eSafety

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Summary

Vehicle technologies and road casualty reduction

Vehicle safety is a key strategy used to address ambitious targets for a safer road traffic system. Secondary safety technologies continue to deliver large savings; primary safety technologies are starting to contribute to casualty reduction and hold potentially large future promise. At the same time, new in-vehicle technologies under development have the potential to increase as well as decrease crash injury risk. Currently, there is uncertainty amongst road safety experts about the safety effects of some of the technologies that are being promoted widely in the name of safety. At the same time, more promising safety technologies, where benefits have been demonstrated, are being promoted or taken up at a lesser rate. Further research is needed urgently

eSafety – a definition

eSafety is defined here as a vehicle-based intelligent safety systems which could improve road safety in terms of exposure, crash avoidance, injury reduction and post-crash phases. This text discusses a variety of measures which are being promoted widely as 'eSafety' measures, the knowledge about which is slowly evolving, including information on the costs and benefits of measures.

eSafety measures – safety effects known

The evaluation of eSafety measures is a young science. However, research in the EU and elsewhere has confirmed that the following measures could make a large contribution to efforts to meet ambitious safety targets: Intelligent Speed Adaptation (advisory ISA, Speed Alert); seat belt reminders in all seating positions in new cars, electronic stability control, alcolocks for repeat offenders and fleet drivers, and event and journey data recorders. All are at different phases of implementation. In some cases, the safety effects of measures are known e.g. anti-lock braking in car, but the available evidence does not indicate clear safety benefits.

eSafety measures – safety effects unknown

Systems such as electronic driving licences and eCall hold promise. In general, most of the devices for improvement of braking and handling interfere with driver behaviour, and the questions of driver acceptance, risk compensation and driver reaction when the system is activated are important. Brake Assist, for example, is often cited as an eSafety measure, but its contribution to road safety is unknown. Collision Avoidance systems offer future promise and are receiving much attention, but will systems under development work in practice? Will systems address key safety problems and, if so, will the benefits be greater than other alternatives which have less active promotion?

EC and national initiatives

Since 2000, the EU institutions have played an active role in promoting eSafety policy and research. Sweden has been particularly active in promoting evidence-based eSafety measures in the national fleet and their approach should be taken up widely. The EU should encourage the early implementation of systems which have proven safety benefits and give priority in long-term development to systems that have significant potential to improve safety. Above all, the EU and Member States should establish a monitoring system to evaluate the design, development and implementation of new in-vehicle technologies and their short, medium, and long-term impacts on road safety.

Predicting casualty reduction

Although some aspects of this are being addressed within the research domain there is no accepted, systematic approach to predict the impact on safety of a new system. This is an essential component of any benefits analysis. An accepted, routine approach is now required.

Evaluating measures

A clear framework is needed urgently to identify, evaluate, deliver and monitor technologies which improve safety and to identify and discontinue work on those which cost lives. Measures described as eSafety measures; need to be demonstrably effective safety aids before they are introduced widely.

Consumer information

There is no information source that is readily available to the public to indicate whether the system offers large safety benefits or whether the system addresses other aspects of driving. A consumer information programme would be useful and should be developed.

1. Vehicle technologies and road casualty reduction

Vehicle safety is a key strategy used in addressing international and national road casualty reduction targets to achieve a safer road traffic system. Vehicle safety addresses the safety of all road users and currently comprises measures for crash avoidance (or primary safety) or reduction of injury in the event of a crash (crash protection or secondary safety). In-vehicle and advanced driver assistance systems which aim to reduce exposure to risk and assist post impact care are also envisaged for future application.

Primary safety systems

Driver behaviour can modify the performance of primary safety systems and the human-machine interface needs to be assessed. There is large future promise of casualty reduction from primary safety technologies, as long as development is prioritised to provide maximum casualty reduction.

Secondary safety systems

Substantial and evidence-based improvements have been made in the last 20 years and research has identified continuing large scope for enhanced vehicle safety. Further implementation of existing secondary safety technology provides the best opportunity for saving lives in the short term and new crash protection technologies hold much future potential.

New technologies for road safety have collectively been known as Intelligent Transport Systems (ITS) and transport telematics (although these cover a wide range of road and vehicle based systems), advanced driver assistance technologies and, more recently, *eSafety,* to reflect increasing use of electronic and telecommunication technology within the road transport sector. However, as the European Commission notes, "*not all new technologies for cars are for safety; they can be for comfort, professional use, traffic management. Safety is a precious public good; there may be a temptation to declare technologies as safety technologies to get policy makers interested in promotion and funding, while the normal business case should prevail*." [50]. New in-vehicle technologies have the potential to increase risk as well as decrease crash and injury risks [41].

