Desired technologies would be non-invasive, reliable, accurate, and precise, with the goal of preventing alcohol impaired drivers above the legal limit from moving their vehicle. This program has been involved in the development and testing of alcohol detection prototypes that would be suitable for installation and use in vehicles. The system prototypes—one focused on the driver's exhaled breathe, and the other a touch-based technology—are now being developed and undergoing extensive laboratory and field testing. This five year effort will result in working prototypes installed in a research vehicle.

Driver Impairment Monitoring

In 2010, the Impairment Monitoring to Promote Avoidance of Crashes using Technology (IMPACT) program developed real-time algorithms to detect driver alcohol impairment using vehicle-based sensors. The study developed two types of algorithm, a general algorithm that does not consider individual differences in driving and an individualized algorithm.

Ideally, one would desire both the capability of identifying impaired driving regardless of the source, and the capability of specifying the source of impairment. The IMPACT algorithms with slight modifications may present one or both capabilities in addition to detection of alcohol impairment. A follow on program, Driver Monitoring of Inattention and Impairment Using Vehicle Measures (DrIIVE), aims to evaluate the breadth and specificity of the algorithms developed in IMPACT for use in detecting and distinguishing among multiple forms of driver impairment (alcohol impaired driving, drowsy driving, and distracted driving). The current phase of DrIIVE focuses on developing algorithms to detect drowsy drivers.

Nathaniel Beuse

Collision Warning Interface Research

Recognizing the important role of the driver in crash avoidance systems, NHTSA is now focusing research on developing a better understanding of, and guidelines for, the collision warning interface for FCW and LDW systems. The work involves consideration of the unique driving environments for both light vehicle and commercial and heavy vehicle drivers. This work examines the effectiveness of various warning methods, determines the potential need for standardizing certain system features, and explores methods for objectively measuring the performance of interface solutions.

Quieter Car

Pedestrian safety can be compromised by modern vehicles, e.g. electric vehicles that produce little or no sound. The goal of this program is to understand the safety risks, characterize the acoustic environment, and identify possible countermeasures to enable pedestrians to detect the presence of vehicles in motion. Recent phases in the program have measured the effectiveness and acceptability of various countermeasures. Results will support agency rulemaking as directed by Congress, and reported elsewhere in this paper.

Human Factors for Connected Vehicles

The objective of the research program in human factors for wireless traffic safety systems is to assess, counteract, and ultimately eliminate possible driver distraction from technologies that enable wireless communication between vehicles. The program aims to research and implement technology-based solutions that could deter drivers from multitasking and reduce vehicular sources of distraction. The Human Factors Research program is a highly collaborative effort that addresses the effectiveness of safety applications by evaluating any potential issues around driver distraction. The program is working towards mitigating any distracting by products from using in-vehicle information systems and portable devices, and developing technology-based solutions. The program consists of five Tracks.

Track 1: Improve our understanding of crash risk due to driver distraction. This will be accomplished by evaluating the nature and scope of the distraction safety problem and the evolving technology devices and features offered to drivers by analyzing data from a variety of sources.

Track 2: Develop and evaluate performance metrics for distraction mitigation. By monitoring new technology interfaces and developing best practices, objective test procedures can be developed to assess distraction and usability factors in production vehicles and portable nomadic technologies.

Track 3: Produce an integration strategy that allows nomadic systems to be functionally integrated with vehicle-based systems to optimize the driver-vehicle interface. Integration can reduce interface complexity and the occurrence of multitasking.

Track 4: Develop qualified exposure testing through field experiments that determine the long-term safety impacts of crash warning technologies and their effects on driver behavior.

Track 5: Conduct strategic stakeholder outreach to identify requirements, information needs, and usability issues, toward the goal of public acceptance.

Human Factors Evaluation of Automated Driving Concepts

Motor vehicle automation can potentially improve highway safety by helping the driver to detect crash risk sooner, by providing precise and consistent vehicle control during normal driving, and by maintaining appropriate driver attention to traffic and roadway conditions.

Accordingly, a new research program has been initiated to improve motor vehicle safety by defining the requirements for automation in normal driving that is: 1) functionally safe and electronically reliable; 2) operationally intuitive for drivers under diverse driving conditions; 3) compatible with driver abilities and expectations; 4) supportive of improving safety by reducing driver error ; 5) operational only to the extent granted by the driver and always deferent to the driver; and, 6) secure from malicious external control and tampering.

Electronic Systems Safety

In addition to research involving current and emerging crash avoidance technologies, NHTSA is also engaged in research related to electronics reliability, cyber security; and automated vehicles. In 2011, electronic systems safety was added as a new area of vehicle safety research at NHTSA.

Electronic control systems in vehicles raise concerns for driver safety in the areas of system reliability, cyber security, and vehicle automation. The safe reliability area addresses strategies for fail safe operation, diagnostics, software reliability, hardware validation, and electromagnetic compatibility. The cybersecurity area addresses challenges of on-board tamper-proofing, hacking and malicious external control. The automated vehicles program addresses safety questions about driver engagement and re-engagement across levels of automation, evaluation of concepts of operation, development of system requirements and guidelines for automated sensing and control, and multi-modal coordination.

Significant Rulemaking Actions

Overview

NHTSA is continuing rulemaking efforts outlined in the NHTSA Vehicle Safety and Fuel Economy Rulemaking and Research Priority Plan 2011-2013 (NHTSA, 2011a). In addition, on July 6, 2012, President Obama signed the "Moving Ahead for Progress in the 21st Century Act" (MAP-21), P.L. 112-141 which among the various provisions includes action items for NHTSA regarding child safety standards, commercial motor vehicle safety, motorcoach enhanced safety, vehicle electronics, and enhanced safety authorities and accountability. The agency has incorporated the rulemaking action items in MAP-21 into its rulemaking agenda. The following provides a brief summary of the agency's significant rulemaking actions.

Improve Rear Visibility

This action pertains to FMVSS 111 and the Cameron Gulbransen Kids Transportation Safety Act of 2007 requiring regulation related to power window safety, rearward visibility, and rollaway prevention. On December 7, 2010, the agency published a Notice of Proposed Rulemaking (NPRM) proposing an image behind the vehicle be visible to the driver when in reverse. On February 28, the agency extended the comment period until April 18, 2011, and announced two public meetings to be held in March.

Sound for Hybrid Vehicles

This action pertains to the Pedestrian Safety Enhancement Act, to provide means of alerting pedestrians, especially those who are blind, to the presence of a motor vehicle in operation. On January 14, 2013, the agency published a Notice of Proposed Rulemaking.

Heavy Vehicle Stability Control

After an extensive research program to evaluate the available technologies, an evaluation of the costs and benefits, and a review of manufacturer's product plans, NHTSA believes it is necessary to promulgate a new Federal standard that considers stability control systems on truck tractors and motorcoaches that address both rollover and loss of control crashes. Rollover and Loss of Control crashes' involving heavy vehicles is a serious safety issue that is responsible for 304 fatalities and 2,738 injuries. They are also a major cause of traffic tie-ups, resulting in millions of dollars of lost productivity and excess energy consumption each year. Suppliers and truck and motorcoach manufacturers have developed stability control technology for heavy vehicles to mitigate these types of crashes

Heavy Truck Tire Upgrade

This action pertains to FMVSS No. 119, applied to new pneumatic tires for motor vehicles with a GVWR of more than 4,536 kilograms (10,000 pounds) and motorcycles. This applies only to new tires, not to retreaded tires. On September 29, 2010, the agency published an NPRM proposing to upgrade FMVSS No. 119 by increasing the stringency of the endurance test, primarily by increasing the test speed, increasing the load, and lowering the inflation pressure, and adding speed rating labeling on the sidewall. A new high speed test with test speeds up to 75 mph was also proposed.

Keyless Ignitions

This action pertains to FMVSS 114, Theft protection and rollaway prevention. This rulemaking addresses three safety issues regarding Keyless Ignition systems: drivers' inability to shut down a moving vehicle, drivers failure to place the transmission in park before shutting off the vehicle (leading to rollaways when the driver exits the vehicle), and drivers inadvertently leaving a vehicle with the propulsion system active (leading to carbon monoxide poisoning if the vehicle is parked in a garage adjoining a living space). The agency published the NPRM.

Accelerator Control Systems

This action pertains to FMVSS 124, accelerator control systems. The issues are: (1) updating the throttle disconnection safety requirements and test procedures of the standard to better address electronic throttle control and alternative power trains; and (2) adding a new requirement for a brake-throttle override system on light vehicles. The agency published the NPRM.

Lighting

FMVSS No. 108 has been in existence since 1968. The standard had been amended over the years but has never undergone a comprehensive review. Regulated parties had stated that the standard was difficult to interpret because of its organization. In response to these concerns the agency sought to rewrite the standard to make it more understandable by adopting a simplified numbering scheme, to improve organization by grouping related materials in a more logical and consistent sequence, and to reduce the certification burden of regulated parties who previously needed to review a few dozen third-party documents. The agency issued a final rule on December 4, 2007. Several petitions for reconsideration of the Final Rule are under consideration

Speed Limiters for Heavy Trucks

In 2007, NHTSA was petitioned by the American Trucking Association and Roadsafe America to require the installation of speed limiting devices on heavy trucks. In response, NHTSA requested public comment on the subject and received numerous comments supporting the petitioner's request. The agency has granted the petition. The agency anticipates issuing a proposal in 2013.

Tire Aging

Tire Aging refers to the reduction in a tire's material properties, which over time leads to a reduction of its performance capabilities and could result in tire failure. As a result of the agency's comprehensive tire aging research program, we have developed a tire aging test protocol that includes 5 weeks in the oven, which is followed by roadwheel testing. The protocol is available in docket NHTSA-2005-21276. Validation tests are being conducted on several currently produced light vehicle tire models to evaluate their performance to the test protocol. After completion of validation testing, the agency will decide on the next steps in 2013.

Next Generation New Car Assessment Program (NCAP)

The NHTSA's New Car Assessment program provides vehicle safety information that enables consumers to compare the safety performance and features of new vehicles. This helps consumers in making their new vehicle purchasing decisions and encourages manufacturers to improve the safety aspects of existing vehicle designs and include new or better safety technologies in future designs. As recently as the 2011 model year, NHTSA upgraded NCAP to increase the stringency of the criteria that must be met to achieve high safety ratings and to provide consumers with more vehicle safety information. The agency also added the first performance tests for crash avoidance advanced technologies: electronic stability control (ESC), lane departure warning (LDW), and forward collision warning (FCW) systems. These program enhancements created additional market forces to improve vehicle safety.

Since the last program upgrade three years ago, manufacturers have made significant safety improvements to their vehicles to achieve 4- and 5-star ratings. In addition, current crash avoidance advanced technologies promoted by the enhanced program, have resulted in a significant increase in the availability of ESC, LDW and FCW. Other new and emerging technologies are being considered for inclusion into the program. Thus, the agency plans to publish a Federal Register notice requesting public comments on various subject areas in 2013 to help the agency plan future enhancements to the NCAP program that will create additional incentives for manufacturers to continually improve vehicle safety. The crashworthiness aspects of vehicle safety improvements under consideration will include, among other things, improved rear seat, older occupant, and pedestrian protection, updating injury criteria in frontal impact and side impact programs, adjusting the baseline injury risk in all three programs to ensure that vehicles are measured against a meaningful benchmark, revising testing protocols, and providing improved consumer information.

Motorcoach Enhanced Safety

The MAP-21 incorporated in Subtitle G, the "Motorcoach Enhanced Safety Act of 2012," which directs the Secretary to consider various motorcoach rulemakings, in provided timeframes, relating to seat belts on motorcoaches, improved roof support standards, advanced glazing standards and other portal improvements to prevent partial and complete ejection of motorcoach passengers, rollover stability enhancing technology, tire pressure monitoring systems, and tire performance standards. Most of these MAP-21 rulemaking actions were already included in the DOT Motorcoach Safety Action Plan

In 2009, the Department of Transportation (DOT) issued the U.S. DOT Motorcoach Safety Action Plan, which outlined a department-wide strategy to enhance motorcoach safety.[1] An update of this plan was issued on December 12, 2012.[2] The 2009 DOT motorcoach safety action plan and the 2012 updated plan identified factors and a prioritized plan for enhancing motorcoach safety, which included mitigating passenger ejection, improving rollover structural integrity, improving emergency evacuation and fire safety, requiring advanced technologies such as electronic stability control systems (ESC) and event data recorders (EDRs), and addressing operational issues such as driver fatigue and vehicle maintenance.

