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EUROPEAN COMMISSION

EU at the steering wheel of Road Safety

EU-funded research to make Europe's roads safer

Directorate-General for Research
Cooperation/Transport (including Aeronautics)

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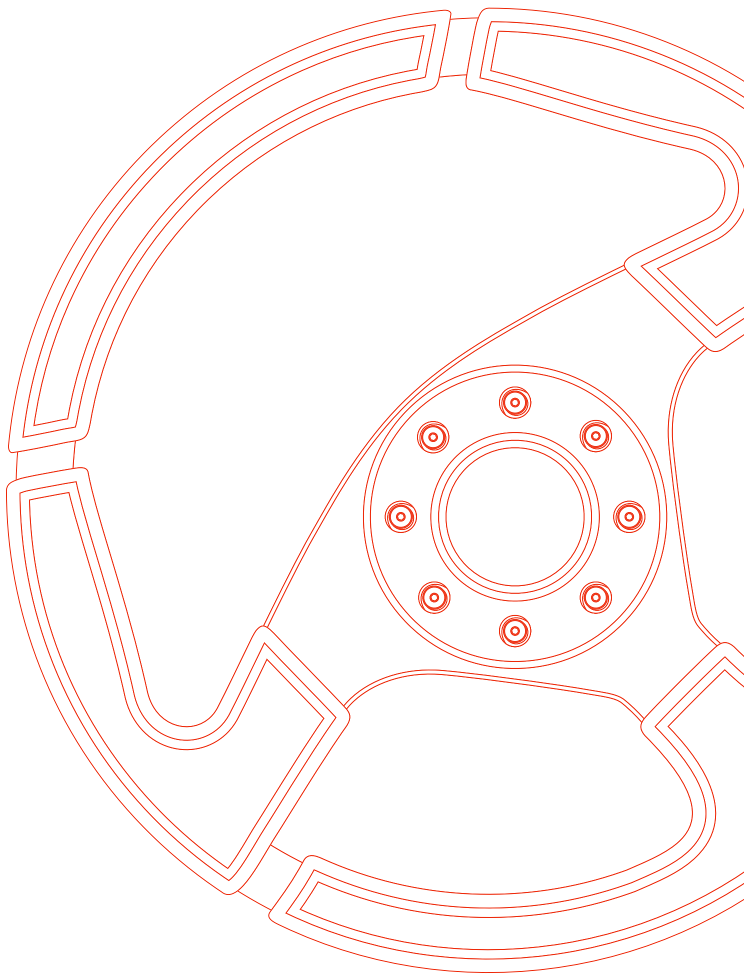

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CHAPTER 1

Introduction

Every year, over a million people are killed on the roads worldwide. In Europe, road fatalities are declining but their incidence remains worryingly high, especially among pedestrians and motorcyclists. In recent years, the EU has put in place a wide range of measures designed to dramatically reduce the number of people killed and injured on European roads. The EU is also supporting research to improve road safety in a variety of ways.

A gloomy global picture

According to the World Health Organization (WHO), road traffic accidents kill 1.27 million people annually worldwide, or an average of 3 242 people every day([1]). This makes road accidents the ninth leading cause of death globally, ahead of diabetes and malaria. For 15 to 29 year-olds, road traffic injuries are the leading cause of death. In addition to these deaths, many more people (estimates range from 20 million to 50 million) are injured in road accidents every year.

The vast majority (90%) of deaths occur in low and middle-income countries, even though they have barely half of the world's registered vehicles. The high death toll in these nations is largely due to the absence of effective legislation to tackle drunk-driving and speeding and enforce the use of helmets, seat-belts and child restraints. Worryingly, the WHO predicts that by 2030, road accidents will result in 2.4 million fatalities per year.

On the economic front, the WHO has calculated that traffic accidents cost between 1% and 1.5% of gross national product (GNP) in low and middle-income countries, and 2% of GNP in high-income countries.

1 Peden, M. et al. (eds), World report on road traffic injury prevention, World Health Organization, Geneva, 2004.

The situation in Europe

In Europe the picture is somewhat better, with road accident fatalities declining steadily. In 2001, over 54 000 people(2) were killed on the roads of the 27 countries currently making up the EU. By 2009, the latest year for which data is available, that figure had fallen by 35% to 35 500. In addition, over 1.5 million people were injured on EU roads in 2009.

However, road safety varies widely within Europe. While Spain, France, Latvia, Luxembourg and Portugal managed to cut road deaths by over 40% between 2001 and 2008, road fatalities actually rose in Bulgaria and Romania, and there has been little progress in Poland and Slovakia. The safest roads in Europe are found in the Netherlands, Sweden and the UK.

Much of these improvements in road safety can be attributed to stricter legislation and the growing uptake of various road safety technologies and measures. For example, improved 'passive safety' measures (e.g. technologies such as seatbelts and airbags that protect road users during a crash) are thought to have prevented over 5 500 deaths between 2001 and 2008.

While this progress is undoubtedly significant, the EU is still unlikely to meet its road safety targets: in 2001, the EU issued its Transport White Paper in which it pledged to halve road deaths from 2001 levels to 27 000 per year by 2010. If the number of road fatalities continues to decline at current rates, this target will not be met until 2017.

The burden is not shared equally

Statistics show that some groups have benefited more from road safety measures than others. For example, new measures to protect pedestrians have been slower to appear on the roads than measures to protect people in cars. This is a pressing issue as 21% of those killed on European roads are pedestrians.

With their smaller, more fragile bodies, lower visibility and lack of experience on the roads, children are a particularly vulnerable group. The good news is that fatalities among those aged 0 to 14 have fallen faster than fatalities among the general population. However, over 1 000 children still die on Europe's roads annually, and the European Transport Safety Council (ETSC) estimates that half of these deaths could be prevented if all EU countries improved their levels of road safety for children to reach those found in Sweden.

Motorcyclists and moped riders also face an increased risk of injury and death on the roads; in 2008, they made up 18% of fatalities in the EU even though they account for just 2% of kilometres driven. While many safety features for cars have been introduced over the past decade, motorbikes have been largely neglected. At the same time, the number of motorcyclists has doubled over the past two decades.

Fatalities among cyclists have fallen in recent years. Nevertheless, they still constitute a vulnerable group of road users, accounting for just over 7% of road deaths in Europe.

2 European Transport Safety Council (ETSC), 2010 on the Horizon - 3rd Road Safety PIN [performance index] Report, June 2009.

EU action on road safety

Improving road safety requires action on diverse fronts and from many people. Stricter traffic rules, more effective public education and training, safer cars, better roads and improved trauma care all help to make Europe's roads safer, and public authorities, road hauliers, the car industry and ordinary individuals all have a role to play.

The inspiration for much of the EU's current road safety activities can be found in the Transport White Paper of 2001, in which the European Commission acknowledges that 'of all modes of transport, transport by road is the most dangerous and the most costly in terms of human lives.'

Commenting that road accidents are seen as a fact of life, the European Commission asks: 'How else can the relative acceptance of road accidents be explained when every day the total number of people killed on Europe's roads is practically the same as in a medium-haul plane crash?'

The White Paper was followed two years later by the third European Road Safety Action Programme (2003-2010). Most of the 62 measures and actions proposed in the action plan fall into 3 main categories: driver behaviour, vehicle safety and infrastructure safety.

Driver behaviour

Driver behaviour, particularly speeding and drunk driving, is a factor in many accidents. According to the European Road Safety Observatory (ERSO), up to a quarter of road deaths in Europe are alcohol-related, while the ETSC has calculated that over 2 200 road deaths could be prevented every year if average driving speeds fell by just 1 kilometre per hour (km/h).

In recent years, the EU has introduced legislation on driving licences, the compulsory wearing of seatbelts and training for professional drivers. In addition, the Commission has adopted a proposal for a Directive on cross-border enforcement of traffic offences, as well as a recommendation on the enforcement of road safety legislation[3].

The European Commission also launched the European Road Safety Charter. Through the charter, companies, public authorities, associations and research institutions can commit to helping the EU meet its road safety targets by taking concrete steps to improve road safety and share ideas and experiences. To date, the charter has attracted some 1 450 signatories.

3 OJ L 111 of 17 April 2004, p. 15.

Vehicle safety

On vehicle safety, EU legislation has brought about the introduction of regular compulsory roadworthiness tests and roadside checks for almost all classes of vehicle. Another piece of legislation requires all lorries, new and old, to be fitted with 'blind spot mirrors' that help lorry drivers avoid hitting cyclists and motorcyclists while turning. Further laws set out technical specifications for the bonnets and bumpers of cars; these are designed to protect pedestrians and cyclists in the event of a collision.

Researchers are constantly developing new devices to improve vehicle safety, and the EU now has legislation in place making these innovative features compulsory on new vehicles. Examples include airbags, anti-lock braking systems (ABS) and Electronic Stability Control (ESC).

In addition, the EU is supporting the 'ChoosESC' information campaign to have ESC systems installed on all new vehicles. If a car appears to be skidding, the ESC system intervenes by braking the relevant wheel, bringing the car back under the driver's control. According to ChoosESC, the technology could cut accidents caused by skidding by 80%. Given that some 40% of fatal accidents are caused by skidding, it is clear that ESC has immense potential to save lives on the roads.

Work is also underway to promote the eCall system. When an accident happens, eCall automatically sends details of the vehicle's location to the emergency services. The system could halve response times and save around 2 500 lives every year.

Another initiative that receives EU support is the European New Car Assessment Programme (Euro NCAP), which provides car buyers with information on different safety aspects of vehicles on the market. Euro NCAP subjects cars to a test programme that represents the main types and severities of road accidents in which passenger cars are involved.

Cars are tested in four key areas: adult occupant protection; child occupant protection; pedestrian protection; and safety assistance. The safety assistance tests evaluate features, such as ESC, which help to prevent accidents or reduce their impact. Features that can win cars extra safety points include ESC (if it is fitted as standard), intelligent seatbelt warnings and speed limitation devices.