Examples of new in-vehicle technologies	
Electronic Stability Control	Active Cruise Control with emergency brake
Blind Spot Monitoring	Brake Assist
Adaptive Headlights	eCall
Obstacle And Collision Warning	Advance hazard warning
Lane Departure Warning	Seat belt reminders

While many predictive studies on *eSafety* have been carried out, research on the effects of systems in practice is few and far between. Ongoing studies include TRACE, eIMPACT, PREVENT. Results of studies carried out to date are available on the safety effects website, www.esafety-effects-database.org and it is important that such resources are kept up to date. These studies utilise a variety of approaches and it is necessary to evaluate the statistical robustness of the approaches used.

While attempts have been made to classify the impacts of *eSafety* measures (including advanced driver assistance measures), it is acknowledged to be a young science [25][1][45][47]. While systems are under development, they are not yet mature. Before measures are described as *eSafety* measures, positive safety performance needs to be demonstrated before they are introduced widely.

Based on current knowledge (albeit limited) about safety impacts and feasibility, this site accordingly discusses measures in two broad groups:

- *eSafety measures - safety effects known*
- *eSafety measures – safety effects unknown*

The measures selected for discussion are those which are being promoted widely as '*eSafety*' measures, the knowledge about which is slowly evolving, including information on the costs and benefits of measures.

A clear framework is needed urgently to identify, evaluate, deliver and monitor new *eSafety* technologies.

2. eSafety - a definition

Safety professionals understand *eSafety* as vehicle-based intelligent safety systems which could improve road safety in terms of reducing exposure to risk, crash avoidance, injury reduction and automatic post-crash notification of collision.

3. eSafety measures - known safety effects

A wide variety of *eSafety* technologies are in use today, some of which are fitted to vehicles increasingly as standard equipment. Research on seat belt reminders, alcohol interlocks, intelligent speed adaptation (ISA) and electronic stability control (ESC) indicates that these measures offer significant safety potential. These technologies now need efforts from policymakers to ensure their rapid application and deployment.

3.1 Intelligent Speed Adaptation (ISA)

What is ISA?

ISA is a system which informs, warns and discourages the driver to exceed the statutory local speed limit. The in-vehicle speed limit is set automatically as a function of the speed limits indicated on the road. GPS allied to digital speed limit maps allows ISA technology to continuously update the vehicle speed limit to the road speed limit. There are three types of ISA:

Informative or advisory ISA gives the driver a feedback through a visual or audio signal. A Speed Alert System is an informative version of ISA; it is able to inform the driver of current speed limits and speeding.
Supportive or warning ISA increases the upward pressure on the accelerator pedal. It is possible to override the supportive system by pressing the accelerator harder.
Intervening or mandatory ISA prevents any speeding, for example, by reducing fuel injection or by requiring a "kick-down" by the driver if he or she wishes to exceed the limit.

What road safety problem does ISA address?

Excess speed contributes to around 30% of fatal crashes [51]. Typically 40% to 60% of the drivers exceed the limit. Results from a wide range of studies indicate that reducing average speeds by just 1km/h can result in a 5% reduction in fatal crashes.

How effective?

The EU-funded and SRA co-ordinated project PROSPER looked into ways that advanced assisted driving technology and technology relating to speed limitation devices can improve safety, and also at the barriers for the implementation of ISA. The PROSPER project calculated crash reductions for six countries. Reductions in fatalities between 19-28%, depending on the country, were predicted in a market-driven scenario. Even higher reductions were predicted for a regulated scenario – between 26-50%. Benefits are generally larger on urban roads and are also larger if more intervening forms of ISA are applied [11]. Trials with ISA have been carried out in ten European countries: Austria, Belgium, Denmark, Finland, France, Hungary, The Netherlands, Spain and Sweden [19]. An earlier study in the Netherlands showed that ISA could reduce the number of hospital admissions by 15% and the number of deaths by 21% [35]. Research has shown that ISA and physical measures to reduce road speed are complementary rather than competing methods [39].

Benefits to cost?

Benefit to cost ratios ranging from 2.0 to 3.5 and 3.5 to 4.8 were calculated in the PROSPER project for the two scenarios: market driven and regulation driven. The costs were based on the premise that by 2010, all new vehicles will come with a satellite navigation system [11].

Other benefits?

Other ISA benefits have been identified as fuel savings, CO2 savings and the potential to *reduce* journey time (managed motorways; reduction in incidents).

Who uses ISA now?

While trials and further experimental studies are being carried out in Norway, the Netherlands and the UK, large-scale demonstration has only been implemented in Sweden.

Sweden's National ITS Strategy for 2006-2009 targeted better speed compliance as one of four ITS road safety initiatives national and internationally with its Nordic partners. Sweden sees the establishment of speed limit data base, the targeting of the road transport industry and the introduction of in-house policies as essential first steps.