The agency published a proposal to require lap/shoulder belts for all seating positions in motorcoaches on August 18, 2010. A final rule is expected in 2013. The agency is also developing proposals for enhancing motorcoach rollover structural integrity and advanced glazing and window retention which are expected in 2013.

Child Passenger Safety

The MAP-21 incorporated in Subtitle E, "Child Safety Standards," which directs the Secretary to consider various rulemaking actions to enhance child safety including improving side impact protection for children in child restraints, amending the bench seat in the standard to be more representative of the rear seat environment in the current vehicle fleet, improving the ease of use of child restraint anchorage systems, requiring safety belt use warning system for rear seat positions, and minimizing the risk of hyperthermia and hypothermia to unattended children in rear seating positions. The child safety action items in MAP-21 were already in progress according to the NHTSA's Vehicle Safety and Fuel Economy Rulemaking and Research Priority Plan 2011-2013.

On February 27, 2012, the agency issued two final rules expanding the applicability of FMVSS No. 213 to CRSs for children weighing up to 80 lb. by incorporating the Hybrid III 10 year old child dummy into FMVSS No. 213 and into Part 572. The agency is developing proposals to incorporate a side impact test procedure, performance requirements, and a new 3-year-old side impact child dummy, "Q3s" into current standards to evaluate side impact protection of child restraint systems. These proposals are expected to be issued in 2013. The agency is also developing a proposal to improve the ease of use of child restraint anchorage systems, which is expected in 2013.

In February 2011, NHTSA announced its intent to launch a new initiative as part of the New Car Assessment Program to provide consumers with information from auto manufacturers about the specific child safety seats they recommend for individual vehicles (76 FR 10637, Docket No. 2010-00062). Vehicle manufacturers would recommend a minimum of three seats from each of the three child restraint system type categories, rear facing, forward facing, and booster, and would span across a range of price points. Participation in the program would be voluntary.

Rear Seat Belt Reminder Systems

In 2010, the agency published a Federal Register notice requesting comments on petition for rulemaking that would require rear seat belt reminder systems in passenger cars. Additionally, the MAP-21 Subtitle E, "Child Safety Standards," requires the agency initiate a rulemaking for rear seat belt reminder systems (SBRSs) within two years from the Act's date of enactment, and to issue a final rule or report within three years from the Act's date of enactment. In support of the agency's efforts, a research contract was initiated in 2012 to collect information from the driving public to determine drivers' and car passengers' seat belt usage habits as well as the effectiveness and consumer acceptance of rear SBRSs in order to support an analysis of the potential benefits of requiring rear SBRSs.

Safety of Electric Powered Vehicles

On July 29, 2011, NHTSA issued a final rule responding to petitions for reconsideration of the June 14, 2010 final rule requiring manufacturers to design their electrically powered vehicles so that, in the event of a crash, all high voltage components of the power train are either electrically isolated from the vehicle's chassis or their voltage is below specified levels considered safe from electric shock hazards. The July 29, 2011 final rule better aligns the definitions and language with the draft global technical regulation for hydrogen powered vehicle safety.

The United States, along with China, Japan, and the European Union, is co-sponsoring an effort to develop a United Nations Global Technical Regulation (UN GTR) to address the safety of electric powered vehicles. The UN GTR would attain

[1] http://www.fmcsa.dot.gov/documents/safety-security/MotorcoachSafetyActionPlan_finalreport-508.pdf

[2] http://www.fmcsa.dot.gov/safety-security/pcs/Motorcoach-Safety-Action-Plan.aspx

equivalent levels of safety for electric powered vehicles as for conventional gasoline powered vehicles. The UN GTR would address the unique safety risks posed by the rechargeable energy storage systems of electric powered vehicles and their components, taking into account the actual use in the market. It would be performance-based to the extent possible so as not to restrict future technologies. The draft UN GTR is expected to be completed by the end of 2014.

Event Data Recorders (EDRs)

On December 13, 2012 NHTSA proposed to establish a new Federal Motor Vehicle Safety Standard to mandate the installation of Event Data Recorders (EDR) in light vehicles. EDRs are already voluntarily installed on 96% of model year 2013 vehicles to provide critical crash data that might not otherwise be available. The proposed standard would incorporate the current voluntary regulation, 49 CFR Part 563, which established the current reporting requirements of voluntarily installed EDRs in light vehicles. Part 563 presently requires vehicle manufacturers who are voluntarily installing EDRs to be in compliance with the regulation by September 1, 2012. This proposal does not modify any of the Part 563 data elements, data capture and format requirements, data retrieval specifications, or data survivability and crash test requirements. Moreover, this proposal to mandate EDRs across the entire light vehicle fleet would contribute to advancements in vehicle designs, and advanced restraint and other safety countermeasures.

In a separate rulemaking action, NHTSA will propose expanding the amount and type of data EDRs capture in light vehicles in the event of a crash. The rulemaking would consider requiring some of the optional data elements specified in 49 CFR Part 563. In addition, this rulemaking would make revisions to the optional data elements to account for the latest advances in vehicle safety. To support this effort, the agency initiated a research project to improve the agency's understanding of current state-of-the-art light vehicle EDR technologies and vehicle manufacturer future plans for installation of EDRs. Additionally, the research will assess potential updates to EDR performance requirements (e.g. fire or immersion survival), data retrieval (e.g. EDR reader interface or connector standardization), and data elements collected (e.g. more data points, longer time intervals). The research effort will also conduct a feasibility study on implementing EDRs on heavy vehicles or vehicles with a GVWR greater than 4,536 kg (10,000 pounds). The project is scheduled for completion in 2013.

Pedestrian Safety

A Global Technical Regulation (GTR) providing standards for pedestrian safety was established in January 2009 by the United Nations' Economic Commission for Europe (UNECE) World Forum for the Harmonization of Vehicle Regulations (WP.29). The GTR No. 9 provides requirements for the hood and bumper areas of light vehicles to reduce injuries and fatalities to struck pedestrians. As a signatory to the United Nations commission, the United States has agreed to initiate domestic rulemaking by proposing a new pedestrian safety FMVSS based on the GTR. This rulemaking action may also require NHTSA to propose adding additional test device(s) to Part 572.

Evolving Vehicle Safety Strategy

Safety technology continues to evolve at a fast pace. Government agencies, acting alone, cannot expect to keep up with this pace. NHTSA believes it must continue to explore collaborative models with all stakeholders, such as OEMs, suppliers, research centers, advocates, and other government agencies. These collaborative models provide for a more transparent technology development and implementation process, significantly reducing the time for advanced safety technologies to reach the consumer.

In sum, our Vehicle Safety Strategy is designed to proactively expand our focus on vehicle safety needs and to dynamically manage our safety programs in a culture of accountability and global leadership. It constitutes a method for managing our responses to vehicle safety needs through a flexible but disciplined approach that keeps pace with changing vehicle safety priorities over time. As new opportunities for vehicle safety emerge from our strategy, our methods will help to ensure a clear path of transition of these to main stream vehicle safety programs, such as those described through the body of this paper.

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GOVERNMENT STATUS REPORT OF JAPAN

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TRENDS OF THE ROAD TRAFFIC ACCIDENTS IN JAPAN

The number of fatalities (those who died within 24 hours) resulting from traffic accidents in 2011 was 4,612. This represents the eleventh consecutive year that the number of fatalities has been decreasing. This number was below one-third the 16,765 fatalities in 1970, which was the year in which the number of fatalities reached a peak. In addition, the number of accidents resulting in injury or death and the number of injured persons decreased for the seventh consecutive year in a row since 2004, when the numbers were at their worst.

However, the number of fatalities and injured persons and the number of accidents resulting in injury remained high in 2011, as there were approximately 850,000 fatalities and injured persons, and approximately 690,000 accidents resulting in injury or death.

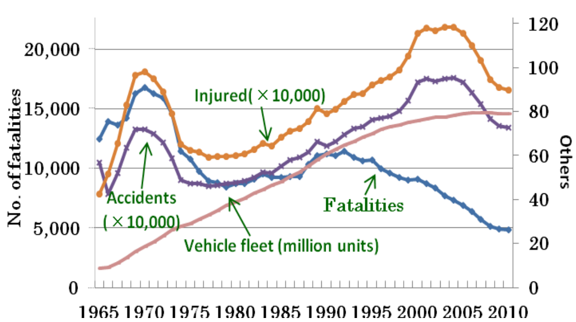

Figure 1. Trends of the road traffic accidents in Japan

New targets were established: to reduce the number of fatalities to below 3,000 (those who died within 24 hours) and to below around 3,500 (those who died within 30 days) by 2015 in the Ninth Fundamental Traffic Safety Program for 2011–2015.

The road transport environment is beginning to change greatly due to the change in types of traffic accident victims reflecting the aging society and the introduction of new technologies including electric vehicles for a low carbon society.

Therefore, on 1 June 2011 the Working Group on Technology and Vehicle Safety of the Council for Transport Policy of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) reported a new target for 2020 to reduce the number of fatalities by implementing vehicle safety measures and evaluating their effect, and setting the policy for reaching the new target.

Future direction of safety measures includes the following:

1) Correspondence to declining birthrate and a growing proportion of elderly people
2) Reduction of traffic accident victims for pedestrian and bicycle crew's
3) Correspondence to new mobility such as EV, micro mobility
4) Measures against grievous accident in which heavy duty vehicles are involved

FUTURE RESEARCH IN FINDING SOLUTIONS TO THE SAFETY PROBLEMS IDENTIFIED

To reduce the number of traffic accidents, approaches will be made towards the following measures upon speculating future changes in social structures, such as future developments in IT and the progression of declining birthrates and an aging society.

- Promotion of safety measures for pedestrians;
- Promotion of neck injury prevention measures;
- Introduction of standards on crash

compatibility;

- Research on advanced technologies, etc.

Concrete approaches regarding each of the measures are introduced below.

1. Promotion of safety measures for pedestrians

With regard to accidents involving pedestrians, which account for a high percentage of the number of fatalities caused by traffic accidents in Japan, it is necessary to implement popularization and promotion of pedestrian protection performance standards. As a result, with regard to measures for pedestrians, pedestrian head protection standards were introduced in 2004, and reviews are being conducted on the introduction of pedestrian leg protection standards. At the same time, a global technical regulation for pedestrian leg protection is now being discussed at GRSP under WP.29 and Japan continues actively contributing to those activities.

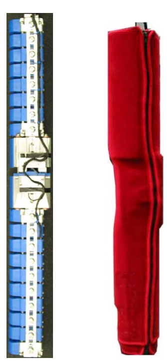

Figure 2. FLEX-PLI

According to rapidly spreading of hybrid cars, Japan judged that measures are needed to address the quietness of hybrid cars. And then the MLIT set up a study committee to investigate the problem of quietness.

In 2010, this committee reported to the MLIT on a future direction and specifically recommended that these vehicles should emit a sound. Based on these results, the MLIT published a guideline on Approaching Vehicle Audible Systems (AVAS) for short, which are designed to solve the quietness of HVs and similar vehicles.

WP.29 established a guideline in March 2011 based on Japan's guideline and now expects to develop it as a global technical regulation (gtr).

Figure 3. Demonstration of sound devices that could equip "silent cars"

2. Promotion of neck injury prevention measures (standardization of dummies)

Accidents involving neck injury account for more than half of the total number of accidents, and as there is an increasing trend in the number of such accidents in recent years, the enhancement of standards for headrests, etc. is being promoted as measures for neck injuries.

At the same time, with regard to assessments of whiplash injuries, which 80% of occupants in rear-end collisions suffer, the mechanism behind the occurrence of whiplash is complex, and as a result, there is not enough scientific clarification and it is also unclear as to which dummies should be used and what items to assess.