Looking to the future, the EU is supporting efforts to speed up the development and uptake of novel car safety technologies through the Intelligent Car Initiative([4]). 'Intelligent' systems can help drivers avoid dangerous situations and lessen the impact of accidents by controlling the car's speed and distance from the vehicle in front and keeping the car within the lane. They can also alert the driver to potentially hazardous situations and even take control of the car if the driver fails to respond to warnings.

These systems have the potential to prevent thousands of accidents. If just 3% of cars were fitted with adaptive cruise control (ACC), which helps drivers maintain their distance from the vehicle in front, 4 000 accidents could be avoided every year.

The recently adopted Intelligent Transport Systems (ITS) Action Plan represents an important step towards the deployment of intelligent transport systems. It will provide much-needed policy instruments to complement the work that the Intelligent Car Initiative and the eSafety Programme have been doing to make cars safer, cleaner and smarter.

4 The Intelligent Car Initiative is a policy framework created by the European Commission in order to promote the use of new information and communication technologies to make cars safer, cleaner and more efficient.

Infrastructure safety

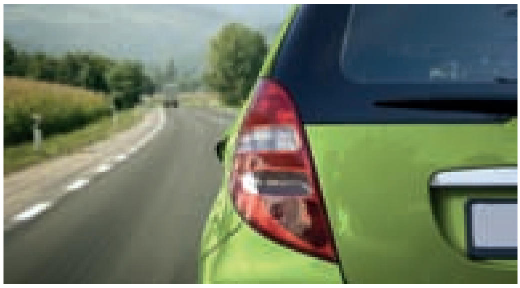
The road infrastructure is implicated in around a third of fatal accidents, and the EU has been extremely active in this area. EU legislation on the safe management of roads states that a road safety impact assessment must be carried out before a new road is constructed or major changes to an existing road are made. The law also ensures that road safety is taken into account at all stages of a project, from planning to operation, so that any unsafe features can be identified and tackled as soon as possible. In addition, roads must undergo regular safety inspections.

Accidents and fires in tunnels can quickly turn into catastrophes, while the long-term closure of a tunnel following an incident can have serious economic impacts for freight companies and others who are forced to switch to secondary roads, albeit temporarily.

Under EU legislation on road tunnel safety, all tunnels that are over 500 metres long must meet certain basic safety requirements. In addition to technical aspects, the legislation sets out the roles of the different bodies involved in tunnel safety.

The EU's road infrastructure and tunnel legislation is complemented by the European Road Assessment Programme (EuroRAP) and the European Tunnel Assessment Programme (EuroTAP).

EuroRAP awards star ratings to roads across Europe and identifies practical measures that could save lives on stretches of road that are considered particularly dangerous. According to EuroRAP, very often simple measures such as clearer road markings or the installation of safety fencing can make roads much safer. EuroTAP publishes reports on the safety of tunnels across Europe and provides advice on how to drive safely in tunnels.



The future

Despite all these efforts, the EU is not on track to meet its goal of halving road deaths by 2010. It is therefore working on a new European Road Safety Action Programme that will run from 2011 to 2020. The European Commission proposes to pursue the ambitious objectives of the third Road Safety Action Programme and further reduce the number of deaths and injuries, which remains very high. Although details of the programme have yet to be finalised, it is likely to focus on accidents on rural roads (which cause 60% of all road deaths) and vulnerable road users.

Road safety research

Research is an important component of the EU's road safety policies and it has already resulted in dramatic improvements in road safety. Safety features that we now take for granted, like airbags, anti-lock braking systems (ABS) and collision warning systems, were all developed and improved through research. Other devices and technologies are just starting to become commonplace on our roads, and yet more are still in the research and development (R&D) phase.

Since 1994, the EU has invested over EUR 500 million in road safety research. Projects co-funded under the EU's Framework Programmes for Research and Technological Development (RTD), have resulted in major developments that have helped make vehicles and road infrastructures much safer, and improved both driver behaviour and the enforcement of traffic rules.

The following pages provide a general overview of all areas of EU-funded road safety research. As well as highlighting the key outcomes of completed projects that are already contributing to road safety, they profile exciting new projects that are working at the cutting edge of road safety research today:

- passive vehicle safety or crash safety measures;
- active vehicle safety and crash avoidance measures (pre-crash), including the human-vehicle interface;
- safer road infrastructures;
- driver behaviour and training;
- improved rescuer support (post-crash);
- accidentology.

CHAPTER 2

Passive and integrated vehicle safety

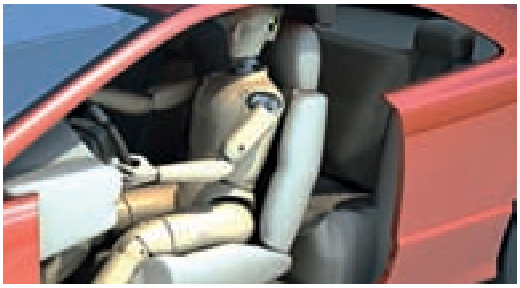
When a road accident happens, devices like seatbelts, airbags and the vehicle's structure itself can be vital in saving lives and preventing serious injury. Measures that protect road users in an accident are called passive safety measures. EU-funded research projects are constantly developing innovative safety devices as well as test procedures to ensure that these systems are effective in real crashes on the roads.

Obvious examples of passive safety devices include restraint systems such as seatbelts and airbags. Structures that make the car more crashworthy, like side impact bars, also fall under the passive safety banner, as does work on crash compatibility, which seeks to lessen the damage one vehicle inflicts on another in an accident.

Crash test dummies have contributed greatly to our knowledge of what happens to car occupants during a crash and the injuries they suffer. Research in this area focuses on developing physical and virtual test dummies that behave more realistically.

As well as protecting car occupants, passive safety systems reduce the impact of accidents on other road users such as pedestrians, cyclists and motorcyclists. While many of these systems are still in their infancy, there are already cars whose bonnet can pop up when the car 'senses' that it has hit a pedestrian, softening the pedestrian's landing. There is also interest in the idea of fitting airbags to the windscreen; these would inflate on impact with a pedestrian or cyclist.

For a long time, the safety of motorbike and scooter riders was largely neglected. However, that is now changing, and exciting new safety devices designed specifically for these vehicles are under development.



APROSYS
Tackling passive safety on all fronts

One of the EU's largest-ever road safety projects, APROSYS, resulted in major advances in a number of areas of passive safety. In the field of biomechanics (which investigates the mechanics of how our bodies sustain injuries in an accident), the project developed a 'female' crash test dummy as well as virtual crash test tools. The team also developed features to protect cars in lateral impacts, designed a helmet and suit to reduce the risk of injury among motorcyclists and investigated ways of cushioning pedestrians who impact the front of a car.

Advanced protection systems
Coordinator | TNO Automotive (the Netherlands)
Total budget | EUR 30 million
EU funding | EUR 18 million
Start/end | 01/04/2004 – 31/03/2009
Website | http://www.aprosys.com/

Keeping children safe on the road

Children face a much lower risk of dying in a road accident than the average adult, and the numbers of children killed on the roads are falling. Nevertheless, over 1 000 children are killed on Europe's roads each year and the protection of this group remains a high priority. Children pose specific challenges for safety systems designers. As Philippe Lesire of Renault in France explained, 'Children are not adults in miniature.'

For a long time, a lack of crash test dummies representing children was a major problem facing auto makers and road safety regulators. The EU-funded CHILD project addressed this issue by developing a series of dummies and testing them in reconstructions of real accidents. The CASPER project is carrying this work forward, refining the dummies developed under the CHILD project and creating new dummies for sizes that do not yet exist. A third project, EPOCH, targets the development of a crash test dummy representing a child aged 10 to 12. Currently, no dummy for this age group is available.

These dummies enhance our understanding of which parts of children's bodies are most vulnerable at different ages and the kinds of injuries children are most likely to sustain.

For example, a baby has a relatively large head accounting for up to 30% of its body weight, while its neck is relatively weak and the bones are not fully fused. These factors make babies and young children particularly vulnerable to head and neck injuries if the upper body is thrown forwards during an accident.

It has been proven that rear-facing baby seats are best for preventing many head and neck injuries in babies and small children. As the child grows, front-facing child seats with strong harnesses and eventually booster cushions combined with an ordinary seatbelt are key for minimising the risk of injury.

However, even the best child seats on the market will not offer high levels of protection to young passengers if they are not fitted and used correctly. Unfortunately, research has shown that between 65% and 80% of child restraint systems are not used properly, placing the children that use them at greater risk of serious injury and even death.

Part of the CASPER project entails an investigation of why so many parents fail to secure their children properly in cars. 'It could be due to technical problems — maybe they can't attach the seat because it's too complicated,' commented Mr Lesire, who is CASPER's Project Coordinator. 'It could also be that parents don't know the laws or don't understand the importance of securing their children.'

CHILD

New insights into road safety for children

The CHILD project shed new light on the injuries sustained by children of different ages and pioneered the development of crash test dummies representing children, On top of this, the CHILD team led the way in the use of virtual test tools in child protection research. The researchers also highlighted the problem of incorrectly used child safety equipment.

Advanced methods for improved child safety

Coordinator	Renault (France)
Total budget	EUR 4.5 million
EU funding	EUR 3 million
Start/end	01/09/2002 – 30/06/2006
Website	http://www.lboro.ac.uk/research/esri/vehicle-road-safety/projects/child%20web%20site/index2.htm

CASPER

Taking child safety research to the next level

The CASPER project builds on the work initiated in CHILD. The hardware and virtual tools generated by CASPER will be useful to both child seat manufacturers and authorities responsible for ensuring that such products meet minimum safety standards. As well as investigating if and how children are secured in cars, the team is assessing the consequences in terms of a child's injuries in case of an accident. The project's findings should help road safety authorities target their campaigns more effectively.