Swedish ITS Strategy ISA Targets: Proposals made in 2006 and progress to date
In 2006 the SRA will provide quality assured speed data on the state and municipal road network across Sweden. *This data has been provided according to plan.*
The SRA and seven other parties, such as city municipalities, transport purchasers and transport providers, will in 2006 introduce support systems for speed compliance or similar systems in their own and leased vehicles as new vehicles are acquired. *Today 60-80 organisations have implemented speed alert systems; in total 2000-3000 units.*
In 2006 there will be an agreement at a Nordic ministerial level to support a greater implementation of ISA. This should be based on the Swedish focus for implementation. Cross-border ISA on a selected number of Nordic corridors will be shown by 2009 at the latest. *Cross-border testing has been carried out and further tests are planned within the European TeleFOT-project. The Norwegian road administration plans to implement SpeedAlert in their own vehicles.*
At least three suppliers of vehicle equipment should offer support systems for speed adaptation to commercial vehicles by 2007. *There are 5-8 suppliers to date.*
In 2007, leading market players (content providers) will be handling speeds from the National Road Database (NVDB). *Speed data from NVDB is being provided to leading market players.*

Future use?

Different trials using informative and supportive systems across Europe have shown that approximately 60-75% of users would accept ISA in their own cars. A MORI poll in the UK carried out for the FIA Foundation in 2002 indicated 70% support for warning ISA in urban areas with 58% in support of non-overidable limiters on residential streets if that meant road humps would be removed. One has shown that 73% of drivers reported being more positive towards ISA after using it [3]. Lahrmann, Madsen and Boroch [32] reported that 15 out of 20 drivers became more favourable to using ISA after experiencing the system

Next steps for implementation?

While positive benefits to cost have been identified for ISA, number of criticisms of ISA have hindered widespread implementation. A review - Intelligent speed assistance – myths and reality – discussed 'myths' regarding ISA and argues that ISA (and Speed Alert) technologies can work reliably [19].

An EU-funded SpeedAlert project co-ordinated by ERTICO was set up in 2004 to harmonise the in-vehicle speed alert concept definition and investigate the first priority issues to be addressed at EU level, such as the collection, maintenance and certification of speed data.

While there is considerable public support for ISA, an implementation strategy is needed to speed up the process of implementation of ISA in vehicles [39]. This should include the development of speed limit maps by European, national and regional authorities (to date, Sweden and Finland have established speed limit databases although these are under development in the UK and the Netherlands). Also, awareness of ISA / Speed Alert has to be created. Authorities and organisations (e.g. fleet owners) can act as forerunners by implementing ISA in their vehicle fleets. Last but not least, further harmonisation activities are needed on the international level.

3.2 Seat belt reminders

What are they?

Seat belt reminders are intelligent, visual and audible devices that detect whether seat belts are in use in various seating positions and give out increasingly urgent warning signals until the belts are used. Based on the Swedish experience, the European Enhanced Vehicle-Safety Committee (EEVC) Working Group recommended in 2002 that [30]:

- Seat belt reminders should target part-time users, i.e. people who understand the value of a seat belt but sometimes do not use it.
- They should not affect the driveability of the vehicle.
- A combination of visual and sound signals should be used.
- The reminder signal should use multiple steps, i.e. build up progressively.
- Seat belt reminders should also be expanded to the rear seats

EuroNCAP has developed a seat belt reminder protocol along these lines (though requiring only a visual signal for the rear seat in the absence of seat occupancy information) and encourages their installation. Cars meeting the specification receive points which contribute to the star rating.

What road safety problem do they address?

Research studies indicate that the risk of dying in a crash could be reduced by about 60% by using the seat belt and by more, when belts and air bags are combined (WHO 2004). While most drivers in EU countries wear seat belts in the fronts of cars, a significant proportion involved in crashes are unrestrained, even in countries with highest seat belt use. Seat belt wearing levels in the rear seat are not high in most EU countries [21].

How effective?

User trials and research in Sweden and the United States have shown that seat belt reminders with advanced reminder systems with visual and audible warnings were the most effective systems for increasing seat belt use [21].

A Swedish study examined differences in driver's seat belt use in cars with or without different reminder systems and found that 99% of drivers used their seat belt in cars with the most advanced reminders (in compliance with EuroNCAP criteria), 93% of drivers used their seat belt in cars equipped with "mild" reminders producing a visual and soft sound signal, 82% of drivers used their seat belt in cars without seat belt reminders.

Earlier US studies found a 7% increase in seat belt use among drivers of cars with seat belt reminders, compared with drivers of unequipped vehicles (Williams et al, 2002). A driver survey found that of the two thirds who activated the system, three quarters reported using their seat belt and nearly half of all respondents said their belt use had increased [57].