In particular, with regard to dummies, there are concerns regarding the consistency of assessments due to differences in structures, etc. of the dummies, and it is necessary for dummies to be standardized by having the research institutions, etc. of each country make approaches by contributing to efforts to elucidate the mechanism behind the occurrence of whiplash injuries and decide on assessment standards and indicators.

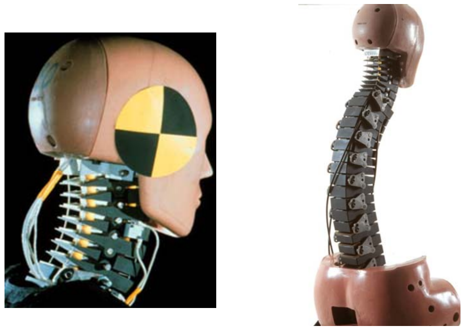

Figure 4. Standardization of dummies

3. Introduction of standards on crash compatibility, etc.

In addition to the above, crash compatibility measures for accidents involving frontal collision are also one of the passive damage mitigation measures for which approaches should be made. Japan considers measures for mini vehicles as being necessary. For the short-term, reviews are currently being conducted on the installation height of structural members so that the structural members interlock when there is a frontal collision.

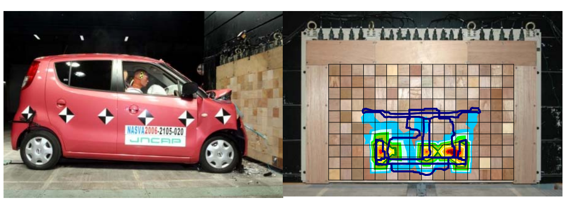

Figure 5. Crash Compatibility

Standards relating to performance for protecting occupants from electric shock after the collision of an electric vehicle or hybrid vehicle were introduced in 2007, and based on these regulations, UNECE regulations were established at WP.29 in 2010. Currently, a global technical regulation for electric vehicles is now being discussed at GRSP under WP.29 and Japan continues actively contributing to those activities.

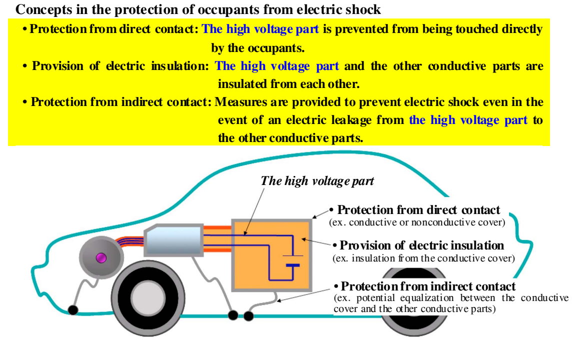

Figure 6. Concepts in the protection of occupants from electric shock

4. Research on advanced technologies

To prevent errors by drivers before they occur and decrease the number of accidents resulting in death and injuries, Japan has, with regard to ASVs, which are vehicles equipped with a system for assisting the driver to drive safely that makes use of advanced technology, established the ASV Project, which is a project to promote the development, practical application, and popularization of technology related to ASV, in 1991, and has been progressing with this project through joint efforts by industry, academia, and government.

For example, with regard to ASV technology that uses communications technology, technological developments are being promoted in the automobile industry through the implementation of experiments on public roads. In 2009, a Large-scale Field Operation Test on public roads using approximately 30 vehicles equipped with inter-vehicle communications was conducted based on cooperation between the public and private sectors. Based on this Test results, the MLIT will be planned to establish design requirements for practical system utilizing communications.

Figure 7. Communication-based driving assistance system for safety

From among the ASV technologies that are already mature, the lane-keeping assistance system and high-speed adaptive cruise control, have already been put to practical use, and are equipped in commercially-sold vehicles.

Furthermore, those with large effects in damage mitigation and accident reduction and those for which there are large social needs should be disseminated in an early manner, and thus, active dissemination measures that include means for incentives are necessary.

The MLIT established a technical regulation for the damage mitigation braking system for track and bus. Compulsory installation will be started from 2016 November. In addition, the MLIT decided to support for the car equipped with the ASV device, and established tax benefits for the track with the damage mitigation braking system.

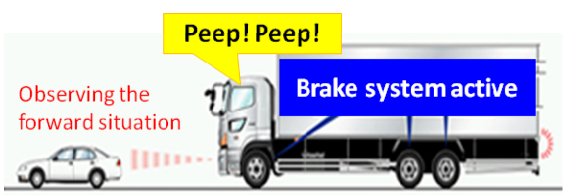

Figure 8. Illustration of activating AEBS

Thus MLIT has been examining the ideal way of the safety measures from the viewpoint that introduces regulations with high effect using the cycle of vehicle safety measures shown in the figure below.

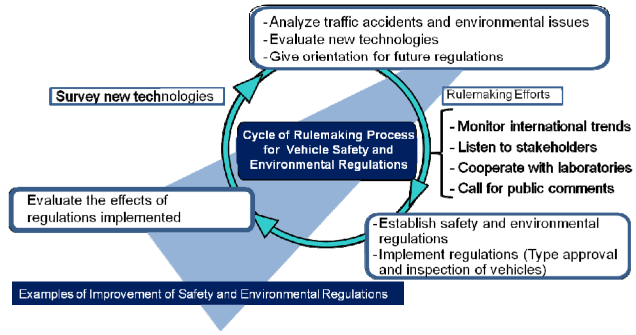

Figure 9. Study process before & after rulemaking

IDEAS FOR POTENTIAL COLLABORATIVE RESERCH INTER NATIONALLY

Japan would like to collaborate internationally to establish regulation against head restraint because accidents involving neck injury account for a high percentage of the number of fatalities in Japan as mentioned above. And also global technical regulations on new technologies like QRTV, AEBS and ITS in general could be established and in order to do so it would be needed to collaborate internationally by doing so, we could surely promote smooth diffusion of safe and convenient vehicles with equipments utilizing above mentioned advanced automotive technologies.

CONCLUSION

Measures that are being taken in Japan have been described above, but in order to promote international harmonization in the aspects of further advancing safe and environmentally friendly vehicles in the future, it is perceived that approaches made in coordination with the ESV Conference, WP.29, ITS World Congress, etc. will become increasingly important.

KOREAN GOVERNMENT STATUS REPORT: THE FIRST AUTOMOTIVE POLICY MASTER PLAN (2012-2016)

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Korea

ABSTRACT

Over the last 50 years, Korea has seen huge changes in automotive policy conditions in terms of both quantity and quality. Accordingly, the Korean government has realized the necessity of establishing policy plan to manage vehicles more efficiently and improve vehicle safety. In particular, in establishing a mid-term master plan related to the automotive industry, Korea as an advanced car-making country focused on the globalization of automotive safety standards and the development of future vehicles. This plan is a record on automotive safety in the First Automotive Policy Master Plan, which was established by the Korean government based on the result of research on the master plan.

INTRODUCTION

Over the last half-century, the number of new vehicle registrations in Korea has continued to increase, and accordingly the national interest in safer vehicles has also continued to rise. As the Korean automotive environment has changed significantly in both quantity and quality, it has become necessary to establish a comprehensive plan based on long-term prospects on vehicle supply and automotive technologies in order to manage vehicles more efficiently and improve safety. Accordingly, in order to provide systematic and predictable automotive policy guidelines, the Korean Ministry of Land, Transport and Maritime Affairs (MLTM) commenced establishing the plan in the second half of 2011, and completed the First Automotive Policy Master Plan (2012-2016) through investigations and consultations, expert workshops and discussion with related authorities and announced it. This paper will explore detailed contents of this plan aimed at providing safer and more convenient automotive use environments to the people.

STATUS OF VEHICLE SUPPLY IN KOREA

The number of new vehicle registrations in Korea exceeded 1 million in 1985, and with the successful hosting of Seoul Olympics in 1988 and the continued economic growth, the number passed 10 million in 1997. As shown in Figure 1, annual new vehicle registrations recorded 18.87 million vehicles as of the end of 2012, and are expected to reach 20 million vehicles in 2015.

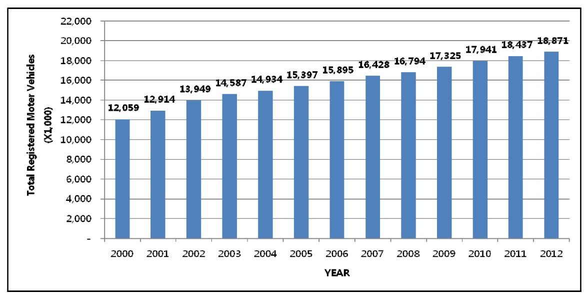

Figure1. Total Registered Motor Vehicle Statistics in ROK

In addition to the increase in the number of new vehicle registrations, population per vehicle also recorded less than 3 for the first time in 2008, and as of the end of 2012, the number is 2.70. As the number of vehicles and population increase, vehicle-related traffic accidents have also become an important factor to be managed. As shown in Figure 2, traffic fatality has continued to decrease since 2002 but the rate began to slow down from 2004.

Although it is the world's No.5 in vehicle production, the traffic fatality per every 10,000 vehicles is 2.4 persons as of the end of 2011, which is one of the lowest ranks among the OECD member countries. For this reason, the Korean government established the "Reduce Traffic Fatality by Half" policy and has run it. As one of the methods to achieve the goal in terms of automotive policy, the government has continued to strive to protect human lives before or in traffic accidents by reinforcing automotive safety.

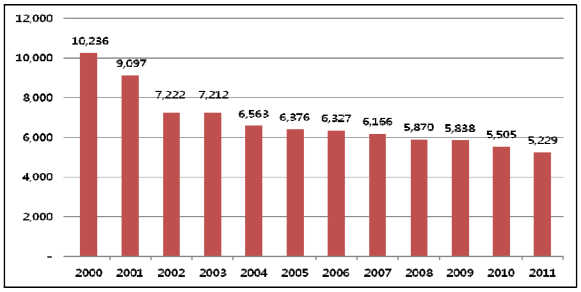

Figure2. Fatalities Statistics since 2000

Not only automotive safety but also eco-friendly vehicles have also been actively developed. Since the development of Hyundai's Click Hybrid in 2004, a variety of hybrid cars have been released in the market. In addition, according to the government's green car development strategy established in 2010, electric cars are developed and supplied to public authorities first, and will be expanded to the private sector.

Table 1.
Strategies of the First Automotive Policy Master Plan and its tasks

Securing global-level automotive safety	1. Strategically globalize automotive safety standards 2. Continue to seek enhancement of automotive safety
Vitalizing the operation of state-of-the-art future vehicles	1. Reinforce automotive R&D 2. Activate the operation of electric vehicles early
Establishing the foundation for the development of automotive policy	2. Improve laws related to future-oriented vehicles

To respond to changes in automotive industrial environments, such as increase in vehicles and rapid increase in the development of eco-friendly and cutting-edge safety vehicles, and to advanced and diversified automotive services, it is necessary to move into a new automotive policy paradigm represented by three keywords of 'state-of-the-art', 'smart' and 'green'. In order to satisfy the policy demand for the whole life cycle of vehicles, considering the new automotive policy paradigm and aiming to create safe and convenient automotive use environments that can satisfy the needs of the era of 20 million vehicles, the First Automotive Policy Master Plan (2012-2016) which comprises 5 Strategies and 18 Tasks was established.

This paper will focus on the automotive safety area in the Automotive Policy Master Plan, and discuss the main implementation tasks for automotive safety: securing global-level automotive safety, vitalizing the development of state-of-the-art future vehicles, and establishing the foundation for the development of automotive policies.

STRATEGY1. SECURING GLOBAL-LEVEL AUTOMOTIVE SAFETY

Strategic internationalization of automotive safety standards

Establishment and revision of global standards regarding vehicles have been actively discussed mainly by UN/ECE/WP29, and Korea also established its 5-year automotive safety standard globalization plan and has continued to globalize safety standards. Korea plans to complete the current phase 1 plan by 2014, and continue to carry out safety standard improvement, including the implementation of the phase 2 plan.