Child advanced safety project for European roads

Coordinator	Renault (France)
Total budget	EUR 5.8 million
EU funding	EUR 3.9 million
Start/end	01/04/2009 – 31/03/2012
Website	http://www.casper-project.eu/

Restraint systems

Seatbelts have helped to dramatically slash road deaths, and they have been fitted as standard equipment in the front and back of cars for many years. Yet a quarter of front seat passengers and over half of back seat passengers in Europe fail to wear seatbelts([5]). The ETSC estimates that half of all car occupants killed on European roads could have survived had they worn a seatbelt([6]).

Meanwhile, seatbelt technology continues to improve. Seatbelts in many newer vehicles are now equipped with 'pre-tensioners' that tighten the seatbelt during the crash. As well as preventing users from being flung around as a result of the impact, pre-tensioners reduce the risk of users sliding below a loosely worn belt. Furthermore, intelligent seat belts are being developed which optimise the protection of people with different body postures than average or people who are not seated upright at the moment of impact (for example because they are leaning towards another person or the radio). Seatbelts are also made of more elastic material than in the past; this absorbs the wearer's kinetic energy during a crash.

One of the most pressing needs in the field of restraint systems is a greater understanding of whiplash injuries and their prevention. From a medical point of view, whiplash is far less severe than many other injuries sustained in car crashes. Nevertheless, over 300 000 people in Europe suffer whiplash-related injuries every year, and around 15 000 of them will have symptoms that last for a long time. The problem costs European society some EUR 4 billion annually.

5 ETSC, *Cost Effective EU Transport Safety Measures*, Brussels, 2003.

6 ETSC, *Police enforcement strategies to reduce traffic casualties in Europe*, Brussels, 1999.

Despite its high social and economic costs, no one knows exactly what injuries to the neck cause the excruciating pain associated with whiplash. Some believe that it is caused by nerve damage, while others believe it could be due to damage to the tissues in the joints connecting the vertebrae.

The EU-funded WHIPLASH II project developed one of the first crash test dummies that is able to accurately predict whiplash injuries; key to the dummy's success is its flexible neck, which behaves more realistically than the neck of a conventional crash test dummy.

The partners also came up with test methods which car and seat manufacturers can use to test their products' ability to protect people against whiplash.

The good news is that many cars are now fitted with seats proven to reduce the risk of whiplash. The bad news is that they are less effective for women than for men, and this is where the ADSEAT project comes in.

'We have seen from injury data that females don't benefit as much from the countermeasures that have been developed,' said ADSEAT Project Coordinator Astrid Linder of the Swedish National Road and Transport Research Institute. 'Therefore in this project we address females.'

ADSEAT is developing a mathematical, virtual model of an average woman that can be used alongside the existing male model to test safety systems' ability to protect car occupants against whiplash.

Looking to the future, more research is needed into why women are more vulnerable to whiplash than men. In addition, around half of all whiplash cases arise when cars are hit from the rear, and most studies focus on these kinds of impacts. However, up to a third of cases are caused by head-on crashes and currently there is little research into these cases.

WHIPLASH II
A major European effort to tackle whiplash

As well as creating a crash test dummy that accurately mimics whiplash injuries, the WHIPLASH II team developed methods to test how well a seat or seatbelt protects the user against whiplash. These test methods have since been adopted by the European New Car Assessment Programme (Euro NCAP). In addition, the WHIPLASH II team developed software that simulates the human body, both at rest and in motion during an accident. 'The nice thing is that you can simply predict with the computer model the risk of injury,' commented road safety expert Jac Wismans, who was involved in the project. The software is now being used by car and seat manufacturers in the design of new products.

Development of new design and test methods for whiplash protection in vehicle collisions

Coordinator | TNO Automotive (the Netherlands)

Total budget | EUR 3.7 million

EU funding | EUR 2.1 million

Start/end | 01/03/2001 – 31/08/2004

Project information on CORDIS | http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_LANG=EN&PJ_RCN=4939514

ADSEAT
Whiplash protection for all

The aim of the ADSEAT project is to reduce the risk of whiplash and related injuries for women as well as men. The project builds on a mathematical model of the BioRID (Biofidelic Rear Impact Dummy), a model of an average man, which was designed to be used in low-severity impact tests. The model was subsequently used by the auto industry to develop the anti-whiplash systems in today's vehicles. As soon as the ADSEAT model is ready, seat and car manufacturers involved in the project will be able to use it so that in the future, both male and female car passengers will be better protected from whiplash injuries.

Adaptive seat to reduce neck injuries for female and male occupants

Coordinator | VTI, Swedish National Road and Transport Research Institute (Sweden)

Total budget | EUR 3.4 million

EU funding | EUR 2.5 million

Start/end | 01/10/2009 – 31/03/2013

Website | http://www.vti.se/adseat

Physical and virtual test methods and tools

Before being released onto the roads, vehicles undergo a battery of tests to ensure that they meet minimum safety requirements. A great deal of research focuses on how the human body behaves during different kinds of crashes, and how this behaviour can be reconstructed using either physical or virtual tools. For example, head-on crashes result in different kinds of injuries to lateral impacts.

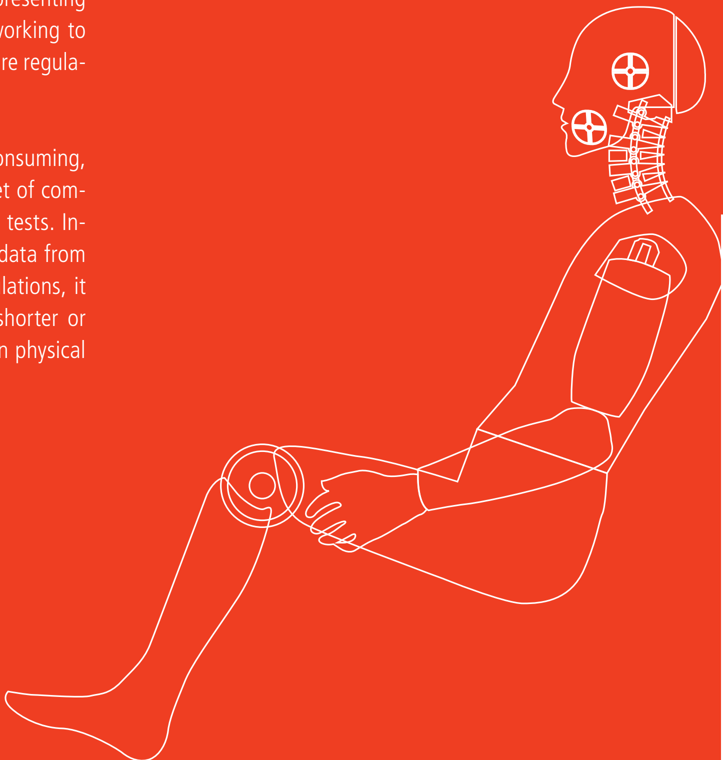
A major priority in this area is developing a greater understanding of how people of different ages and gender respond in a crash. Currently, most tests use a dummy representing an 'average male'. A car that is safe for this average male may not be safe for someone who is older or younger, or taller or shorter, or fatter or thinner than the dummy. For example, older people, particularly women, have relatively brittle bones and are more susceptible to fractures. Children, meanwhile, have more flexible bones.

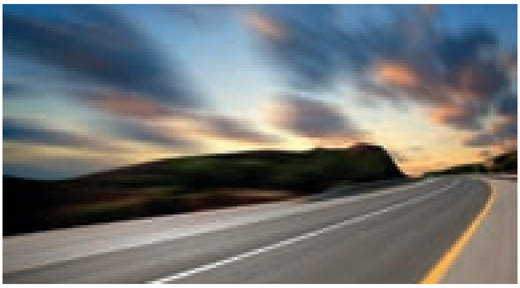
One of the most important outcomes of the EU-funded APROSYS project was a crash test dummy representing an average woman. The researchers are now working to ensure that this female dummy is included in future regulatory tests worldwide.

Crash tests are extremely expensive and time consuming, and another key outcome of APROSYS was a set of computer simulation tools that can run virtual crash tests. Information from virtual tests could complement data from real crash tests. For example, in computer simulations, it is easier to add road users that are taller or shorter or older or younger than the 'average male' used in physical crash tests.

Two further projects, THORAX and THOMO, are devoted to the fate of the thorax in a crash; this is an important issue as injuries to this area cause between 20% and 25% of road deaths. THORAX is looking at the kinds of thoracic injuries sustained by road users of different ages and of both genders. The THORAX team has already found that in frontal impacts, older people are more likely to suffer from broken ribs while younger people are more prone to lung injuries. The results of THORAX will help make crash test dummies more reliable.

Meanwhile, THOMO is developing a highly detailed virtual model of the human thorax. The work feeds in to a wider global initiative to create a virtual model of the entire human body for use in road safety research.





COVER
Coordinating biomechanics research

The COVER project links up four major EU-funded projects in the area of biomechanics research. Two projects, THORAX and THOMO, focus on the thorax, while CASPER and EPOCH revolve around child safety in cars. The COVER project facilitates the exchange of information, expertise and materials between the projects by organising joint events, for example.

The results of all four projects have the potential to significantly improve both regulatory safety tests and the Euro NCAP consumer tests. COVER issues recommendations based on the projects' results to both regulators and Euro NCAP.

Coordination of vehicle and road safety initiatives

Coordinator | First Technology Safety Systems (the Netherlands)

Total budget | EUR 450 000

EU funding | EUR 450 000

Start/end | 01/04/2009 – 31/03/2013

Website | http://www.biomechanics-coordination.eu

Vehicle crashworthiness / crash compatibility

Car manufacturers endeavour to ensure that if a vehicle is involved in an accident, the vehicle's structure protects the occupants inside. Crash tests verify this 'self protection' aspect of car safety.

Despite some improvements, protecting car occupants during lateral impacts remains a problem, and they are the second most dangerous crashes after frontal impacts. The APROSYS project developed a demo system to reduce the impact of lateral accidents. When sensors detect that a crash is imminent, smart materials in the side of the car lock the doors more firmly in place. This not only effectively strengthens the car's side panels, but it also decreases the penetration of the car's interior and protects the people inside. Euro NCAP has recently made its side impact safety requirements more stringent, and the project team is lobbying regulators to do the same for their tests.