Seat belt reminders can help part-time users to develop habits of belt use. But they are likely to have little effect on hard-core non users who actively choose not to buckle up. More aggressive solutions, such as interlock systems, may be needed to encourage this small but important non user group to belt up [21].

Benefit to cost?

A cost-benefit analysis for the mandatory introduction of audible seat belt reminders for front seats in 2004 was undertaken by ETSC in 2004. It was based on the assumption that roughly 50% of fatally injured front seat car occupants killed in the EU did not wear seat belts and that audible seat belt reminders for the front seat could increase seat belt wearing among front seat occupants to 97%. After twelve years of introduction, the costs would amount to about 11 million Euro while the benefit would be 66 million Euro. The benefit to cost ratio of seat belt reminders was estimated at 6:1 [18]. A Belgian study by the Belgian Policy Research Centre for Traffic Safety has found that a seat belt reminder system would be beneficial to society even if it prompted only 5-15% of non users to fasten up over a period of ten years [7].

Who uses them?

Of all new cars tested by EuroNCAP since 2003, over 70% are fitted with seat belt reminders. Around 80% of new cars sold in Sweden in 2006 were fitted with seat belt reminders. Sweden has created a demand for this safety equipment nationally through its own in-house safety policy for staff travel and as one of the safety requirements of its road transport contracts. By 2010, the Swedish policy is that all new cars sold in Sweden should have seat belt reminders

Next steps for implementation?

There have been calls for the mandatory fitment of seat belt reminders in all seats in Europe, given the great potential of this technology. In 2005, the CARS 21 High Level Group included EU regulation on seat belt reminders in its 10 year road map for the automotive industry in Europe.

Recommendations of the European Transport Safety Council (ETSC, 2006)

European Commission

- The European Commission should include seat belt reminders to type approval in its CARS 21 Communication outlining the regulatory framework for the next 10 years.
- The European Commission should then adopt legislation according to this timetable to ensure that every new car has as standard equipment an enhanced seat belt reminder system for front and rear seat occupants with audible and visual warnings.

Member States

- Until all cars are equipped, Member States should provide, in co-operation within the EU, tax breaks for cars with seat belt reminders.
- They should encourage motor insurers to lower insurance premiums for drivers of vehicles with seat belt reminders.
- They should run campaigns informing drivers of the benefits of this technology.

Vehicle Manufacturers

- Vehicle manufacturers should continue to introduce seat belt reminders to new models.

The European Transport Safety Council has called for their installation to be extended to all front seats, then to back seats. In parallel, retro-fitting of vehicles with seat belt reminders to all seats should be introduced [21].

The SUPREME project reports that ACEA, the European Automobile Manufacturers Association, has expressed its commitment to continue to equip progressively passenger cars of categories M1 and commercial vehicles with seatbelt reminders for the driver's seat believing that the majority of new models will be equipped accordingly by 01.01.09 at the latest and of new vehicles by 01.01.10 at the latest. ACEA will also provide on a regular basis statistics regarding the availability of seatbelt warning on vehicles registered in the EU.

3.3 Electronic stability control

What is Electronic Stability Control (ESC)?

Electronic stability control (ESC) is an active safety system which can be fitted to cars, buses, coaches and trucks. It is an extension of antilock brake technology, which has speed sensors and independent braking for each wheel. It aims to stabilise the vehicle and prevent skidding under all driving conditions and situations, within physical limits. It does so by identifying a critical driving situation and applying specific brake pressure on one or more wheels, as required. If necessary, the engine torque is also adjusted automatically (SUPREME).

What road safety problem does ESC address?

ESC addresses the problem of skidding and crashes due to loss of control of vehicles, especially on wet or icy roads or in rollovers.

How effective?

Evaluation studies have shown that the fitment of ESC in cars can lead to substantial reductions in crashes, deaths and serious injuries. A Swedish study in 2003 showed that cars fitted with ESC were 22% less likely to be involved in crashes than those without. There were 32% and 38% fewer crashes in wet and snowy conditions respectively [48]. In Japan, a study showed that electronic stability reduced crash involvement by 30-35% [2]. In Germany, one study indicated a similar reduction while another showed a reduction in 'loss-of-control' crashes from 21% to 12% [8]. UK research indicates that equipping a vehicle with ESC reduces the risk of being involved in a fatal crash by 25%. The research also shows a particularly high effectiveness for reducing serious crashes involving other loss of control situations such as skidding (33%), and rollover (59%) [23]. Research at the US Insurance Institute for Highway Safety (2006) found that ESC led to a reduction rate of 32% of the risk of fatal multiple vehicle crashes and a reduced risk of single vehicle crashes by more than 40% (of fatal ones:56%). It is estimated that equipping all vehicles with an ESC system could save over 500 deaths and 2500 serious injuries per year in the European Union alone (FIA Foundation, 2007).