Table 2.
Status of the international harmonization of the Phase 1 Automotive Safety Standard

Classification	Pre-2010	2010	2011	2012-	Total
Int'l Harmonization Items	9 items	5 items	3 items	39 items	56 items

As many governments come to pay more and more attention to reducing traffic fatality, UN/ECE/WP.29 is actively implementing the internationalization of new-concept safety technology standards, such as establishing and revising UN Regulation and Global Technical Regulation (GTR), and is discussing innovative methods, such as International Whole Vehicle Type Approval, agreeing to the efforts to reduce trade barriers in the existing system. Korea has also actively participated in such international activities.

In addition, in order to implement the internationalization of such automotive safety standards, Korea plans to establish an international harmonization organization or separate institutes comprising a variety of stakeholders, including MLTM, Korea Automobile Testing & Research Institute (KATRI), domestic car makers, import car makers, and related associations

One of important characteristics in terms of internationalization is reflection of trade issues initiated since 1995. Korea and USA made 2 memorandums of understanding about foreign motor vehicles in Korea in 1995 and in 1998. Stimulated by such MOUs, EU also raised trade issues related to automotive goods. Resultantly, Korean detailed enforcement regulation of safety standards came to have an exceptional provision regarding some of the two countries' motor vehicle safety standards as equivalent to the corresponding Korean Motor Vehicle Safety Standards (KMVSS) in 1997.

In the same context, Korea enlarged the range of the exceptions through the Korea and US FTA and the Korea and EU FTA. The basis of this exceptional provision is that there will not be much influx of foreign vehicles in the total population of vehicles so that such small amount of vehicles can be dealt as exceptional case. However, the market share of foreign vehicles is increasing to the remarkable level. Thus, MLTM plans to deal with this matter through research oriented approach.

Continuous improvement of automotive safety

Expanding the safety assessment of new vehicles

Korea has conducted the safety assessment of new vehicles since 1999. However, there is an increasing demand for expanding its assessment function and provision of assessment results. For this, Korea plans to introduce the automotive safety rating system to rate the results of safety assessment (collision, driving and pedestrian), and push ahead to improve various systems, including mandatory automotive safety rating labeling.

The government will also establish methods to assess new cutting-edge safety devices, and provide more variable automotive safety information to consumers by reflecting socially-interested items, such as airbag suppression collision test and exhaust invasion.

Table 3.
Automotive Safety Rating System

Classification		Assessment items								
		Impact							Driving	
Vehicle model		Full Frontal Impact	Offset Frontal Impact	Side Impact	Whip-lash	Side column	Overall Rating	Pedestrian	Roll over	Brake (Dry/ Wet)
Sub-compact car	A	★★★★★ (13.2, 83%)	★★★★★ (14.0, 88%)	★★★★★ (15.5, 97%)	★★★★★ (5.2, 87%)	2.0, 100%	**1st Class (49.9, 92%)**	★★★ (17, 57%)		44.1 m 44.4 m
Compact car	B	★★★★★ (15.5, 97%)	★★★★★ (15.3, 96%)	★★★★★ (16.0, 100%)	★★★★★ (5.1, 85%)		**1st Class (51.9, 96%)**	★★★ (14, 47%)		44.6 m 50.3 m
	C	★★★★★ (15.6, 98%)	★★★★★ (13.4, 84%)	★★★★★ (16.0, 100%)	★★★★★ (5.2, 87%)	2.0, 100%	**1st Class (52.2, 97%)**	★★★ (15, 50%)		41.6 m 43.0 m

Self-certification system for automotive parts

The government plans to expand the current automotive safety management system to automotive parts and gradually expand the subject parts for the system, and continue to expand test facilities to secure the public confidence of the self-certification system for automotive parts.

Table 4.
Subject items of the self-certification system for automotive parts by year

Year	Items
2012	Brake hose, safety belt, lighting system (3 items including asymmetry headlight), reflex reflector, rear safety valve
2013	Brake lining, passenger car wheel, pressure tire, window, lighting system (14 items including fog lights), reflex system (4 items including rear reflecting plate)

2014	Connector, recapped tire, hydraulic brake fluid, lighting system (parking light), lighting source (2 items including filament lamps)
2015	Children protection equipment, spare tire, lighting system (3 items including daytime running lights), reflex systems (reflecting strip)

Note) The above items for the self-certification system for automotive parts by year are provisional

<u>Plan for establishing the safety standards for state-of-the-art safety devices</u>

The government is implementing some pilot projects for installation of safety equipment, such as lane departure warning system (LDWS) and electronic stability control (ESC), for vans and trucks. By reflecting the results of the pilot projects, the government will gradually expand the installation and obligation of such equipment by device and vehicle model. It will also establish plans to promote the development of vehicles and manage vehicles more efficiently by introducing the assessment system for a variety of safety and convenience devices for a variety of classes (female and elderly drivers).

STRATEGY 2. VITALIZING THE OPERATION OF STATE-OF-THE-ART FURTURE VEHICLES

Reinforcement of automotive R&D

Many countries across the world set their “zero traffic accident” vision and have strived to reduce traffic fatality for the recent 10 years. Korea is also implementing the “Reduce Traffic Fatality by Half” campaign at the government level. In addition, the paradigm of the automotive industry is changing from the existing internal combustion era to the era of eco-friendly and clean vehicles, in order to prevent the depletion of fossil fuels and environmental contamination.

In order to respond to such global demand for enhanced automotive safety and eco-friendly vehicle development, the Korean government will also develop technologies required to enhance the safety of future vehicles through intelligent technological convergence.

The research areas related to the development of safety enhancement technologies will include driving support for accident prevention, driving warning technology, state-of-the-art safe automotive technologies for developing collision avoidance/relaxation technology and standardized technology, vehicle-to-vehicle passenger protection for better safety in accidents and technologies for securing safety in vehicle collisions for active protection of pedestrians and future lighting systems for better visibility.

In order to vitalize the R&D activities for eco-friendly vehicles, researches on the security of safety of alternative fuel, electric and hydrogen fuel cell vehicles will be also conducted. Moreover, in order to secure the safety of communication-based vehicles, vehicle-vehicle and vehicle-infrastructure, researches required to secure technologies related to functional safety of electronic control systems, such as autonomous cruise, vehicle-vehicle communication control, hacking prevention technology and sudden unintended acceleration (SUA) and malfunctioning, will be also carried out.

The assessment technologies and safety standards obtained as the result of these researches will be utilized not only in Korea but to lead international safety standards, such as WP29.

Early vitalization of the operation of electric vehicles

As advanced car makers, including BMW, Nissan and GM, strive to boost the progress of their development and supply of popular electric vehicles, Korean car makers also need to have the basis for vitalizing the operation of electric cars earlier than they originally planned.

As of the end of 2012, the total number of electric vehicles registered in Korea is 860. (including 193 neighborhood electric vehicles). At present, the Ministry of Environment plans to execute the pilot project for supply of EVs to the private sector in 2013, and the full-scale supply of EVs in 2014.

In order to supply safer electric vehicles, MLTM executed the EV road driving monitoring project and the safety assessment technology development project from 2010 to 2012 to comprehensively assess the safety standards, safety performance and EV charging infrastructure safety of EVs. According to the result of the monitoring and the development of safety assessment technologies, the government is currently improving its safety standards and related regulations in preparation for increase in the supply of EVs.

STRATEGY 3. ESTABLISHMENT OF THE FOUNDATION FOR THE DEVELOPMENT OF AUTOMOTIVE POLICY

Improvement of laws related to future-oriented vehicles

The current Automotive Management Act is a mixture of automotive management matters, such as registration and trading, and technical matters required to secure the safety of vehicle driving. In order to manage vehicles more efficiently, therefore, it is necessary to improve the act. In order to reflect rapidly changing automotive policy environments, such as the advent of an 18-million vehicle era and the development and supply of eco-friendly vehicles, the government is currently planning to split the current Automotive Management Act into the Automotive Act and the Automotive Safety Act, and establish them separately.

Table 5.
Improvement of the legal system related to vehicles

As-is		Split into 2 laws	As-is	To-be
Automotive Management Act (Chapter 10, Article 88)	↗	Automotive Act (Chapter 12, Article 94)	Master plan, registrations, Automotive management business, computing	Unification of registration procedures and expansion of convenience, green license plate, management business co-op, automotive informatization, spread of technical development, automotive service complex, spread of automotive culture
	↘	Automotive Safety Act (Chapter 13, Article 77)	Safety standards, certification and troubleshooting for vehicles, parts and pressure-resistant containers, registration of car makers, inspection and maintenance	Incentives for new technology vehicle certification, integration of maintenance and inspection, supply of safety devices, promotion of R&D, re-training

CONCLUSIONS

The Automotive Policy Master Plan will be established every 5 years from 2012 in accordance with the Automotive Management Act revised in 2011. This plan was established to suggest efficient automotive management methods required to prepare for the era of 20 million vehicles and respond to changes in the future automotive environments based on the prospects for state-of-the-art automotive technologies. As a plan that comprehensively covers a variety of policy tasks as well as the direction of automotive policies required to improve the safety of vehicles, the Automotive Policy Master Plan is expected to play a critical role as the basis of Korean automotive management in the future.

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STATUS REPORT, FEDERAL REPUBLIC OF GERMANY

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23th ESV-Conference

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1 Status and Trends

1.1 Road accidents in Germany

The number of 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 2010. On the long run, there is a slight increase since 2000 by 0.5 percent in 2011 and the forecast for 2012 once again indicates a further increase in accident figures (2011: 2.36 million road accidents).

The number of road accidents with personal injury has decreased by 20 % since 2000, resulting in 306,266 road accidents with personal injury in 2011. For 2012 a further decrease of almost 1.4 % to approximately 302,000 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 22 % from 511,577 in 2000 to 396,374 in 2011. For 2012 a reduction of approximately 1 % compared to 2011 has been predicted – to about 392,500 casualties in 2012.

Since 2000, the number of severe injuries has been reduced by nearly 33 % to 68,985 seriously injured road users in 2011 and the number of slight injuries has been reduced by nearly 20 % to 323,380 slightly injured road users. Fatalities have decreased by 47 % from 7,503 fatalities in 2000 to 4,009 fatalities in 2011. A reduction to approximately 3,750 fatalities has been predicted for 2012.

Despite this positive development on the long term, the year 2011 was the first time since the unification in 1991, that the number of fatalities has increased by altogether nearly 10 %. Also the number of injury crashes increased by 6 %. While other factors play an important role for the long term development of fatality and crash figures, this short-term increase results mainly from different and extreme weather conditions. E.g. in 2010 January and December were characterized by very wintery conditions, resulting in extremely low fatality figures. On the contrary the spring time as well as the December in 2011 was unusually warm and dry, resulting in an increase of traffic, mainly recreational. As a result, fatality figures are unusually high for these months of 2011.

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 2010 amounted to approximately 30.44 billion Euro.

Furthermore, personal injuries amounted to 12.36 billion Euro. Costs of about 18.07 billion Euro were caused by damage to goods.
The costs per person add up to 1.02 billion Euro for a fatality, 114,020 Euro for a severely injured person and 4,458 Euro for a slightly injured person.

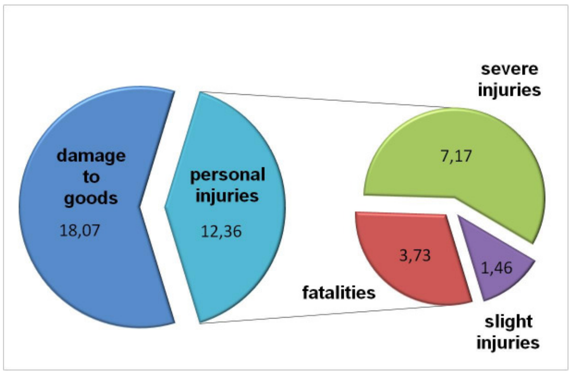

Figure 1: Costs due to road traffic accidents in 2010 (billion Euro)

1.3 Vehicle population and road performance

Germany, with its 81.8 million inhabitants, is the Europes country with the highest population and plays an important role for transit traffic. The number of passenger cars in Germany was 42.3 million on 01/01/2011. Traffic frequencies on federal motorways (approx. 12,800 km) in 2010 came up to an average of 46,300 vehicles per 24 hours (AADT).