However, consumer and regulatory tests do not investigate how much damage a car may inflict on another vehicle in an accident – a problem known as 'compatibility'. 'The classic example is the big SUV [sports utility vehicle] impacting with a smaller car,' explains Mervyn Edwards of the Transport Research Laboratory (TRL) in the UK.

The auto industry is aware of the problem and many manufacturers aim to ensure compatibility within their fleets. SUV makers have also taken steps to prevent their vehicles from 'over-riding' smaller cars when they collide with them. They have done this by lowering some of the main structures of the SUV so that they interact with the strongest structural components of ordinary cars in a collision.

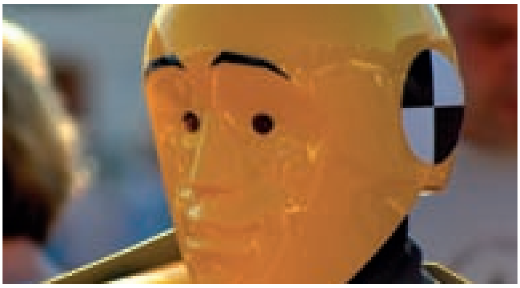
Nevertheless, improving compatibility and creating tests to evaluate it remain among the most pressing issues in passive safety research. Figures from the EU-funded VC-

COMPAT project suggest that if compatibility of cars' frontal structures were improved, up to about 1 300 lives could be saved and up to around 15 000 serious injuries could be avoided every year in the EU-15.

VC-COMPAT helped to develop two new test procedures to evaluate compatibility in frontal impacts between two cars. The tests provide data on the vehicle's potential to interact well with the other vehicle involved in the collision and hence help to protect the occupants of both vehicles.

Regarding collisions between cars and lorries, the VC-COMPAT team produced recommendations to improve the under-run guards on the rear of vehicles. The researchers estimate that 10% of car passengers killed in head-on crashes with lorries could be saved if all lorries were fitted with energy-absorbing front under-run protection. In addition, over a third of car occupants killed in rear impact truck accidents could be saved by improving rear under-run protection.

Building on the work carried out under VC-COMPAT is the FIMCAR project. FIMCAR will assess the effectiveness of different frontal impact test procedures and also investigate the usefulness of tests involving a moveable deformable barrier (MDB).



VC-COMPAT
Developing test procedures for compatibility

The goal of the VC-COMPAT project was to develop crash tests to assess a vehicle's compatibility. In addition to two test procedures to evaluate vehicles' compatibility in frontal impacts between two cars, the team developed recommendations designed to help protect car occupants during a collision with a lorry.

Improvement of vehicle crash compatibility through the development of crash test procedures

Coordinator | TRL Ltd (UK)

Total budget | EUR 5.8 million

EU funding | EUR 2.8 million

Start/end | 01/03/2003 – 031/12/2006

Website | http://vc-compat.rtdproject.net/

FIMCAR
Taking compatibility research to the next level

The researchers in the FIMCAR project are following up on the work carried out in VC-COMPAT on tests to assess compatibility (as described by the self-protection level and the structural interaction between the vehicles involved) in a frontal collision between two cars. Improving compatibility will decrease the injury risks for occupants in both single and multiple vehicle accidents. By the end of the project, the FIMCAR test procedures should be ready for use in regulatory or consumer tests.

Frontal impact and compatibility assessment research

Coordinator	TU Berlin (Germany)
Total budget	EUR 6 million
EU funding	EUR 3.8 million
Start/end	01/10/2009 – 30/09/2012
Website	http://www.fimcar.eu/

Integrated safety

Traditionally, road safety systems could be divided into passive systems (which protect road users in case of an accident), and active systems (which are designed to prevent an accident from happening in the first place). Today, however, the line between active and passive safety is increasingly blurred.

New systems are being developed which use sensors such as radars, cameras, lidar, real-time video processing systems, ultrasound or infrared to detect potentially dangerous situations on the road. Based on what they see, the systems are able to take actions to avoid the crash. If a crash is unavoidable, the car can intervene to reduce the impacts of the crash on the car occupants by braking to reduce the car's speed, tightening seatbelts and deploying airbags.

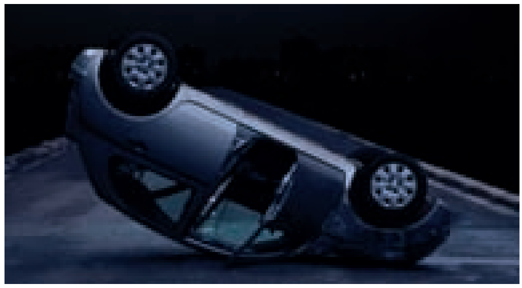
'With these measures, you can really prepare the entire vehicle for the crash and reduce the loads on the occupants,' comments Paul Lemmen of First Technology Safety Systems in the Netherlands.

A lot of research is ongoing to develop these systems, but so far few have made it onto the roads, and those that have are only available in the top-of-the-range models.

Meanwhile, test procedures to evaluate the efficacy of these systems and their ability to save lives in real accidents are urgently needed to enable their widespread introduction into the vehicle fleet, and that is where the ASSESS project comes in.

The ASSESS project is developing procedures designed to gauge the effectiveness of integrated vehicle safety systems. The test methods developed by ASSESS will focus on three aspects of novel integrated safety systems. Firstly, how well do the sensors work? Secondly, if the sensors trigger an alert or cause the car to brake automatically, how does the driver react? Finally, assuming that a crash does indeed take place and the system works as it should (in terms of slowing the car or tightening seatbelts), to what extent are injuries to the car occupants reduced?

ASSESS will test its procedures on existing systems produced by car makers Daimler (Germany) and Toyota (Japan), both of which are project partners.



ASSESS
Setting tests for the safety systems of the future

The ASSESS project is developing assessment procedures to see how well integrated vehicle safety systems work in the most dangerous kinds of crashes. The project partners hope that their test procedures will be taken up by Euro NCAP (which is involved in the project's advisory board) and regulators.

Assessment of integrated vehicle safety systems for improved vehicle safety

Coordinator | First Technology Safety Systems (the Netherlands)

Total budget | EUR 5.81 million

EU funding | EUR 3.64 million

Start/end | 01/07/2009 – 31/12/2012

Website | http://www.assess-project.eu

Safety systems for powered two-wheelers

Those on powered two-wheelers (motorbikes and mopeds) are among the most vulnerable road users, accounting for around 18% of all road deaths. The EU-funded MAIDS ('Motorcycle accidents in-depth study') project revealed that a passenger car is involved in over 60% of motorbike accidents, and the primary contributing factor in 87% of all motorbike accidents is human error (either on the part of the rider or the car driver).

While recent years have seen the addition of a plethora of safety devices to four-wheeled vehicles, the same cannot be said for two-wheelers. This is important because the number of powered two-wheelers on the roads has doubled over the past 20 years. Now, researchers are beginning to provide bikers with safety features that are tailored to suit their needs.

The SIM project has developed a suite of safety features and attached them to a standard, three-wheeled scooter (which has two wheels close together at the front and one wheel at the back). One of SIM's most innovative results is an advanced braking system that communicates with the scooter's equally novel electronic suspension system. 'The behaviour of the suspension is adapted depending on the manoeuvre of the rider for a better braking manoeuvre,' said Project Coordinator Dr Marco Pieve of Piaggio & C. SpA in Italy.

The scooter is also equipped with an airbag that inflates when sensors in the nose and fork of the vehicle detect a crash. Furthermore, the researchers developed an inflatable jacket that is also triggered by the sensors.

Elsewhere, the project partners revamped the scooter's display panel to make riders more aware of critical safety information. Controls on the handlebars define what is highlighted on the display panel allowing the rider to toggle between different functions while keeping a firm grip on the handlebars.

In addition, the team developed a helmet fitted with a head-up display panel. This provides the rider with the same information as the conventional display panel, but in a more effective way. Warnings can be delivered via the helmet's earpiece.

For its part, the APROSYS project came up with a helmet that lowers the risk of brain injuries and a special suit that offers greater protection to the rider's thorax.

SIM
Towards safer scooters

The SIM project has kitted out a standard three-wheeled scooter with a number of novel safety features, including two airbags (one on the bike itself, the other in the rider's jacket), an advanced braking system and an improved display panel. Most of the technologies developed in SIM are still in the prototype stage, and more research is needed before they are likely to be ready for the road. Nevertheless, they represent an important step towards improved safety for scooter and motorbike riders alike.

Safety in motion

Coordinator	Piaggio & C. SpA
Total budget	EUR 4 million
EU funding	EUR 2.2 million
Start/end	01/09/2006 – 30/11/2009
Website	http://www.sim-eu.org/

CHAPTER 3

Preventive and active safety

While passive safety measures seek to protect road users during an accident, active safety measures are designed to stop an accident from happening in the first place. EU-funded projects are helping to refine and improve existing systems, as well as developing entirely new technologies that will enhance road safety long into the future.

Many active safety devices are already widespread. Anti-lock braking systems (ABS) must be fitted to all new cars in Europe, and Electronic Stability Control (ESC), is becoming more common, as are adaptive cruise control, anti-collision devices and systems that help drivers stay within their respective lane.

Research in the active safety area focuses on the development of new sensor systems: the human-machine interface (HMI, through which information is communicated to the driver) and cooperative systems, in which safety information is passed from vehicle to vehicle and between vehicles and the infrastructure

These intelligent transport systems (ITS) rely heavily on advanced information and communication technologies (ICTs). In the future, autonomous on-board safety systems will be integrated with so-called cooperative technologies, which obtain safety-related information from other vehicles and the road infrastructure (i.e. traffic signs, lights and management centres).

For example, in a cooperative system, if one car skids on the road, it sends a warning signal to the surrounding vehicles, giving the other drivers time to slow down and increase their distance from the car in front. Information may also be transmitted between cars and the road infrastructure. In the skidding example, the intelligent infrastructure could lower the speed limit along the affected stretch of road.