Benefits to cost?

A Norwegian benefit to cost analysis considered two scenarios for ESC fitment [16]. The first was that ESC continues to be fitted gradually through the vehicle fleet, but is not made mandatory. The benefit-cost ratio in this scenario was estimated to be 4. The second scenario was ESC retrofitted on all cars of whatever age producing a benefit-cost ratio of about 0.4.

Who uses ESC now?

ESC has been on the market since 1995 and is standard equipment in many cars of the middle and upper price classes, but not yet in smaller cars. A country fitment rating is published by EuroNCAP which promotes its fitment as an important safety device. Sweden has been foremost in the national promotion of ESC and in 2006 over 90% of new cars sold in Sweden were fitted with electronic stability control.

Next steps for implementation?

An international group of experts has been set up to agree a harmonised technical specification and test method for a Global Technical Regulation (GTR) on ESC systems intended to be fitted to cars and light vans. In November 2007, the United Nations announced it would require trucks and heavy vehicles to be fitted with anti-skid Electronic Stability Control (ESC) from 2010, as a result of a new agreement reached in Geneva. The new regulation drawn up by the United Nations Economic Commission for Europe (UNECE) promotes the harmonisation of standards globally. Similar requirements for passenger cars are expected to be agreed next year.

The Australasian New Car Assessment Programme has announced that only vehicles with ESC will be given five stars from 2008 onwards. In the US, legislation was passed in 2007 making ESC mandatory standard equipment for all passenger cars, multipurpose vehicles, trucks and buses with gross vehicle rating of 4,536 kg or less from model year 2012.

3.4 Alcolocks

(See also Alcohol webtext)

What are alcolocks?
Alcolocks or alcohol interlock systems are automatic control systems which are designed to prevent driving with excess alcohol by requiring the driver to blow into an in-car breathalyser before starting the ignition. The alcohol interlock can be set at different levels and limits.

What road safety problem do alcolocks address?
Excess alcohol contributes to about 25% of all road deaths in Europe. A large part of the problem consists of 'high risk offenders' who offend regularly and/or exceed legal blood alcohol levels by a large amount. With a BAC of 1.5 g/l the crash rate for fatal crashes is about 200 times that of sober drivers. In some countries e.g. Britain, levels of police enforcement of legal limits has dropped in recent years, leading to increases in drinking and driving. Alcolocks address excess alcohol in the driving population at large, as well as repeat offenders.

How effective?
Large scale quantitative research on alcohol ignition interlocks in use has shown that alcolocks are 40 to 95 percent more effective in preventing drink driving recidivism than traditional measures such as license withdrawal or fines [45]. A literature review (UK Department for Transport, 2004) showed a recidivism reduction of about 28-65% in the period where the alcolock is installed compared with the control groups who were not using the alcolock. An EU study indicated that alcolocks need to be fitted permanently to have an effect, for after removal of the lock recidivism increases again [5]. Alcolocks clearly have an important role to play within rehabilitation programmes.

There has been no evaluation of the impact that alcohol interlocks used in commercial transport have on road safety but Swedish companies report that fitting alcolocks prevented excess alcohol amongst fleet drivers.

Benefits to cost?
In a recent cost benefit analysis, estimations are made for implementing alcolocks for drivers caught twice with a BAC between 0.5g/l and 1.3g/l and for drivers caught with a BAC above 1.3g/l in several countries [55].

Benefits to cost of alcolocks in different countries [55]
• For the **Netherlands**, the reduction of 35 traffic fatalities annually is valued at 4.8 million per death, leading to a benefit of 168 million Euros.Benefit/cost ratio =4.1 • For the **Czech Republic**, the 8 fatalities prevented are counted at 1.1 million Euro/death, leading to estimated benefits of 9 million Euro/year. Benefit/cost ratio = 1.6 • For **Norway**, the benefits are calculated as 5.5 deaths less per year a rate of 5.9 million Euro per death, or at 32.5 million Euro /year. Benefit/cost ratio =4.5 • For **Spain**, the reduction with 86.5 deaths/year at 800.000 Euro per death would imply benefits of 69 million Euro/year. Benefit/cost ratio = 0.7

Who uses alcolocks now?

These have been used widely in North America and Sweden in rehabilitation schemes for repeat offenders driving with a blood alcohol content over the legal limit. They are also used in government and company fleet cars in Sweden. Trials have been taking place in various countries such as the US, Australia, Canada, Belgium and Sweden.