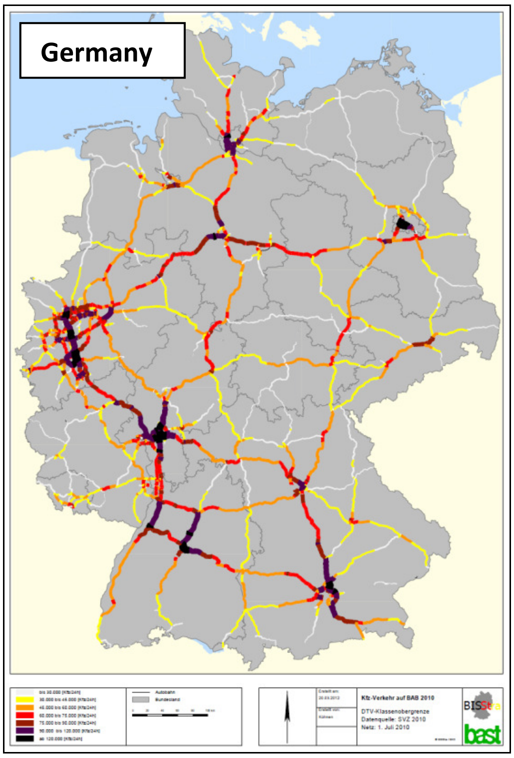

Figure 2: AADT of all vehicles on federal motorways in 2010

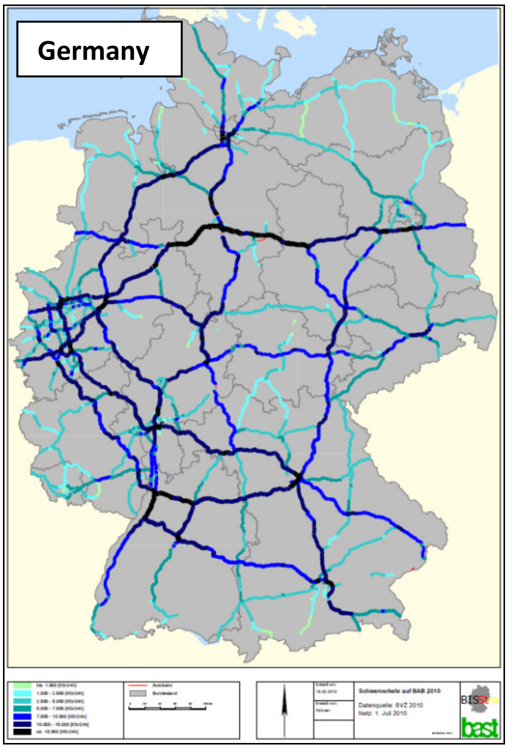

Figure 3: AADT of heavy vehicles on federal motor-ways in 2010

The AADT number of heavy vehicles on federal motorways (busses and trucks with a permitted total weight of more than 3.5 t) in 2010 was 6,900 vehicles. Figure 2 and 3 show the situation in 2010.

The total driving performance of all vehicles in 2010 preliminary was about 704.8 billion vehicles/km, of which already/only more than 30% took place on federal motorways.

1.4 Electromobility

eMAP (electromobility – scenario based Market potential, Assessment and Policy options)

In the light of climate change and local environmental problems stemming from nitrogen oxide emissions and particulate matters most of the developed countries discovered a pressing need to prepare for a post-petrol future in the transport sector. Electric driven vehicles offer a potentially solution provided that the whole production chain does not emit too much greenhouse gas. Therefore, a global rise in research, trialling and deployment of innovative vehicle systems has been initiated.

As part of the European research initiative ERA-NET PLUS Electromobility+ the Federal Highway Research Institute (BASt) is leading a consortium consisting of six partners from three different countries (Poland, Finland, Germany) in order to address research questions regarding the usage patterns, deployment pathways, economic impacts and relevant stakeholders in the field of electric vehicles.

The project eMAP (electromobility – scenario based Market potential, Assessment and Policy options), which started in July 2012 and will last 33 months, concentrates on the analysis and assessment of the market deployment of electric vehicles and its socio-economic impacts.

Figure 4: eMAP, electromobility – scenario based Market potential, Assessment and Policy options (http://www.project-emap.eu/)

In this process feasible deployment paths of electric vehicles will be investigated for the time horizon until 2025-2030. This will be done in a scenario based market model which specifies consumer demand and market supply of electromobility.

The socio-economic impact of the deployment of electromobility on greenhouse gas and local emissions, transport costs, energy supply safety, and technological change in industry and economy will be evaluated given the different scenarios. Political supporting actions and strategies of electric vehicles will be identified and their impact on the deployment path will be analyzed and evaluated. In the end, recommendations for optimized political strategies will be derived.

1.5 Alternative power train technologies: market penetration and consequences

Reliable quantitative data of the development of vehicles with alternative power train technologies are necessary for anticipatory work in the field of road safety. Therefore in 2010, the Federal Highway Research Institute initiated the observation and analysis of the development of vehicles with alternative power train technologies (e.g. hybrids, electric and fuel cell vehicles) in Germany. The development of the vehicle market and the detailed observation of the accident involvement of such vehicles form the centre of the research. The main goal is to identify possible consequences on road safety.

Objectives of the study:

- tracking of the factual implementation of the technological development in marketable products,
- early and detailed knowledge about the market development of the technological development in vehicles,
- contemporary identification of undesirable developments with regard to road safety.

Table 1 shows the stock of passenger cars, subdivided by different power train technologies. The number of hybrid passenger cars has been increasing on a constant rate of approximately +30% per year, while the number of passenger cars powered by gas remained static since 2007. The number of electrically powered passenger cars was almost non-existent in 2007, but has shown an enormous increase until 2011.
Table 2 shows the involvement of passenger vehicles in accidents with personal injuries according to their power train technology. In 2011, 370,632 passenger cars were involved in accidents with personal injury.
Among the passenger cars with information about their power train technology, cars powered by petrol have the highest share (69%) of all passenger cars involved in accidents. 353 hybrid vehicles have been involved in accidents, which amounts to a share of 0.1% of all vehicles involved in accidents. In the year 2011, 17

Stock of type-approved passenger cars

Catalogue of type-approved passenger vehicles

(stock of passenger cars on the 31.12./01.01; definition of the different motor fuels see Federal Motor Transport Authority, SV1 2009)

	motor fuel code							
	petrol	diesel	electric	gas	hybrid petrol/electric	fuel-cell/hydrogen	petrol/ethanol	total
2007	30,063,404	9,810,106	59	358,831	16,619		- - -	40,249,019
2008	29,960,754	10,057,074	57	357,123	21,452		8	40,396,468
2009	29,872,527	10,580,915	78	349,312	27,870		1,082	40,831,784
2010	30,082,247	10,939,078	212	344,114	35,996	18	2,492	41,404,175
2011	30,090,624	11,562,268	1,880	335,951	45,914	55	5,709	42,042,486
2011 / 2010	0.0%	5.7%	786.8%	-2.4%	27.6%	205.6%	129.1%	1.5%

Tab. 1: Stock of type-approved vehicles

	Motor fuel code/power source [1)]								total
	petrol	diesel	electric	hybrid	petrol/ Ethanol e.g. E85	gas (CNG, LPG)	others	not specified	
2007	271.154	95.113	0	113	0	3.198	0	43.388	412.966
2008	254.185	93.540	0	151	0	3.159	0	36.739	387.774
2009	244.841	93.045	0	204	1	3.162	0	36.459	377.712
2010	227.537	91.408	0	220	12	3.078	0	32.664	354.919
2011	242.896	101.077	17	353	23	5.192	6	21.068	370.632
change 2011/2010									4%
distribution 2011	69%	29%	0,00%	0,10%	0,01%	1,49%	0,00%		100%

[1)] until 2010: different motor fuels corresponding to the catalogue of type-approved passenger vehicles since 2011 added by the Federal Motor Transport Authority

Tab.2: Passenger cars in accidents with personal injury, subdivided by power train technology

passenger cars with pure electric power train were involved in accidents with personal injury.

It has to be noted that the type of passenger cars (and especially its power train technology) can only be identified when they are type-approved and consequently classified in the statistics of the Federal Motor Transport Authority. For the time being this is only the case for a minority of vehicles with alternative power train technologies. Nevertheless, a substantial increase of type-approved vehicles is expected in the near future and will give more opportunities for the analysis of the stock and accident involvement of vehicles with alternative power train technologies.

More information about currently available vehicles with alternative power train technologies or detailed information about the accident occurrence of vehicles with alternative power train technologies can be found in the annual report to this study ("Alternative Antriebstechnologien: Marktdurchdringung und Konsequenzen").

2 Research

2.1 Electromobility

2.1.1 Safety of electric vehicles

The successful integration of electrically driven vehicles into Europe's future transport system will depend on clear and transparent functional and safety requirements for the vehicles and their subsystems. These requirements are critical for all stakeholders in the transport system: the road user must have confidence that vehicles are safe to operate and the road owner must know if new vehicle types have new requirements for the road infrastructure.

A consortium of Swedish and German partners is working on the European project EVERSAFE (Everyday Safety for Electric Vehicles) founded by ERA-NET Plus Electromobility+ program. The overall objective of the project EVERSAFE is to provide safety requirements for electrically propelled vehicles to support the previously mentioned stakeholders in their decisions. This is achieved mainly by investigating safety issues of second generation vehicles with electric drive systems, which means that not only fully electric vehicles are in focus, but all kinds of electric vehicles, including hybrid electric vehicles, fuel-cell electric vehicles and plug-in hybrid electric vehicles are investigated. All these vehicles are referred to as Electric Vehicles (EV) in general.

Safety issues are categorized into two groups; active and passive safety and each addresses relevant aspects of vehicle safety of electric vehicles. This approach is complemented by a user evaluation of safety related aspects, since user acceptance is crucial for future market penetration. Through this exercise, the consortium can identify both perceived and real safety issues that must be addressed to facilitate consumer acceptance of the vehicles. In this context recommendations for requirements for the design of future electric vehicles can be made and will be made available to all relevant stakeholders.

2.1.2 Driving dynamics of electric propelled vehicles

A major challenge within the electrification of the power train is the concern regarding the battery in terms of capacity, charge, package and safety.
Furthermore it's necessary in hybrid vehicles to define the operating strategy of electric motor (EM) and internal combustion engine (ICE) or the brake systems in terms of recuperation. Especially this aspect has implications on driving dynamics of vehicles which are not known in this kind in existing conventional propelled vehicles.

For that reason a research project is analyzing the fundamental differences between conventional and alternative drive concepts in terms of driving dynamics. A full vehicle simulation model represents various drive concepts with wheel-specific drive or braking torque. Questions arise with respect to different torque characteristics of EM and ICE, changes within the chassis or the package due to electrification as well as the recuperation. Further on critical scenarios are defined, which are then mapped in the total vehicle simulation. The effect of various recuperation strategies are carried out on two sample cars (front-wheel drive concept, rear-wheel drive concept) and are analyzed in terms of stability and driver's perception.
A critical driving situation in daily operation of a vehicle is "braking in a turn". Here, an unsteady state braking maneuver is superimposed to steady state cornering with different parameters: curve radius, lateral acceleration and coefficient of adhesion. Additionally two other maneuver are analyzed with respect to recuperation: The sudden ramp steer input within a straightforward braking and braking on one-sided slippery track surface when driving straight-ahead. Based on the results it is shown that the possibility of recuperation of hybrid and electric vehicles can have a significant impact on vehicle dynamics, especially when combined longitudinal and transverse forces.

2.1.3 New requirements for the periodic technical inspection (PTI) of electric and hybrid vehicles

The periodic technical inspection of vehicles shall ensure that they retain their level of safety throughout the life of the vehicle. For the future, however it is expected that the number of electric and hybrid vehicles will increase. This results in completely new aspects for the roadworthiness tests. In addition to the mechanical safety comes the electrical and functional safety. The safety systems in the vehicle will be designed different for electric vehicles than for conventional vehicles. The existing test requirements and procedures may no longer fit. The same applies to electrical energy storage.