Sophisticated sensors

One project that has been particularly active in the development of novel sensors is PREVENT. 'The aim was to develop safety systems which are relatively close to market introduction,' explained Project Coordinator Matthias Schulze of Daimler in Germany. One tool which is now in the final stages of development is a lane-keeping system. Current systems only work if there are clear markings on the road. However, the PREVENT system draws on enhanced digital maps and data from different sensors to keep cars on course even when lane markings are missing.

Another part of the project helps lorry drivers avoid crashes. Lorry drivers simply cannot see things that are right in front of them or very close to their sides. PREVENT uses cameras to monitor these areas; if an obstacle is detected, the system stops the vehicle from accelerating. The team also worked on systems that apply the brakes once an obstacle is identified.

On a more futuristic note, the researchers investigated the use of laser scanners in hazard detection; lasers are far more effective than cameras or radars. However, they are also bulky and rather expensive, so further research is needed before these devices go to market.

PREVENT
Systems that spot hazards before you do

The PREVENT project has developed a suite of tools to give drivers advance warning of hazards in their path and help them avoid them. Some of the devices developed in the project were tested in demonstration vehicles and feedback was generally positive. Many technologies developed in the project are likely to be available on the market in the not-too-distant future.

Preventive and active safety applications contribute to the road safety goals on European roads

Coordinator	Daimler AG (Germany)
Total budget	EUR 54.2 million
EU funding	EUR 29.8 million
Start/end	01/02/2004 – 31/03/2008
Website	http://www.prevent-ip.org/

Closer cooperation

The EU is leading the way in the development of cooperative safety systems, and has already allocated the 5.9 gigahertz (GHz) radio frequency range to carry these wireless communications between vehicles and the infrastructure.

The CVIS consortium set out to develop and test the core technologies needed to make cooperative safety systems a reality. 'We have done some fairly unique things,' commented Project Coordinator Paul Kompfner of ERTICO - ITS Europe in Belgium. 'I think we were the first group in the world to develop and demonstrate a technology based on the latest global standards that can maintain a continuous connection between a vehicle and the roadside when hopping from one communication means to another.'

In other words, while the system prefers to use the short-range, wireless 5.9 GHz channel, if that is not available, it can switch seamlessly to the more widespread 3rd Generation (3G) mobile signal, or even infrared signals.

Another plus point for the CVIS system is the way applications are managed. Just as Apple allows other people to develop applications which can then be sold to iPhone users via the 'apps store', CVIS envisages something similar for its systems.

'We don't think that anyone would be able to outguess the innovativeness of the marketplace,' said Mr Kompfner. Obviously road safety could be a feature of many of these applications, transmitting warnings of fog, slippery roads, wrong-way drivers or potential collisions from vehicle to vehicle and to the infrastructure. The CVIS system is also able to determine the position of a vehicle with pinpoint accuracy by combining satellite positioning with data from different Wi-Fi hotspots. This allows applications to distinguish which lane the vehicle is in, something which is not possible on current navigation systems.

Another major EU-funded project in the cooperative systems area is SAFESPOT. The key concept in SAFESPOT is the Safety Margin Assistant (SMA) that Deputy Project Co-ordinator Giulio Vivo of Centro Ricerche Fiat in Italy likens to today's air traffic control systems, which provide aeroplanes with all the information they need to safely fly the aircraft long before they encounter any potential danger related to the surrounding environment.

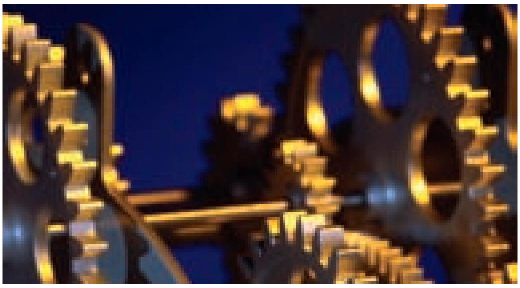
The SMA gets its information from the surrounding cars and infrastructure via the dedicated 5.9 GHz car-to-car communications bandwidth. In this way, drivers can 'see' stopped cars around a bend in the road, for example. Similarly, if you brake suddenly, all the cars behind you receive a warning. On a larger scale, if the infrastructure detects an accident, it can send a warning to all approaching vehicles or impose a lower speed limit along that stretch of road.

The SAFESPOT team has developed a number of applications and scenarios highlighting the many ways their system can improve road safety. These include safety distance and speed advice, the detection of ghost drivers (i.e. people driving in the opposite direction to traffic), overtaking assistance, lane change assistance, dangerous curve warnings and vulnerable road user detection.

Cooperative systems are largely developed in isolation at present, but these will need to be integrated in the future. In Europe, many EU-funded road safety projects work closely together to ensure their systems are compatible. For example, SAFESPOT, CVIS and other similar projects are coordinating their activities.

However, significant barriers remain to the wider introduction of cooperative safety technologies. Firstly, having the cars fitted with the system is not enough; authorities need to equip their road infrastructure with the relevant wireless transmitters and receivers. To get these systems up and running, the vehicle and road infrastructure industries, as well as telecommunications companies and road managers must agree on both business models and what standards to adopt so as to ensure that the different components of the system are fully interoperable. This process has already begun. 'Everybody is banking on this, working together to make it happen,' stated Mr Kompfner.

At the same time, trials involving large numbers of users across Europe are expected to start in 2011; these will help researchers and the industry refine and improve the systems. According to Dr Vivo, 'the usage of communication as a sensing system has a cost which is a fraction of the cost of other technologies. For instance, radars or laser sensors cost much more than a small communication device.'



CVIS
A trailblazer in cooperative safety systems

CVIS is a world leader in the development of cooperative systems for safety, traffic efficiency and driver support. The project team has a vision of one adaptable system that can run a wide range of applications addressing road safety and many other issues. The technologies have been tested at several sites across Europe and, by the end of the project, CVIS partners hope to be working towards advanced products that are ready for further development. Early results indicate that in addition to saving lives, the systems will reduce congestion on the roads and curb energy consumption and air pollution.

Cooperative vehicle-infrastructure systems

Coordinator	ERTICO - ITS Europe (Belgium)
Total budget	EUR 41.2 million
EU funding	EUR 21.8 million
Start/end	01/02/2006 – 30/06/2010
Website	http://www.cvisproject.org/

SAFESPOT
Communication as a sensor

At the heart of SAFESPOT is the novel Safety Margin Assistant (SMA) system that provides drivers with an unprecedented overview of what is going on around them. Prototype systems have been fitted to cars, lorries and motorbikes and tested at six sites around Europe. The SAFESPOT team hopes that, following extensive field trials and standardisation of the relevant technology, these cooperative systems could be actively helping to protect drivers on the roads within the next decade.

Cooperative systems for road safety
'Smart Vehicles on Smart Roads'

Coordinator	Centro Ricerche Fiat ScpA (CRF) (Italy)
Total budget	EUR 37.7 million
EU funding	EUR 20.6 million
Start/end	01/02/2006 – 30/06/2010
Website	http://www.safespot-eu.org

The human factor

A major challenge facing active safety researchers is ensuring that the diverse systems do not conflict with one another, and integrating them in a logical way so that drivers and road users are not bombarded with messages. The key, according to Dominique Cesari, Chair of the European Enhanced Vehicle-safety Committee (EEVC) and a researcher at INRETS, the French National Institute for Transport and Safety Research, is optimising the transfer of information to the driver. 'The system has to have a certain hierarchy to make sure that the best information is going to the driver at the right time,' he notes. If the driver is simultaneously being told that the tyre pressure is low, the speed is too high and the road is slippery, he or she cannot make choices easily or safely.

Both SAFESPOT and PREVENT have applied filters to their systems to reduce the amount of data being fed to the driver. For example, the SAFESPOT SMA knows that someone driving along a motorway does not need to know about obstacles on the other carriageway.

In addition, the ROADSENSE and other projects have worked on the human-machine interface (HMI), which governs drivers' interactions with the systems, identifies common mechanisms of drivers' failures and defines the most dangerous situations.

ROADSENSE
Road awareness for driving via a strategy that evaluates numerous systems

ROADSENSE set out to provide the European automotive industry with a framework for studying human-vehicle interactions, and to construct a simulation environment for the evaluation of new technologies. A general-purpose driver behaviour interface test equipment (D-BITE) was produced. Since the end of the project, several project partners have continued to work on the system to make it more reliable.

Coordinator | Jaguar Cars (UK)
Total budget | EUR 4.41 million
EU funding | EUR 2.80 million
Start/end | 01/02/2001 – 30/06/2004
Further information | http://www.cvisproject.org/download/roadsense.pdf

CHAPTER 4

Safe road infrastructure

The road infrastructure has a major influence on road safety; faded or missing signs and road markings, badly designed road layouts and poorly maintained road surfaces all raise the risk of an accident occurring. Furthermore, the road infrastructure can worsen the consequences of an accident; many motorcyclists are killed or seriously injured when they slam into barriers and other structures on the side of the road, for example. Fortunately, EU-funded research is revealing how the road infrastructure can be made safer in a number of different ways.

According to the European Campaign for Safe Road Design[7], the number of serious accidents could be halved when simple safety measures, such as crossings, crash barriers and hazard markings, are installed.

The EU-funded ROSEBUD ('Road safety and environmental benefit-cost and cost-effectiveness analysis for use in decision-making') project investigated how many lives could be saved if four key road safety management procedures (namely, road safety impact assessments, road safety audits, network safety management and road safety inspections) were applied to certain types of roads in Europe[8]. They found that if safety management procedures were enforced on both motorways and main roads, some 1 300 lives could be saved every year. This would cut fatalities on these kinds of roads by 12% and result in welfare savings of over EUR 5 billion per year.