Alcolock policy and practice in Sweden

In a trial running from 1999 to 2002 in Sweden, 300 alcolocks were installed in commercial passenger and goods transport. Subsequently, manufacturers such as Volvo and Toyota offer installation of alcohol interlocks in trucks as a dealership option in Sweden. One transport company in Sweden decided to equip all their 4000 vehicles with alcohol interlock systems before the end of 2006. From 2006 all trucks of 3.5 tons and over, which are contracted by the Swedish Road Administration (SRA) for more than 100 hours per year, have to be fitted with alcohol interlocks (SRA, ITS Strategy, 2006-9).

More than 5000 company cars in Sweden are today equipped with alcohol interlocks and the number is growing rapidly. The Swedish Driving Schools Association has fitted all their 800 vehicles with alcohol interlocks [31]. In 2007 Volvo launched an alcohol interlock for normal use in cars.

In 2004 the SRA required that all the SRA's purchased or leased vehicles must be equipped with alcohol ignition interlocks during 2008 at the latest. By 2010, 50% of all new cars used by companies in Sweden should have alcolocks [46].

Next steps for implementation?

Sweden has recently introduced a strategy on alcolocks and the rehabilitation of offenders and has proposed that from the year 2012, all new cars should have an alcohol ignition interlock installed. However, Sweden is the only EU Member State that uses alcohol locks at present, even in rehabilitation programmes, although experiments are being carried out in Spain, Belgium, Germany, and Norway. More widespread application will require a technical specification to be devised for alcolocks as well as debate about their use, whether for rehabilitation or in normal use.

3.5 Black boxes/ in-vehicle data recorders

What are black boxes or in-vehicle data recorders?
These devices can be used in cars and commercial transport as a valuable research tool to monitor or validate new safety technology, to establish human tolerance limits and to record impact speeds.

Black boxes can also be used to influence driving behaviour and facilitate forms of automatic policing (100% surveillance of all traffic offences). Offenders can be tracked more easily and fined automatically by means of devices such as Electronic Vehicle Identification – See EVI website. At the same time the system can be used to reward safe behaviour [42] and to reduce insurance premiums [59].

Two types of in-vehicle data recorders are currently used: **crash data recorders** and **journey data recorders**.

3.5.1 Crash data or event data recorders

These collect data over a period before and after the crash. They are often based on the airbag control module and will cease to store information once the airbag has deployed [33].

What road safety problem do they address?
These devices are an important monitoring and research tool for road safety management, as illustrated below.

Usefulness of event data recorders or crash recorders [30]

- Increased quality of accident data
  - Increased accuracy of data
  - Possibility to use information previously not possible to obtain
- Better evaluation of new safety technology
- Knowledge of injury thresholds for the design of a crashworthy road transport system
- Better understanding of injury causes and injury mechanisms
- Influence on accident involvement risk?
- Useful from legal aspects (insurance)
- Information used for ”e-Call” systems
- Pre-crash data to investigate collision causation - Evaluation of active safety systems
- Crash data to investigate crashworthiness
  - Evaluation of interior safety systems
  - Calculation of injury risk versus impact severity
- Crash reconstruction

How effective?
Data recorders as enforcement devices. Research indicates that data recorders fitted to trucks and vans lead to an average reduction of 20% on the number of crashes and damage [59]. The effect derives from the driver’s knowledge that traffic law infringements can in principle be detected by examination of the driving records.

Value of crash data recorders based on past experience [53]
▪ Significant improvement in crash reconstruction ▪ Legal security ▪ Attentive driving ▪ Direct or indirect reduction in crashes and damages ▪ Reduction of fuel consumption and vehicle maintenance ▪ Real data for vehicle safety design ▪ Real data for tuition and training ▪ Legal (data privacy) concerns that can be overcome ▪ Limited interest from original equipment manufacturers in Europe
Main aims of event data recorders based [53] VERONICA recommended that the main purpose of event data recorders is to : ▪ Provide reliable information ▪ On vehicle crash causation ▪ Via wireless format in the vehicle ▪ For further processing by certified experts ▪ For dedicated road safety, legal, security and crime fighting application

Data recorders as research tools
The increasing use of intelligent systems means that it is increasingly difficult to assess the performance of systems in crashes. Dual-stage airbags have been fitted to cars for several years yet it is not possible to assess the level of deployment without stored data. Similarly there are many intelligent primary safety systems entering the market and it will only be possible to assess the impact on safety at a detailed level if there is stored data on their operation. Finally, while all restraint systems are tuned to a particular range of crash acceleration pulses, derived from barrier tests, we need crash pulse information from real-world studies and only crash recorder data can supply this.

Benefits to cost:
The benefits and cost ratios of Crash Data Recorders have been estimated for the Netherlands [33].