Finding the defects should be ensured. These include, for example, defects in the high-voltage system and its isolation, defects in other systems to protect against electric shock, defects in the battery system (fire risk, risk of leakage of hazardous substances), etc. For these reasons should be identified in the ongoing project, which points are relevant for the periodical technical inspection of electric and hybrid vehicles. Based on this up to 5000 vehicles in use are examined in a field study by FSD (central body for PTI in Germany) on behalf of BASt . The analysis of the field study allows the identification of additional and possibly unnecessary checkpoints for electric and hybrid vehicles.

2.2 Forward looking safety systems

Forward-looking active safety and primary safety systems are emerging into the vehicle market. While last ESV's status report stated that these systems will provide potential, it is now commonly agreed that there definitely is potential to lower the risk in road accidents (with the risk being the product of exposure and severity). The consumer test organization Euro NCAP will start testing automatic emergency brake systems (AEB) that address rear-end collisions of passenger cars from next year on, and they have announced to test AEB for pedestrians by 2016. In addition, a UN ECE regulation for AEB for heavy commercial vehicles will be implemented form 2015 on. Another regulation for AEB for medium size commercial vehicles of category M_2 and N_2 is currently under development and will be implemented from 2016 on.

In Europe the research project ASSESS (Assessment of Integrated Vehicle Safety Systems for improved vehicle safety), which is funded in the 7th R&D framework programme by the European Commission aimed at developing harmonised and standardised assessment procedures and related tools for frontal pre crash sensing systems. Procedures were also developed for driver behaviour evaluation, pre crash system performance evaluation, crash performance evaluation and socio economic assessment. ASSESS activities ended in December 2012. As result a relevant set of test and assessment methods applicable to a wide range of integrated vehicle safety systems was developed.

For the development of harmonised test procedures for integrated safety systems all German car manufacturers and two major Japanese manufacturers, the Federal Highway Research Institute (BASt) and the German Insurance Association have got together under chairmanship of DEKRA in the consortium "vehicle frontal safety systems" (vFSS). Based on real accident data test and assessment procedures for pedestrian protection systems and systems for the avoidance and mitigation of rear-end collisions are developed.

Another group that was very active in developing test methods for passenger car rear-end pre-crash testing is the AEB group, composed of vehicle manufacturers, suppliers and various insurance research bodies. And finally, German Automobile Association provided input based on its own test procedure.

All these projects worked together in the European-wide so-called Harmonisation Platform that delivered the input to Euro NCAP in a condensed form.

The final test protocol therefore is a combination of the most significant aspects of all those initiatives. For instance, the AEB-groups' stepwise increasing test speeds had been selected, part of the Forward Collision Warning test is from the ASSESS project, as well as the aspect of belt pre-tensioning systems. The surrogate target system and accompanying propulsion system had been taken from a development by the ADAC.

Current fields of research are the requirements for an appropriate pedestrian dummy (e.g. should it have articulated arms and legs) and propulsion system as well as the accident scenarios that need to be tested.

Since passenger car rear-end collisions will be addressed by consumer testing from next year (and by regulatory testing in the case of commercial vehicles also soon), the focus for improving traffic safety now moves towards the automatic prevention of pedestrian accidents.

Nearly all ASSESS project members gathered again in the ASPECSS project (Assessment methodologies for forward looking integrated pedestrian and further extension to cyclists safety systems), which focuses on forward looking safety systems that are designed to address pedestrian and cyclist accidents. Again, the aim is to deliver harmonised test procedures as input for further regulatory and consumer rating activities. All other initiatives named above continue to perform research in pedestrian accidents and countermeasures.

Currently under discussion are propulsion systems as well as the accident scenarios that need to be tested.

The above mentioned projects show that at a lot of national and world wide activities are around the specification of active and integrated safety systems. Now it is a matter of bundling these activities and of using the chance of an early world-wide exchange about the potential benefit of advanced forward looking and in case of an imminent crash braking safety systems, no matter if it is an accident between two cars or between a car and a vulnerable road user. This includes an agreement of the definition of test procedures for these systems. BASt serves as the link between European and American research initiatives due to its cooperation agreement with NHTSA signed back in 2010.

Figure 5: Test setup for the test of pedestrian AEB systems. Shown is the dummy (left) on a prototype propulsion system.

2.3 Periodic Roadworthiness Tests – a new regulation in the EU?

The current Directive 2009/40/EC includes minimum standards for the periodic roadworthiness tests of motor vehicles (regular vehicle checks required by law). The 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 proposal of the European Commission for a regulation (published in July 2012) the scope of vehicles to be tested should be extended to the powered two or three wheelers (motorcycles and mopeds) and light trailers (under 3.5 tons). These two categories of vehicles are currently not compulsory under EU law. Also vehicles of historic interest have now been more precisely defined. Relating to the frequency of testing the two aspects age and yearly mileage have to be considered. Therefore annual testing of older cars and vehicles with high mileage was proposed by the European Commission. Other aspects such as the minimum training of inspectors and the common data exchange are also part of the proposal. The proposal does not cover the verification of the electronic vehicle safety systems, such as Adaptive Cruise Control.

Figure 6: Periodic tests of motor vehicles

During the several months of negotiations in the working group of the European Council, the proposal was discussed by the Member States of the EU. The cost-benefit analysis of the Commission (based on AUTOFORE) aims to reduce the time intervals of the roadworthiness test for older vehicles and the extension to other types of vehicles and were doubt drawn by independent cost-benefit considerations of the Danish Ministry of Transport and the BASt (Federal Highway Research Institute on behalf of the German Ministry of Transport). The compromise paper of the Presidency, resulting as a consequence of the discussion in the working group of the European Council, gives Member States more responsibility under the proposed directive to act. The next step is the reading in the European Parliament.

2.4 Cooperative systems – integration of existing systems

During the past years, stand-alone solutions deployed either on the infrastructure side (mostly for purposes of traffic management) or based on in-vehicle equipment (mostly for purposes of driver assistance) have already delivered significant benefits in terms of improved road safety, reduced and more reliable journey times and less environmental pollution. The technological progress in Information and Communication Technologies (ICT) in recent years makes it possible and increasingly affordable to establish a vehicle-infrastructure network on the roads (Cooperative ITS, C-ITS) and - in doing so - explore potential benefits untapped before. C-ITS is designed to make use of hybrid communication concept, involving ITS G 5 (WLAN-IEEE 802.11p) and different generations of cellular communication (3G, 4G).

Many stakeholders have to commit themselves to the deployment of C-ITS. Road authorities and operators have recently prepared the ground for positioning of public authorities as a vital actor in this field. BASt is very active in facilitating C-ITS deployment. BASt drives the development of a roles and responsibilities standard in the context of C-ITS based on architectures for cooperative systems (CEN/ISO TS 17427, expected spring 2013) as an important contribution to fulfilling the European Commission's Mandate M/453 towards the European standardisation organisations. BASt has also initiated the establishment of an integrated view (including C-ITS) on the value chain for traffic and traveler information. Moreover, BASt is engaged in the Cooperative Systems Task Force of the EasyWay programme, analysing the strengths and weaknesses, opportunities and threats associated with different functional schemes for priority C-ITS services from a road operator's point of view.

Road authorities and operators as well as the automotive industry are core actors of Cooperative ITS deployment. The umbrella organisations CEDR, ASECAP, POLIS and Car2Car Communication

Consortium have formed the Amsterdam Group, a voluntary cooperation platform working towards large scale deployment of Cooperative ITS on European roads from 2015 onwards. In summer 2012, the umbrella organisations have signed a Letter of Intent recommending to their members to engage themselves in deployment of Cooperative ITS. Front runner Member States including The Netherlands, Germany and Austria currently discuss with the automotive industry day one-applications to be deployed within a transnational corridor of motorways and high level roads.

2.5 Safety related traffic information

The "ITS Directive"[1] of the European Commission has defined Priority Actions for the development and use of specifications and standards in the upcoming years. One of these priorities is the definition of "data and procedures for the provision, where possible, of road safety related minimum universal traffic information free of charge to users", which was finished in the end of 2012.

The specification – which will become an EU regulation – identifies a standardized list of safety related traffic events (in categories) which should be communicated to ITS users free of charge. Furthermore it requires the compatibility and the integration of the messages into ITS services for real-time traffic. The following list of categories of safety related information is included in the specification:

- *Temporary slippery road*
- *Animal/people/obstacles/debris on the road*
- *Unprotected accident area*
- *Short term roadworks*
- *Reduced visibility*
- *Ghost driver*
- *Unmanaged blockage of a road*
- *Extreme weather conditions*
- *Unexpected end of queue*

Within the next time, the following tasks have to be managed by the European Commission and the member states:

- *Europe-wide implementation of the specification*
- *Installation of a national organisational structure*
- *Define a set of quality criteria for this message categories of safety related traffic information and identification of the national quality level*

[1]Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport"

2.6 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[2] 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.
Moreover, UR:BAN focuses on economic and energy efficient driving by means of intelligent infrastructure and networking with intelligent vehicles enhancing future driver assistance systems with regard to traffic management.
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.

2.7 Automated Driving

The report of the BASt-Expert Group "Legal consequences of an increase in vehicle automation" was released in 2012.
Therein five degrees of continuous vehicle automation have been defined according to the needs of legal assessment. The definitions take their starting point at the level of driver-only, over assistance, partial automation, high automation and full automation. The definitions take the driver's point of view and describe duties vehicle automation technology would expect the driver to accomplish in case of the respective degree. These definitions have attracted attention at international level.
The legal evaluation according to German law and legislation has lead to the conclusion that the distinctive feature to be considered legally, according

[2] www.urban-online.org

to the different automation degrees defined, is the attention of a driver required at the respective level. It has shown that the degree of permanently monitored partial automation, which still requires the driver to permanently pay attention to other traffic and remain in a position to react immediately upon any kind of upcoming situation, will remain in line with today's legal system in Germany (and is comparable with the legal consequences of Driver Assistance Systems today).

The decisive rise in automation is encountered legally at the transition from partial to high automation, the latter of which has been defined to technically allow the driver to detract attention from the driving task and engage otherwise. The use of high automation would lead to a conflict between assumptions underlying today's road traffic regulations, today's road traffic liabilities and even manufacturers would run a substantial risk according to today's product liability regime: In case of accidents whilst highly automated driving, and given causation can neither be assigned to an erroneous intervention of the driver nor to improper driving of another road user (and according to the distribution of the burden of proof), the manufacturer would be liable for these damages.

Important fields of research for future vehicle automation have also been identified. The most important and comprehensive being Human-Machine-Interaction in order to understand more closely human abilities to cope with automated processes in driving

2.8 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 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 next to 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 should be object to scientific investigation. Concerning human machine interaction, it has to be considered, that the perception of velocities and distances of approaching vehicles might be different for CMS as compared to conventional rear-view mirrors and potential influences of factors as the position of the display or drivers' age should be taken into account. In order to shed light on these and further open issues, BASt is currently conducting a study that will cover the use of CMS und controlled conditions as well in real traffic. The first part of the study will focus on passenger cars, while in a second step the empirical investigation will be extended to heavy goods vehicles, where the potentials as well as the limitations of CMS might differ considerably. Results are expected in early 2014 and are planned to be communicated within the relevant standardization and regulation committees.

2.9 Freight transport

2.9.1 'Freight Transport and Logistics Action Plan' and trial with longer trucks

In the context of the predicted increase in freight transport, the Ministry of Transport Building and Urban Development published in 2010 a 'Freight Transport and Logistics Action Plan'. For road freight transport the aim is to increase the productivity and decrease the environmental impact. New technologies and an increased use of combined transport are the main topics. One proposed measure is the introduction of longer but not heavier articulated trucks in a field trial in Germany. The truck combination length may be increased up to 25.25 m (to load 3 instead of 2 swap bodies or containers) while the gross vehicle weight stays at 40 t or 44 t in combined transport respectively. A road network, where these longer trucks may be operated in the Federal States, was published by the German Ministry of Transport, Building and Urban Development. However, this road network is not definite. New stretches are being integrated after approval by the responsible Federal States.