In 2008, the EU adopted new legislation requiring Member States to carry out the procedures studied by the ROSEBUD project. Meanwhile, guidelines developed by the RIPCORD-ISEREST project are now helping governments and road safety authorities to implement the legislation. For example, auditors across Europe are already using the project's road audit procedures, while road authorities can draw on the project's guidelines that relate to road safety inspections.

Another useful tool developed by RIPCORD-ISEREST is a network safety management procedure that helps authorities analyse accident rates on different sections of the network. Armed with this information, they can quickly ascertain which stretches of road are in most urgent need of improvements. In addition, the team designed software to help road authorities tackle accident black spots.

7 See http://www.saferoaddesign.eu online.

8 The calculation covers the 27 Member States of the EU plus Switzerland.

A major goal of research into safer road infrastructures is to develop roads that are 'self explanatory' and 'forgiving'. As the name suggests, self-explanatory roads have a layout and signage that make it very easy for drivers to understand where they need to go and what they need to do. For example, drivers should be able to quickly understand which lane they should be in at any given time, and any signs or messages should be instantly comprehensible.

One EU-funded project that has been particularly active in this area is IN-SAFETY. Its overall aim was to enhance road safety by using new technologies (in the vehicle but also on the road) in combination with traditional infrastructure measures.

The project partners developed language-independent signs and tested them on people in different countries. Going a step further, the team also investigated ways of displaying these standardised signs in cars. In such a system, the infrastructure would send the signals to the cars, which would then be displayed on the satellite navigation system's screen, for example. However, more work needs to be done on standardising traffic signs so that people driving in foreign countries are able to understand signage easily.

'We have done that for a number of signs, for example, traffic jam ahead, vehicle breakdown ahead and fog,' explained Project Coordinator, Dr Evangelos Bekiaris of the Hellenic Institute of Transport in Greece.

The team also assessed innovative technologies such as virtual rumble strips, which help drivers stay within the lane; if the driver leaves the lane, the car itself provides an audio rumble strip effect. Other systems tested include one that warns drivers to reduce their speed when approaching a sharp curve.

Meanwhile, a forgiving road infrastructure is one that protects road users if an accident takes place. For example, crash barriers have now been developed that absorb the energy of objects that hit them. These have already helped to reduce the severity of injuries among motorcyclists.

Although research has already resulted in new insights into road infrastructure safety, more studies are needed. There are a lot of unanswered questions on the safest road layouts – which kinds of slip roads are safest and how bikes should be protected from traffic, for instance.

RIPCORD-ISEREST
Helping road authorities design safer roads

The RIPCORD-ISEREST project is providing governments and road authorities with the guidance they need to comply with recent EU legislation on road infrastructure safety. The project's guidelines are now being adapted to suit national circumstances as individual countries work to implement the European legislation before the 2011 deadline.

Road infrastructure safety protection – core research and development for road safety in Europe

Coordinator	Federal Highway Research Institute (Germany)
Total budget	EUR 3.4 million
EU funding	EUR 2.6 million
Start/end	01/01/2005 – 31/12/2007
Website	http://ripcord.bast.de

IN-SAFETY
Bringing new technologies to the roads

The IN-SAFETY project set out to take innovative technologies and ideas and see how they could be combined with traditional infrastructure measures to improve road safety in a cost-effective way. The IN-SAFETY team has also produced a manual that will guide public authorities, road operators and other groups interested in road safety through the technologies available and help them see what is possible.

Infrastructure and safety

Coordinator	Centre for Research and Technology Hellas (Greece)
Total budget	EUR 4.8 million
EU funding	EUR 2.94 million
Start/end	01/02/2005 – 31/01/2008
Website	http://www.insafety-eu.org

Interaction between the infrastructure and the vehicle

Impacts with roadside barriers and other objects are a major cause of death and injury, particularly among vulnerable road users. Sharp edges can act like guillotines, resulting in amputations, for example. Recent years have seen significant improvements in the construction of roadside barriers. Various systems have been put in place to absorb road users' energy as they impact the barrier, and simply leaving an open area between the edge of the road and the barrier can reduce injuries by giving accident victims more time to decelerate before they hit the barrier.

The EU-funded SMART RRS project is developing 'smart' road barriers that will protect all road users by preventing accidents, reducing the severity of any accidents that do occur, and providing timely information to the emergency services about the nature of accidents.

The system will reduce the number of accidents by providing drivers with information on the state of the road. 'The barrier, by means of distributed sensors, collects information about climatic conditions, traffic flow, obstructions, etc,' said Project Coordinator Professor Juan Alba of the University of Zaragoza in Spain.

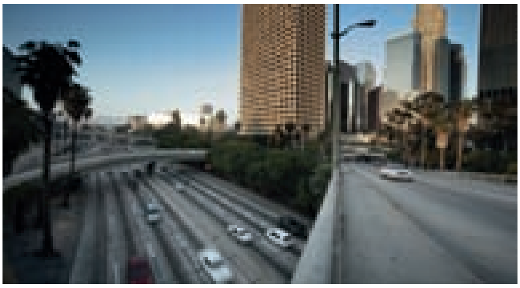
If an accident occurs, the sensors in the SMART RRS barriers will also collect information on the nature of the impact and establish whether there is smoke or fire, for example. This information will be sent to the emergency services so that they can send the appropriate teams to the scene of the accident as quickly as possible.

Elsewhere, the INTRO project is using cars to alert authorities to road infrastructure problems. The team fitted cars with 'black boxes' which pick up information on braking, steering and acceleration, among other things. By using satellite navigation data to locate where these actions took place, road managers can spot potential problems.

'For instance on a straight road, if a lot of cars have made an unexpected use of the steering wheel, we thought there must be something wrong with the road, like a pothole,' explained Project Coordinator Leif Sjögren of Sweden's National Road and Transport Research Institute.

Another focus of the project was the human-machine interface (HMI). Using a simulator, the researchers tested different ways of warning drivers about dangerous sections of road. One popular way of informing drivers of safe speed limits under slippery conditions involved a modified speedometer. Dangerous speeds are lit up in red, while safe speeds glow green.

Looking to the future, research is underway to make the infrastructure 'smart'. For example, Mr Sjögren predicts that 'dust technology' (i.e. using a network of sensors that are barely a millimetre across) could play a role here. Designed to detect vibration, noise and temperature for example, these sensors could be integrated into road paints. They could then transmit this information to a road management system. The challenge here is to improve the sensors' energy supply so that they have 20 or 30 years' life before needing replacement.



INTRO
Towards a smarter road infrastructure

The INTRO project pioneered a system that uses ordinary cars to flag up problems on the roads. The system has proven particularly effective on rural roads and road authorities are now investigating how it could be exploited. The project also tackled road closures due to frost damaged roads, an issue that costs Sweden's timber industry EUR 80 million a year. INTRO developed sensors which allow road managers to see if a road is frozen or not.

Intelligent roads

Coordinator | VTI, Swedish National Road and Transport Research Institute (Sweden)

Total budget | EUR 3.5 million

EU funding | EUR 2 million

Start/end | 01/03/2005 – 29/02/2008

Website | http://intro.fehrl.org/

SMART RRS
Road barriers of the future

The SMART RRS project is building on the state of the art in barrier technology to design safer roadside barriers. As well as providing road users with the information they need to avoid accidents, the novel barriers are designed to lessen the impact of an accident and send information on crashes directly to the emergency services.

Innovative concepts for smart road restraint systems to provide greater safety for vulnerable road users

Coordinator	University of Zaragoza (Spain)
Total budget	EUR 3.42 million
EU funding	EUR 2.19 million
Start/end	03/11/2008 – 02/11/2011
Website	http://smartrrs.unizar.es

Skid resistance

Skid resistance is the contribution of the road surface roughness to friction, and it's a hot topic in road safety as skidding is the cause of many road accidents. Over the years, road builders have accumulated a wealth of experience on what materials make good roads that are resistant to skidding, and they are constantly trying out new ingredients in road surface mixes in a bid to design skid-resistant roads. At the same time, road engineers need to ensure that measures designed to increase skid resistance do not raise the risk of other problems arising such as cracking, potholes and road deformation, or affect other important road surface parameters like noise emission and rolling resistance.

A major challenge in skid resistance research is measuring skid resistance – current techniques allow researchers to compare two different road surfaces but do not provide any insight into the actual processes taking place at the tyre-road interface, their interplay and their control by means of mix design. The EU-funded SKIDSAFE project is working to address this problem.

'We want to try to understand what contributes to skid resistance at material level because that is the level that the industry can control and design for,' explained Project Coordinator Dr Tom Scarpas at Delft University of Technology in the Netherlands.

The team has designed a device that accurately duplicates the interface conditions between a rubber tyre and the road surface. The device provides detailed information on the development and distribution of the stresses generated at this interface.

The SKIDSAFE team plans to use the device to test the skid resistance of typical European road surfaces from Greece, Spain and France.

SKIDSAFE also plans to measure how skid resistance degrades over time – millions of cars driving along a road effectively polish the surface making skidding more likely. Again, while road engineers are able to use their experience to provide good advice on speed limits on degraded roads, this information is primarily based on empirical evidence. SKIDSAFE hopes to change that.

The TYROSAFE project is working to raise awareness of road skidding and tyre-road interaction issues among end users, road authorities and scientists. The TYROSAFE team hopes its work will ensure that future research and legislative activities lead to improvements in key aspects of European roads: skid resistance, rolling resistance and tyre-road noise emission.

SKIDSAFE
The science of skidding

The SKIDSAFE project is developing tools and methods to help road designers test new road surfaces in the lab. The team is working on a device that duplicates the interaction between tyres and the road surface. The device, the test procedures and the computational tools developed by SKIDSAFE could be used by road designers to test new and existing road surfaces.

Enhanced driver safety due to improved skid resistance

Coordinator | Delft University of Technology (the Netherlands)

Total budget | EUR 4.9 million

EU funding | EUR 3.3 million

Start/end | 01/11/2009 – 31/10/2013

Website | http://www.skidsafe.org/

TYROSAFE
Tyre and road surface optimisation

The TYROSAFE project addresses three key issues, namely the lack of awareness of the importance of skid resistance; the absence of harmonised systems for comparing skid resistance; and concerns that solving problems in one aspect of road design may worsen other aspects. The project also aims to create a platform for the development of new, harmonised technologies to improve road safety Europe-wide.