Who uses them?
Crash Data Recorders have been used for many years in cars and commercial transport. In the US, the car manufacturer GM has been using them since the 1970s to evaluate the performance of airbags in crashes. In the UK, police fleet cars have been fitted with black boxes. In Germany a crash recorder called UDS by Mannesmann/VDO has been on the market for more than 15 years.

Examples of event data recorder use in "large fleet" projects [30]
▪ Since 1990s - GM and Ford cars (more advanced in late 90s) ▪ Since 1995 - Volvo DARR in Volvo cars – approx 500,000 cars fitted- and in Saab cars ▪ Since 1992 - Folksam CPR project - 220.000 cars fitted with Crash Pulse Recorders ▪ Since 1995 - UDS in Austria, Switzerland and Germany

Next steps for implementation?
The EC project VERONICA made various recommendations on the next steps for implementation of Crash Data Recorders in the EU. The project reviewed the standardisation of procedures and tools to retrieve the data, the use of the data collected (for crash research, by the police to check driving conditions, or in legal applications to help in the determination of the responsibilities in a crash) and questions concerning the ownership of the data. It recommended the targeting of various road user groups, commencing with the commercial transport sector. It recommended that a UN ECE Working Group be established to prepare a technical specification. It was further recommended that the EU should introduce a Directive rather than a Regulation to give Member States flexibility in implementing Crash Data Recorders.

Target groups for use of event data recorders from the enforcement and insurance points of view [53]

- Hazardous goods transport
- Coaches and buses
- Commercial vehicles
- Vans
- Emergency service vehicles
- Motorcyclists
- Young drivers

It is important to ensure that data from recorders will be collected and stored in such a way that it is available to designers of both cars and road-side objects, and especially to the responsible bodies for the road transport system [30].

3.5.2 Journey data recorders

These collect data during driving. Journey data recorders can provide information regarding driving behaviour and any law infringements, they can be used to monitor driving in relation to insurance costs and the information can be used for traffic management purposes. They can also be an important source of research data regarding the risks of normal driving and the nature of traffic conflicts.

***Benefits to* cost?**
The benefits and cost ratios of Journey Data Recorders have been estimated as 20:1 for the Netherlands [33].

Who uses them?
Tachographs are used in commercial vehicle use to monitor drivers hours of work, speeds and to track cargo. One further example in use is the SAGA system developed in Iceland, which allows for monitoring and reporting on vehicle position and use, speeds relative to posted limits as well as other aspects of driver behaviour. The system is currently used in vehicle fleets of 70 companies leading to significant registered reductions in crashes [38].

Next steps for implementation?
The OECD and ECMT addressed the issue of how journey data recorders might be employed to reduce young driver risk and concluded that economic incentives such as lower insurance premiums could be employed to encourage their use [38]. In addition it was suggested that parents might be able to insist that certain technology be placed in vehicles used by their children.

3.6 Anti-lock braking systems in cars (ABS)

What are anti-lock braking systems (ABS)?

The main purpose of ABS is to prevent skidding where loss of steering and control result from locked wheels when braking hard. Such systems are now fitted to many new cars. This is intended to provide additional steering in the emergency situation, not to decrease stopping distances.

Casualty reduction effect?

A meta-analysis of research studies shows that ABS give a relatively small, but statistically significant reduction in the number of crashes, when all levels of severity and types of crashes are taken together. There are statistically significant increases in rollover, single-vehicle crashes and collisions with fixed objects. There are statistically significant decreases in collisions with pedestrians/ cyclists/ animals and collisions involving turning vehicles. ABS brakes do not appear to have any effect on rear-end collisions. However, while injury crashes decrease (-5%), fatal crashes increase (+6%) [15]. A recent study, however, indicates that anti-lock brakes may not contribute to crash prevention at all [13].

As with other forms of braking, the effectiveness of anti-lock braking depends upon road user behaviour. A German study found that ABS brakes can lead to changes in behaviour in the form of higher speeds and more aggressive driving [4]. It has also been suggested that the results to date may also be partly due to lack of knowledge or incorrect assumptions amongst car drivers about how ABS brakes actually function [9].

4. eSafety measures – unknown safety effects

This section, which is not intended to be exhaustive, discusses a range of new technologies that are being promoted currently by the European car industry, EU institutions amongst others as promising safety measures. These are either being fitted widely, ready for implementation or are under development. While safety benefits have been predicted for such measures – some very high, others much lower- their effects and/or feasibility have still to be scientifically demonstrated. Such technologies may even lead to disbenefits. Those designed to improve braking, for example, could generate a rear impact phenomenon. A car with improved braking could avoid a situation (typically a frontal impact) but there is no guarantee that a following vehicle would have the same capability and hence has a risk of an impact due to less advanced braking provision (VSRC, 2008, unpublished). Their usefulness to road safety is not, as yet, known and needs to be tested before wide scale implementation.