Figure 7: Truck of 25.25 m length

Five new longer truck combinations are allowed in the trial:

1. Elongated tractor-semitrailer combination (+1.30 m)
2. Tractor-semitrailer and additionally a center axle trailer
3. Truck, (steerable) dolly and semitrailer
4. B-double
5. Truck and trailer with max. length of 12 m each

All new longer truck combinations must be capable for combined transport and maneuver the so called 'BO-Kraftkreis' (external circle diameter of 12.50 m and internal circle diameter of 5.30 m). All longer truck combinations must be equipped with driver assist systems of the latest development state, such as ABS, LDW, ESP, EBS and, what is really new, on board WIM on each axle except steering axle. Special demands for the driver performance are fixed in the exemption regulation as well as a general prohibition of overtaking for those combinations. Prohibited is the transport of dangerous goods, fluids in big tanks, live stock, and swinging loads on trailer-ceilings for safety reasons.

The trial runs for five years. The Federal Highway Research Institute (BASt) is commissioned by the German Ministry of Transport, Building and Urban Development to evaluate the trial with the longer truck combinations. It will be interesting to see, which of the new truck combinations will be chosen by the truck operators and how they behave in practice. A lot of practical questions, like driving behavior, influence on traffic flow, fuel consumption and CO_2 emission and logistics' questions have been examined which have to be studied in the time frame of this trial.

Initial experiences are that so far nearly two thirds of the combinations in the trial are trucks with (steerable) dolly and semitrailer. However, all five possible longer truck combinations are in use. They carry a wide range of different goods like food, household appliances and serve as courier, express and parcel services or automobile supplier. As an average the longer truck combinations drive a tour of about 500 km. Most of them operate as a shuttle or point-to-point transport.

2.9.2 Advanced Emergency Braking Systems (AEBS) for heavy duty vehicles

Beginning 1st of November 2013 new types of heavy duty vehicles of more than 8 tons and and new types of buses of more than 5 tons must be equipped with Advanced Emergency Braking Systems (AEBS). The systems have to be designed in a way to warn the driver in time if there is an imminent danger of a rear end collision. If the driver does not react, an emergency braking has to be initiated automatically. It is expected that the systems contribute to reduce accident figures as well as material and personal damage since these accidents are often accompanied with a high severity due to the high mass of the vehicles involved. The mandatory fitment is stipulated by the regulation (EC) No. 661/2009 of the European Parliament and of the Council concerning type-approval requirements for the general safety of motor vehicles. However, requirements for lighter trucks and buses do not exist yet. They are elaborated at present by an informal group of experts on UNECE-level. For the light vehicle categories it has to be considered that these vehicles are more agile with regard to steering manoeuvres so that warning and emergency braking actions will have to be started later, meaning closer to the expected collision, in order to allow the driver to master the situation himself by a lateral movement. On the other hand this inevitably leads to less amounts of speed reduction in the emergency braking phase than for the heavier vehicles.

2.10 „BioRID TEG, dummy harmonization“

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 potentially best suitable 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 a new draft 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. The improvements developed and proposed by the TEG and the new certification procedure are 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 will be the development of validated injury or seat performance criteria addressing the risk of cervical spine distorsions.

There are also activities around the world with regard to the improvement or further development of frontal impact test procedures under regulatory aspects as well as in consumer test programs. The currently used Hybrid III family which was basically developed in the 70th has several limitations. Having in mind the demographic impact and the findings by European projects like THORAX and COVER, an improved test tool seems to be needed e.g. for a better prediction of the thoracic injury risk. The THOR dummy has a good potential for worldwide harmonization on a frontal impact dummy.

Advanced dummy technology for assessment of thoracic injury risk

Analyses of recent accident data show that thoracic injuries are forming the largest portion of severe injuries in motor vehicle collisions. The evaluation of the injury risk to the thorax in frontal motor vehicle accidents is based in current test procedures on the chest deflection measurements in the dummy hybrid III. Several studies have shown the limited biofidelity of this dummy. Furthermore the chest deflection is only measured in one single point of the chest.

BASt is involved in various research activities to address this problem.

A multi-point chest deflection measurement device called RibEye available for the dummy hybrid III is currently been investigated. With this measurement device it is possible to measure the chest deflection at multiple points of the chest. BASt is investigating if an improved assessment of vehicle safety can be achieved with this kind of advanced measurement system.

The RibEye is also available for the side impact WorldSID dummy (Figure 8), which might also have potential for improved assessment of thoracic injury risk in side impact. This will also be evaluated by BASt in future studies.

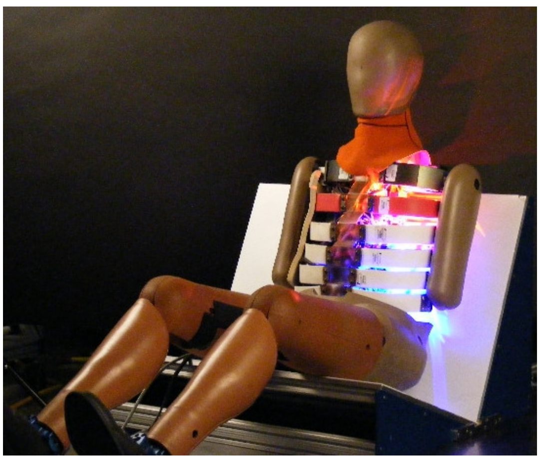

Figure 8: Advanced Chest Deflection Measurement System RibEye integrated in the Dummy WorldSID50%

BASt is also involved in the project THORAX (Thoracic injury assessment for improved vehicle safety) funded by the European commission. The aim of the project is to better understand the mechanism of thoracic injury in frontal impact. For this purpose accident data was analyzed to find the most relevant types of thoracic injury. The two injuries of highest importance were found to be rib fractures and lung injuries. Shoulder injuries and sternum fracture were identified to be of secondary importance.

The research findings of the project were implemented in an updated design of a dummy thorax, which was integrated in the THOR dummy (Figure 9).Within the project injury risk curves based on multi-point deflection measurement and strain gage data will be developed.
BASt was involved in a test series with the updated THOR dummy to build up a data base of test for biofidelity assessment and injury criteria development. Within a further test extensive series at BASt the sensitivity of the new dummy thorax to different restraint system parameters was investigated. The THORAX-project finished April 2013.

After that BASt continues to evaluate the THOR dummy in internal research projects. To support the further evaluation and harmonization of this dummy support, BASt is acquiring an updated version of THOR for internal research projects, and to make it available to other interested parties within Germany and Europe for further testing.

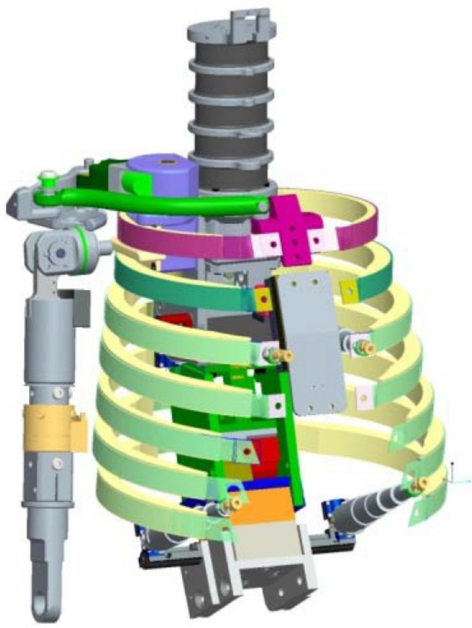

Figure 9: An improved dummy chest was developed in the European research project THORAX and integrated in the THOR dummy

2.11 Frontal Impact and Compatibility

Vehicle safety has been improved in Europe with the introduction of legislative ECE-R 94 and consumer testing Euro NCAP. Stronger occupant compartments and improved occupant restraint systems are evident in the higher assessments awarded in the Euro NCAP testing programme. However, in current passive safety tests the role of the collision partner is not considered explicitly.

Previous research supports the conclusion that vehicle-to-vehicle crash performance is worse than single vehicle-to-barrier test performance, even when the collision partner is an identical vehicle model. This unfortunate fact means that new safety features do not perform as well as expected in real world conditions. This behaviour is a function of the incompatibility encountered in the vehicle fleet today.

Latest accident research shows that in particular deceleration induced injuries were more and more prominent while injuries due to intrusion are getting less.

In previous years frontal impact and compatibility has been analysed worldwide for years but no final assessment approach was defined which motivates a need to further pursue compatibility research to improve the outcome of a significant proportion of EU road casualties.

France made in 2007 a proposal to amend ECE Regulation No. 94 and to introduce the PDB (Progressive Deformable Barrier) but the GRSP Informal Working Group of Frontal Impacts (IWG FI) could not find an agreement between the parties.

The IWG FI is working and trying to set up a new proposal which includes in the first step the introduction of an additional full width test. Germany has made a proposal at the UN ECE on the steps forward and the requirements that shall be covered by the frontal impact regulation including the geometric alignment of vehicles' front structures.

Figure 10: Car-to-car test

In the seventh framework programme the compatibility project, called FIMCAR (Frontal Impact and Compatibility Assessment Research), has established an assessment approach for frontal impact, integrating self and partner protection. The FIMCAR consortium consisted of 18 partners which include the important research organizations from Europe as well as seven different car manufactures. Japanese institutes are not an official partner; however an extensive collaboration is ongoing. Harmonization activities included also interaction with GRSP IWG FI and EEVC WG 15. The project lasted from September 2009 to October 2012.

Figure 11: Small family car in a full-width test with deformable barrier (FWDB) at 50 km/h

The goals of the FIMCAR project were to answer the remaining open questions identified in earlier projects (such as understanding of the advantages and disadvantages of force based metrics and barrier deformation based metrics, confirmation of specific compatibility issues such as structural interaction, investigation of force matching) and to finalise the frontal impact test procedures required to assess compatibility. The identified real world safety issues were used to develop a list of compatibility characteristics. This analysis resulted in the combination of the Full Width Deformable Barrier test (FWDB) with compatibility metrics and the existing Offset Deformable Barrier (ODB) as described in UNECE Regulation 94 with additional cabin integrity requirement as being proposed as the FIMCAR assessment approach.
The proposed frontal impact assessment approach addresses many of the issues identified by the FIMCAR consortium but not all frontal impact and compatibility issues could be addressed.

Further internal research projects have recently started with the aim to investigate the performance of the restraint systems in different impact conditions. Therefore a survey will be conducted to estimate the benefit of an additional restraint test. In addition, the influence on the passenger loading will be analyzed with different dummy sizes, dummy types as well as the change of seating positions and impact velocities.

Figure 12: Frontal impact test with the reference vehicle

2.12 Child safety

CASPER

BASt participated in the European project CASPER (Child Advanced Safety Project for European Roads, 2009-2012). The aim of CASPER was the development of a full understanding of the circumstances of the transport of children and the requirements for the protection of children in vehicles, to enable an improvement in the use of child restraint systems (CRS) and improved opportunities for the development of CRS. The project took into account the aspects of safety as well as sociological aspects. Field data (accident data analysis, studies on use and misuse of child restraint systems, sociological studies) as well as the analysis of existing technical and practical solutions under relevant factors were the basis for the development and improvement of tools that can be used for the approval and development of child restraint systems. Also results were achieved in the area of simulation (Child Dummy FEM, child human body FEM; virtual environment of a test procedure).

Figure 13: UNECE/GRSP Informal Group "Child Safety"

Proposals for test procedures were made, taking into account the highest priorities. CASPER supported the work of the UNECE / GRSP informal group "Child Safety".

BASt is also involved in the work of the UNECE/GRSP Informal Group "Child Safety". The Group deals with a new regulation for CRS. A step by step approach is implemented. The Phase 1 dealt with ISOFix Integral "Universal" CRS, so called "i-size". 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. Actual the group works on phase 2, the implementation of CRS with ISOFix type of connectors, were the child is secured by the vehicle 3-point belt. After finalization of phase two, the group will work on other CRS types in a third phase.