Coordinator | AIT - Austrian Institute of Technology (Austria)

Total budget | EUR 1.16 million

EU funding | EUR 1.16 million

Start/end | 01/07/2008 – 30/06/2010

Website | http://tyrosafe.fehrl.org/

CHAPTER 5

Driver behaviour and training

Driver education and training has the potential to dramatically improve driver behaviour, and with it road safety, in the long term. This is especially important for groups that are particularly prone to driver error such as new drivers, lorry drivers, emergency vehicle drivers and motorcyclists. Recent advances in driving simulator technology could significantly enhance the quality and efficiency of driver training courses.

Human error is the cause in the majority (over 80%) of road accidents. All too often, tiredness, alcohol or a fleeting moment of inattention cause a driver to miss a hazard or fail to react properly and in time. And of course many drivers still engage in behaviour that they know to be dangerous or illegal, for instance speeding (which remains a leading cause of deaths and injuries on the road), ignoring a red light or driving the wrong way down a one-way street.

Certain categories of drivers are more likely to make mistakes than others. For example, novice drivers simply do not have the driving experience needed to calculate risks on the road, and conventional training programmes do not provide learners with the enhanced risk awareness and higher order skills. In contrast, heavy goods vehicle drivers spend long hours on the road and so are at greater risk of being involved in accidents caused by drowsiness. And although emergency vehicle drivers undergo practical training, the fact that each police car is on average involved in one accident per year highlights the importance of extra training for these drivers. Finally, motorcycle drivers are prone to traffic-scanning errors.

Studies have shown that many accidents can be attributed to poor driver education or a lack of risk awareness, and so improving driver training is crucial. While most training still takes place on the road, recent years have seen major advances in driving-simulator technologies.

Simulators could never entirely replace driving lessons on real roads, but they do offer a number of benefits. For example, they allow users to experience (and practise responding to) situations that may be difficult to mimic on the road, such as aquaplaning (when tyres unexpectedly lose contact with the road surface due to wet conditions) or the sudden opening of the door of a parked car.

The EU-funded TRAIN-ALL project brought about major improvements in simulator technology. Before TRAIN-ALL came along, the other cars on the virtual roads in simulations were rather predictable and did not display realistic driving behaviour. TRAIN-ALL made these cars more realistic by drawing on the behaviour of real drivers who used the simulators. 'We record their driving behaviour, meaning the distance from other cars, lane position, how you overtake, and then we include these drivers in other simulations,' explained Dr Evangelos Bekiaris of the Hellenic Institute of Transport in Greece, who is also the Technical Manager of TRAIN-ALL.

TRAIN-ALL also developed a dynamic scenario management module, which spots the types of mistakes a user makes and decides in real time what scenarios he or she would benefit from. Finally, TRAIN-ALL also resulted in major advances in motorbike simulators, which were poorly developed, compared to car and lorry simulators.

TRAIN-ALL
Developing the driver training simulators of the future

The TRAIN-ALL project revolutionised driving-simulator technology. As well as designing training modules for car, lorry, motorcycle and emergency vehicle drivers, the team made the driving scenarios more realistic in terms of traffic behaviour. They also made it possible to link up simulators made by different manufacturers. Simulator manufacturers involved in the project are already adding TRAIN-ALL technology to their product lines, and the research groups participating in the project have sold the rights for some of the technology they developed to manufacturers.

Integrated system for driver training and assessment using interactive education tools and new training curricula for all modes of road transport

Coordinator | Centre for Research and Technology Hellas (Greece)/Hellenic Institute of Transport

Total budget | EUR 3.7 million

EU funding | EUR 2.3 million

Start/end | 01/11/2006 – 31/12/2009

Website | http://www.trainall-eu.org/

Enforcement – Keeping drivers on the straight and narrow

Obviously, road safety campaigns can help promote safer driving behaviour. On the research front, the EU-funded DRUID ('Driving under the influence of drugs, alcohol and medicines') project has come up with recommendations for policymakers on how best to tackle drunk-driving and those who drive after taking drugs or medicines that may affect their ability to drive safely.

Unfortunately not all drivers are responsive to campaigns, and traffic laws need to be enforced to ensure that road users follow the highway code. Enforcement actions often target high-risk activities like speeding, drinking and driving, not wearing a seatbelt, driving through a red light, using a mobile phone while driving and (in the case of heavy goods vehicles) overloading. Police rely on roadside checks as well as automated devices, such as speed cameras, to identify dangerous drivers. Meanwhile, research is developing innovative new systems to assist the police in this area.

A case in point is the ASSET ROAD project which is focusing its efforts on heavy goods vehicles (HGVs), as they pose specific challenges for road safety. At the project's German test site, the team's 'Weight in Motion' (WIM) system uses a flat sensor-array to weigh HGVs as they drive along the road to determine if they are overloaded.

In addition, ultra sensitive far-infrared cameras detect the condition of HGVs' brakes and tyres, while 14 video cameras follow vehicles along a 2kilometre (km) stretch of road to monitor the driver's behaviour. This data can be used for both traffic enforcement and informing drivers about incidents and hazards

Many HGVs travel long distances, crossing many national borders. 'A lot of drivers do not know all the [national] regulations,' comments Project Coordinator Dr Walter Maibach of Planung Transport Verkehr AG in Germany. 'Imagine that there is a vehicle which comes from Ukraine and goes to Brussels. He passes through a lot of countries with a lot of different regulations.'

The ASSET ROAD team is designing a database that will inform lorry drivers of changes in regulations as they cross the border from one country to another. If the lorry driver violates a traffic rule, he or she will be warned of the consequences (e.g. a fine or points deducted from their driving license).

ASSET ROAD
A holistic approach to road safety

The ASSET ROAD project includes studies on driver behaviour, road maintenance and traffic control with the primary focus being heavy goods vehicles (HGVs). As well as implementing systems to promote safer driving among lorry drivers, the researchers are developing a system to work out the damage HGVs inflict on our roads as a result of their weight. This information will contribute to the development of new processes to maintain and repair roads, ultimately making the roads safer and cutting the number of accidents.

Advanced safety and driver support in essential road transport

Coordinator	PTV Planung Transport Verkehr AG (Germany)
Total budget	EUR 8.1 million
EU funding	EUR 6.1 million
Start/end	01/07/2008 – 31/12/2011
Website	http://project-asset.com/

CHAPTER 6

Driver monitoring and accidentology

Research into driver behaviour and the causes of accidents is crucial for improving road safety worldwide. EU-funded research has resulted in new methods to gather comprehensive, comparable data on accidents across Europe. Meanwhile, recent advances in technology are allowing researchers to study driver behaviour in unprecedented depth.

Policymakers and other groups interested in road safety rely on accident statistics and studies of driver behaviour to track their progress towards meeting road safety targets, and to identify the groups at greatest risk and areas where more work is needed.

In Europe, the European Road Safety Observatory[9] (ERSO), developed by the EU-funded SAFETYNET project, represents a major source of detailed information on road safety in Europe for policymakers. When the project started, most countries collected data in different ways making it very difficult to compare different nations' road safety records.

9 See http://www.erso.eu online.

SAFETYNET devised new methods to standardise these diverse national datasets so that they were comparable with one another and could be added up to generate statistics for the whole EU. The partners also carried out detailed analyses of around 1 000 fatal and 1 300 other accidents.

As well as compiling information on the total numbers of deaths and injuries, the ERSO breaks the data down by road user type (e.g. car passengers, pedestrians, cyclists and motorcyclists). It also reveals differences in the numbers of men and women killed on the roads, and variations in fatalities among different age groups.

'Countries like to know that they are achieving their targets and doing well, and they do get uncomfortable with adverse international comparisons,' notes SAFETYNET Coordinator Professor Pete Thomas of Loughborough University in the UK.

Professor Thomas would like to see more information entered into the ERSO database on safety performance indicators like seatbelt use, speeding and drunk-driving. Currently, some countries gather this information, but not all. 'SAFETYNET has given them a method to gather that data, and do it in a comparable manner,' he points out. The most important priority now is to establish a new, in-depth investigation system to identify the key causes of accidents across Europe and to support the development of new safety strategies.

More research is also needed into the socioeconomic costs of accidents. When designing new road safety policies, authorities need to know how much fatalities and injuries cost society, and what benefits different policies will bring. At the same time, the accidentology research community needs to investigate the impacts of new intelligent passive and active safety systems on road safety.

Studying drivers in their 'natural environment'

Until recently, studies into driver behaviour involved driving simulators or heavily instrumented test vehicles. Now, thanks to advances in technology, researchers can monitor drivers in their natural environment, i.e. their own cars. These 'naturalistic driving' studies rely on miniature cameras and other tiny sensors to gather data on when and how hard drivers brake and accelerate, as well as where they are looking, for example. Small data storage devices retain the information, while developments in software make it easier for researchers to analyse the information.

The benefits of these studies are immense. 'In naturalistic driving you can actually be there, so you can see what happened, what condition the driver was in 10 minutes before the accident, and what kind of manoeuvres he undertook to try to prevent the accident,' explains PROLOGUE Project Coordinator Rob Eenink of the Dutch Institute for Road Safety Research.

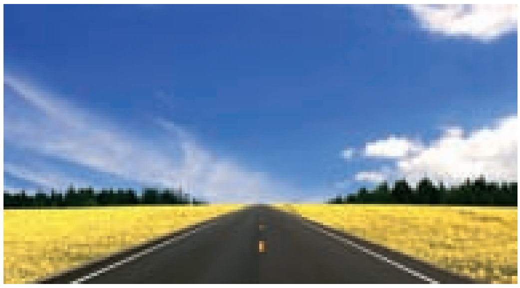
The US carried out a small-scale naturalistic driving study in which 100 cars were tracked for a year. During the study, there were around 70 (mostly minor) incidents, most of which occurred because the driver was not paying attention to the road. The study also proved that after the first few weeks, the test subjects stopped noticing the instruments in their car and simply drove as normal.

The Americans are now embarking on a larger study which will follow thousands of drivers for a few years. Among other things, that study will focus on driver behaviour just before an accident and the kinds of manoeuvres people make during the accident itself. They will also look at fatigue and how this affects people's ability to drive.

In Europe, there are a few naturalistic driving studies at national levels. The PROLOGUE project is currently investigating the feasibility of running a larger, Europe-wide project. 'The ultimate aim is to find out which topics are of most interest to Europeans – industry, scientific organisations and road authorities – and see if we can make a plan and find support to do this large-scale study in Europe,' says Mr Eenink.

Meanwhile, the 2BESAFE project is planning the world's first naturalistic driving study involving motorbikes. The study will cover a small number of bikes in four countries. Instruments attached to the bike will gather data on accelerations, speed, brake use, the rider's location (via GPS – Global Positioning System) and use of the indicators. In addition, video cameras will capture film of the driver's face and where the driver is going.

In addition, the team is carrying out detailed analyses of around 400 accidents with a view to identifying the causes of the accidents and factors influencing the severity of injuries experienced by the rider. Part of the project is investigating the impact of road design on motorbike safety, and how the state of the road is influenced by the weather. In addition, 2BESAFE is studying riders' perceptions and acceptance of risk.



PROLOGUE
Towards a major naturalistic driving study in Europe

The PROLOGUE project is investigating the possibility of carrying out a large naturalistic driving study in Europe. The naturalistic observation method allows researchers to observe road users in an inconspicuous way by equipping passenger cars with devices that continuously monitor various aspects of driving behaviour. On the basis of a number of small-scale field trials across Europe and in Israel, PROLOGUE will develop recommendations and an outline for a large-scale naturalistic driving study in Europe, dealing with questions such as how to best manage the collection, storage and analysis of data.

Promoting real life observations for gaining understanding of road user behaviour in Europe

Coordinator | Institute for Road Safety Research – SWOV (the Netherlands)

Total budget | EUR 2.5 million

EU funding | EUR 2 million

Start/end | 01/08/2009 – 31/07/2011

Website | http://www.prologue-eu.eu/

2BESAFE
A two-wheeled view of road safety

Motorbike and moped users are at greater risk of injury and death than other road users. The goal of the 2BESAFE project is to find out why and come up with recommendations for practical measures that could improve road safety for this vulnerable group. The project is carrying out the world's first ever naturalistic driving study on motorbikes, and the results should provide new insights into the behaviour and performance of powered two-wheelers and their interactions with other road users in both normal and emergency situations.

2-wheeler behaviour and safety

Coordinator | ERT – European Research Transport (France)

Total budget | EUR 5.5 million

EU funding | EUR 3.8 million

Start/end | 01/01/2009 – 31/12/2011

Website | http://www.2besafe.eu

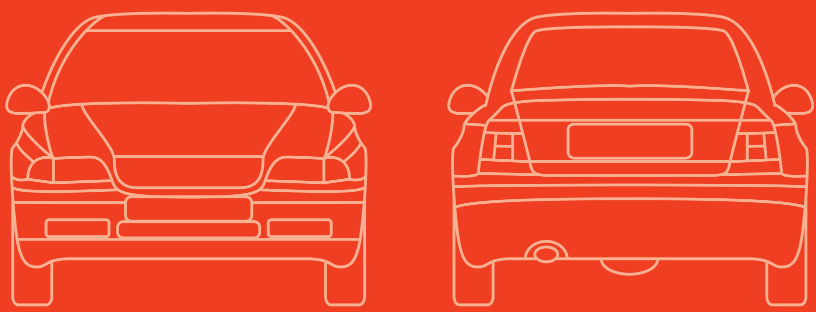
CHAPTER 7

Conclusions and the way forward

In recent years, the EU has made great strides in road safety. Nevertheless, thousands of people are still killed or injured on Europe's roads every year. More research is urgently needed to make our roads safer, especially for vulnerable groups such as pedestrians, cyclists and motorcyclists, who face a much greater risk of fatality than car passengers.

In 2001, the EU set itself the target of halving the number of deaths on its roads by 2010. Despite efforts in many areas, road safety has not improved fast enough and the EU will struggle to meet its 2010 target before the middle of the decade.

Factors that are likely to hinder further improvements in road safety are the rising number of vulnerable road users; the ongoing problem of accident incompatibility between vehicles; the growing number of elderly road users; and a general increase in mobility demand, particularly in urban areas. All of these issues mean that road safety will remain a major challenge in the coming decade.



The EU's future road safety strategy

The European Commission is currently working on the Fourth European Road Safety Strategy (2011-2020), which will build on the ambitious objectives of the Third European Road Safety Action Programme (2003-2010). In the new strategy, the European Commission will propose actions designed to address existing shortcomings in the road safety arena and respond to new societal developments that affect road safety.

Research is set to be a central plank of the new strategy. As the examples in this brochure demonstrate, research has already contributed to significant improvements in road safety. Thanks to advances in passive safety, car drivers and passengers are now protected by vastly improved seatbelts and airbags, while the frontal structures of cars have been modified to reduce the severity of collisions with pedestrians and cyclists. For motorcyclists, improved crash helmets provide enhanced protection against brain damage.

In the active safety field, a number of advanced driver assistance systems (ADAS) and in-vehicle information systems (IVIS) are already on the market. Examples include Electronic Stability Control (ESC), lane departure warning systems and satellite navigation systems. Looking to the future, cooperative systems and intelligent transport infrastructures have the potential to improve road safety still further.

The future of road safety research

Between now and 2020, the road safety research community should continue to take an integrated approach to the issue, combining accidentology and emergency management with efforts to develop novel passive and active safety features, as well as safer infrastructures and cooperative systems. This approach will broaden the scope of road safety work beyond the vehicle itself to take in the way drivers receive and respond to information on the road and the traffic around them.

Future research should focus on the development of technologies that will enhance drivers' awareness of road safety risks and help them take decisions that will increase road safety. New technologies are also needed to help drivers control their vehicles.

Advanced vehicle safety features could be significantly improved by the development and integration of new sensor systems. Sensors provide information on what is going on in the immediate vicinity of the vehicle. Intelligent infrastructure technologies are therefore also needed to give drivers safety-related information on the broader road infrastructure and traffic situation.

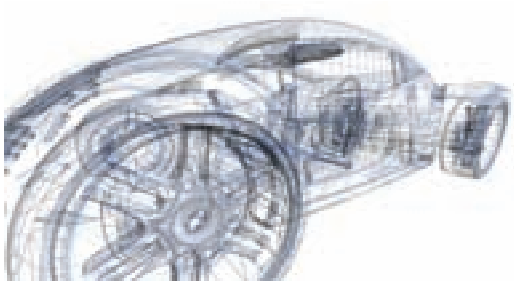
Another priority for future research should be on virtual testing. Virtual testing methods could play a greater role in the design of vehicle structures and restraint systems in future years. As well as being cheaper than physical test methods, they open up the potential to test a much wider range of crash scenarios involving road users of different genders, ages and sizes.

The human touch

Future research should include a strong focus on the human-related aspects of road safety. For example, new technical solutions are needed to improve the protection of vulnerable road users (e.g. cyclists, motorcyclists, pedestrians) during collisions. Inside vehicles, restraint systems need to be developed that provide optimal protection for both male and female car occupants of all shapes, sizes and ages. Refining these systems will require advanced crash test dummies. To develop these dummies, researchers will need to investigate in ever greater detail the way the human body reacts in different kinds of accidents.

Driver error is a leading cause of accidents, and large-scale driver monitoring studies will shed new light on precisely how different aspects of driver behaviour contribute to accidents. Improvements are also needed in driver training programmes; this will help drivers remain alert to risks on the road and maintain control of their vehicles.

Finally, research in the human-machine interface area must highlight systems that can adapt to specific situations and user groups so that drivers get relevant safety-related information at the right time.



New vehicles, new road safety challenges

Rising environmental concerns mean that electric vehicles are likely to become an increasingly common sight on Europe's roads in the not-too-distant future. Yet these novel cars pose novel challenges for road safety. The large battery pack in particular could represent a threat to the safety of both passengers and the emergency services in the aftermath of an accident. There are also questions regarding the crashworthiness of electric cars, which are generally smaller and lighter than conventional cars.

The near-silent nature of electric vehicles represents an additional risk for road safety. Inside the vehicle, inexperienced drivers may not realise how fast they are travelling, while outside, cyclists and pedestrians may simply fail to hear them coming.

From the lab to the road

Across Europe, researchers are busy developing new and exciting systems that have the potential to advance road safety in myriad ways. Yet these technologies will only deliver real progress on road safety if they are made available in vehicles and on our roads. Research must therefore be accompanied by user tests and cost-benefit analyses to help regulatory authorities and consumer testing organisations prioritise different options for action.

Meanwhile, one thing is clear: more research is vital if the EU wants to make further strides in road safety over the coming decade. Thousands of lives depend on it.

European Commission

EUR 24500 — EU at the steering wheel of Road Safety,
EU-funded research to make Europe's roads safer

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Road safety is a major priority for the EU, and since 1994 the EU has invested over EUR 500 million in road safety research.

This brochure offers a snapshot of European road safety research, and explains how the results of EU-funded projects are already helping cut the numbers of deaths and injuries on our roads.

The projects profiled cover all aspects of road safety, including studies into the causes of accidents, the development of better crash test dummies, research on child safety, driver behaviour studies, and research into the best road layouts and road infrastructures. In addition, many projects involve the design of novel technologies to prevent accidents from happening in the first place, or reduce the impact of accidents when they cannot be avoided.

Meanwhile, many of the projects featured are still in their early stages, so this brochure gives an exciting insight into the state of the art in road safety research and provides a glimpse of the road safety technologies and systems we can expect to see on our roads in the coming years.

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