Figure 14: Euro NCAP Child Restraint Systems (CRS)

The Euro NCAP Child Safety Working Group developed a new child protection protocol with the aim to clearly improve consumer information. It shall motivate the CRS industry to develop well performing CRS for smaller children and the vehicle manufacturer to develop robust interfaces that can accommodate a board variety of child restraint systems available on the European market. The CRS assessment is separated from the car assessment for smaller children by the use of existing CRS consumer ratings to identify "best performing child seats", available on the European market. A list of seats, good/ best performing in consumer tests, has been identified for the use in the vehicle assessment. The chosen CRS cover all age groups and installation methods. They are used for the CRS-car interface compatibility assessment. In parallel, from 2013 on, the child dummies of the P-Series in the dynamic testing are replaced by the dummies of the Q-series of the same age group. The Euro NCAP Child Safety working group is now continuing its work to replace the dummies representing smaller children by dummies representing older children in the dynamic test. It will be a clear challenge to the vehicle manufacturer to work on the protection of larger children respectively small adults on rear seats. The Euro NCAP assessment should re-focus on CRS-car interface compatibility, vehicle based assessment and front/side impact dynamic results of older children.

2.13 FlexPLI

A new, biofidelic test tool called FlexPLI (Flexible Pedestrian Legform Impactor) for pedestrian lower legform to bumper tests has been developed from the year 2000 on by the Japanese Automobile Research Institute (JARI). The FlexPLI has more humanlike properties in the tibia and the knee area than the EEVC Pedestrian Legform Impactor that is currently used for type approval tests according to the European Regulations (EC) No. 78/2009 and (EC) No. 631/2009 as well as within the Euro NCAP programme. Seven strain gauges along the entire femur and tibia and four string potentiometers in the knee area enable the acquisition of the femur and tibia bending moments and the knee ligament elongations in order to more precisely predict the risk of femur and tibia bone fractures and knee ligament ruptures in the event of a collision of a pedestrian with a motor vehicle (figure 15).

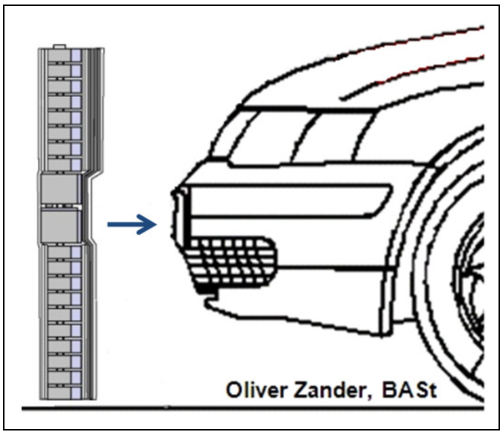

Figure 15: FlexPLI to bumper test.

Due to the lack of an upper body mass the risk of femur injuries still cannot be assessed appropriately, thus the acquisition of the corresponding bending moments is done, for the time being, for monitoring purposes only. The German Federal Highway Research Institute (BASt) is investigating the effects and applicability of an upper body mass developed within the FP6 project APROSYS (Advanced Protection Systems) with the aim of an improved assessment of femur injuries towards a better evaluation of the protection potential of especially vehicles with high bonnet leading edges or flat frontends.

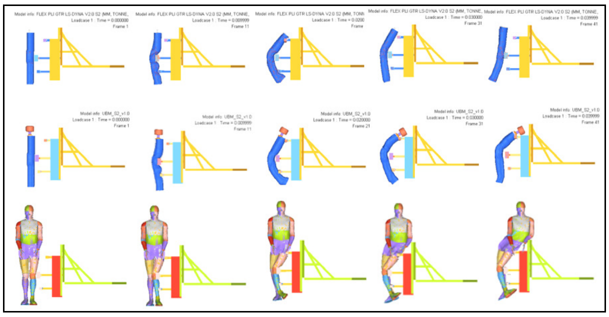

Figure 16: Virtual testing with baseline FlexPLI, FlexPLI-UBM and THUMS

The FlexPLI is aimed at being introduced within the second phase of the Global Technical Regulation No. 9 (GTR9). After finalization of the work of a technical evaluation group (Flex-TEG) under the umbrella of GRSP in 2010, a new informal group under the chairmanship of Germany (IG GTR9-PH2) has been established at the end of the year 2011. The current schedule foresees the submission of a final draft regulation including phase 2 to GRSP before the end of 2013. Final goal is the introduction of the FlexPLI for type approval testing within the new UN Regulation on pedestrian safety No. 127 from the year 2017 onwards.

Within Euro NCAP, the FlexPLI will be introduced in 2014 along with a homogeneous assessment of the bumper test zone using a grid and more stringent limits. As a medium term goal BASt is working on replacing the bonnet leading edge test with the upper legform and the bumper test with the lower legform by a combined test using the FlexPLI with upper body mass.

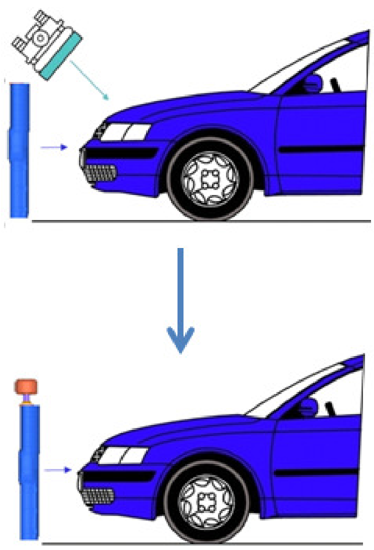

Figure 17: Replacement of upper legform and lower legform by FlexPLI-UBM.

2.14 GIDAS – a blueprint for worldwide In-Depth Road Accident Investigations

2.14.1 The GIDAS Project

BASt started investigating road accidents on the spot already in the early 70s. In order to have a more widespread investigation area and increase the number of accident units under investigation, BASt and FAT (The Research Association of Automotive Technology) initiated and launched a common accident investigation project in 1999 – the GIDAS project (German In-Depth Accident Study).

Since that time more than 23.000 accidents have been reported to the system, each one carrying information on more than 2.500 parameters. The GIDAS survey turned out to be a very efficient tool for rule makers as well as for automobile manufacturers. This is very much related to the fact, that the GIDAS data collection follows a statistical sampling scheme. This ensures that the data collected is a representative mapping of the real world. Consequently GIDAS is ideally suited to be used for cost benefit estimations or injury risk assessment.

2.14.2 Other x–IDAS projects

The basic methodology of the GIDAS project is of interest for other countries to build up own In-Depth investigations. BASt started co-operations in order to assist those countries. In 2010 a memorandum of understanding has been signed with Korea, in early 2011 with the Czech Republic and in mid 2011 a contract was signed with the CATARC authorities in China. Although each country needs to design such accident surveys to their own needs it is appreciable that comparable study designs, data collection techniques and reconstruction methods do exist.

Figure 18: Signature of the CATARC-BASt cooperation contract in Beijing in 2011

The Czech Republic and China have already started their In-Depth accident surveys and are by now producing high quality accident data records. It will be of particular interest in the near future to run some first parallel analysis on the current –idas surveys. This shall result in a much better comparison of countries safety priorities than it has been available in the past.

2.14.3 The iGLAD Initiative – making existing In-Depth data comparable

BASt is participating in another project which is trying to gain more insight into the safety diversity aspects worldwide. The iGLAD initiative (Initiative for Global Harmonization of Accident Data) is meant to be an attempt to make direct comparisons between countries possible. This is achieved by bringing together existing In-Depth road accident data sources. The problem of unified data was already identified quite a while ago, and numerous bi-lateral initiatives, regional working groups and task forces are attempting to find solutions. The drawback is that no truly international and global approach has yet been taken to find a globally harmonized and ultimately standardized approach to accident data.

Today the GIDAS consortium, in compliance with ACEA and FIA, supports the alternative to build a universally accepted common data subset built on top of already existing In-Depth projects. Setting up a suitable business model, data providers and data users can be brought together and the data can be made usable for an interested community of experts. Participants shall be confronted with a win-win situation and no further external funding shall be necessary.

2.15 Druid – Driving under the influence of drugs, alcohol and medicines

The use of psychoactive substances such as alcohol, drugs and medicines is a major cause of many traffic accidents in Europe.

2006 the European Commission launched, within its 6th Research Framework Programme, the integrated project DRUID (Driving under the Influence of Drugs, Alcohol and Medicines) aiming to assess the real scope of the driving under influence (DUI) problem and to develop appropriate countermeasures. The project had a total budget of 24 Mio. € (of which 19 Mio. € were EU contribution) and was implemented by a consortium of 37 partners from 17 EU Member States and Norway. DRUID Coordinator was the Federal Highway Research Institute (BASt, Germany).

The project was divided in seven Work Packages (WPs) to cover the whole area of research. In addition, Working Groups for special issues were established, e.g. for toxicological issues. All DRUID-participants collaborated very closely on a bilateral basis as well as within Work Packages. The range of disciplines within DRUID was widespread - physicians, pharmacologists, psychologists, toxicologists, methodologists, police officers were involved. An important part of the collaboration was knowledge and technology transfer. It was ensured, that all involved partners could work in compliance with unified standards for toxicological laboratories. In some countries, the appropriate equipment had to be installed and the staff had to be trained accordingly.

The project was completed in October 2011. The results of the project received a very good recognition of the scientific community; the European Commission evaluated the project as "good to excellent" for its outstanding scientific work, the rich gain of knowledge and the exploitable results and recommendations.

Some of the key findings from DRUID are:

- Epidemiological studies showed that alcohol is still the most dangerous psychoactive substance used by drivers in Europe. The biggest risk of being seriously injured or dying in a traffic accident arises from high blood alcohol levels or from alcohol–drug and drug–drug combinations. Blood or oral fluid samples collected from 50 000 drivers revealed that alcohol was present in 3.48 %, illicit drugs in 1.90 %, medicines in 1.36 %, drug–drug combinations in 0.39 % and alcohol–drug combinations in 0.37 %.

- Of the 13 oral fluid devices evaluated for practicability and their analytical accuracy only three devices were evaluated positively. Cost-benefit analysis showed that increased drug driving enforcement based on roadside saliva screening is potentially beneficial – especially for countries with lower baseline enforcement level. Yet, if the drink driving enforcement will be decreased for the sake of increasing the drugged driving enforcement, the net benefit for road safety will decrease.

- Psychoactive medicines on the EU market were classified into four categories depending on their influence on fitness to drive, and it was demonstrated that a pictogram on the package indicating the risk when driving was effective in changing patient behaviour. It was also shown that a software package could assist pharmacists in giving advice to patients when dispensing such medicines.

All 50 reports of the project (several thousand pages in total) are available for downloading on the DRUID website (www.druid-project.eu).

The DRUID consortium was established aiming to involve as much key European players in the domain of road safety research as possible. Besides, all relevant agencies over the world have been constantly informed on project results. DRUID partners reported on their activities bilaterally, as well as using international platforms like ICADTS/ TIAFT, TRA, Fit-to-Drive Congresses, etc. Relevant institutions have been involved in the process (e.g. EMA in the development of a classification system for medicines). These measures ensure an adequate dissemination of DRUID generated knowledge.

DRUID partners informed their national governments on DRUID achievements. As a result, many European countries have recently started to work on new national regulations taking into account DRUID findings. Among others, legal limits for some psychoactive substances (THC, Metamfetamine or Cocaine) based on DRUID results are under discussion in some countries and have already been introduced in Norway and Portugal.

Figure 19: DRUID – Driving under the influence of drugs alcohol and medicines

2.16 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.

Therefore BASt 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 finished beginning of the year 2013. A lot of 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 ECE Regulations No. 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 ECE 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 besides smoke also the heat release of burning parts and the ignitability should be limited in order to avoid ignition of adjacent parts and thus minimise fire propagation. Also the concept to use fire suppression systems in the engine compartment should be persued further.

Figure 20: Smoke spread test in the passenger compartment of a bus (source: BAM)