4.1 Brake Assist

What is Brake Assist?

Brake Assist in emergency situations is a technology which comes as standard on some new cars and has been proposed by the car industry and the European Commission as part of an EU legislative package on pedestrian protection (as a substitute for more stringent tests aimed at better crash protection). It aims to address the problem of insufficient pressure being applied to the brake by drivers in emergency situations, so increasing stopping distances. Car manufacturing trials have shown that brake assistance systems could help by providing full braking effect, where the driver does not press hard enough on the pedal. In marketing material, Daimler Chrysler indicate that for a car braking at 100km/h, Brake Assist can reduce the normal stopping distance by 45%. Brake assistance systems can use the ABS capability to allow heavy braking without the risk of wheel locking, but have to distinguish between emergency and normal braking as well as respond appropriately to reduced brake pressure.

Casualty reduction effect?

While various prospective estimates have been made, the casualty reduction effect of Brake Assist has yet to be scientifically established [26]. In general most of the devices described for improvement of braking and handling interfere with driver behaviour, and the questions of driver acceptance, risk compensation and driver reaction when the system is activated are important (especially for old drivers). There is no standard method to assess the safety performance of these devices, which makes it difficult to estimate their potential benefits; moreover, under the same name very different systems can be found, as each manufacturer has its own specification.

4.2 Anti-lock braking for motorcycles

What are they?

Anti-lock braking systems are in-vehicle devices which aim to prevent the locking of wheels during braking when under emergency conditions, so preventing the motorcyclist from falling off their vehicles.

A German study indicated that of a total of 610 motorcycle-car impacts, 65% occurred with motorcycle braking prior to the collision. Among these there were 19% where the motorcyclist fell off his or her vehicle [58].

Casualty reduction effect?

The information of ABS is prospective only and the effectiveness of systems in reducing casualties has still to be demonstrated. A German study concludes that in 93% of cases where the motorcyclist fell of the vehicles, ABS would have avoided the crash or at least reduced the severity of the accident. This finally gives an estimate of reducing all fatal and severe injuries to motorcycle drivers by 8 to 10% in Germany [58]. Another prospective estimate also suggests that ABS might reduce the number of crash victims by at least 10% [44].

Typically, these systems are available on more expensive models of motorcycle. In 2006, 27% of models available in Europe were standard or optionally equipped with an advanced braking system. The ACEM’s (Association des Constructeurs Européens de Motocycles) has made a commitment to fit ABS to all new models. On the basis of prospective information to date, benefits to costs associated with ABS have been forecast for Austria at between 1.11:1 and 1.39:1 [58].

4.3 Collision avoidance systems

A considerable amount of research is addressing *eSafety* systems of the future. Much work is being carried out on technologies such as collision avoidance systems but their usefulness in addressing high-risk crash scenarios typical of most European roads as well as their feasibility has yet to be determined.

Research on collision warning and collision avoidance systems is taking place in Japan, the United States and in the European Union within the European Commission's *eSafety* programme. Very large estimates of the safety potential of such systems have been claimed following laboratory studies, but the range of technical and behavioural issues involved in many of the concepts require full on-road assessment. To be practical, most of the proposed systems require a well controlled traffic situation, such as that found on motorways, but where the casualty reduction potential is relatively low. For an overview of key issues [41] OECD, 2003 Road safety: impact of new technologies. Various systems are under development:

Forward Collision Warning
Is a system which comprises a visual and audible warning that the driver is too close to the vehicle in front. The warning depends on how long the distance is between the vehicle and the vehicle ahead. The level of warning changes from “safe” to “critical” as the following distance decreases.

The Reverse Collision Warning System
Is a visual and audible system which warns drivers about the likelihood of collision with an object behind the vehicle by means of sensors in the rear bumper. The warning intensifies when the distance between the vehicle’s rear and the object decreases.

Adaptive Cruise Control (ACC)
Enhances automatic cruise control found in many new vehicles by automatically maintaining a set following distance to the vehicle in front. The distance to the preceding vehicle is measured by radar, laser systems or both. When the speed of the vehicle in front is slower than the adjusted speed, the ACC system adjusts vehicle speed to allow a safe distance to the lead vehicle.

Collision Mitigation by braking
Is an evolution of ACC with the addition of a braking system that increases headway by braking; these systems may also detect obstacles within the road and brake accordingly. The speed and separation distance at which the systems operate is determined by the arrangement and type of sensors and the recognition ability of the systems.

Lane-Keeping Devices
Are electronic warning systems that are activated if the vehicle is about to veer off the lane or the road. Times to collision in safety-critical lane changes are normally much less than one second. Since mean driver reaction time is about one second, there is not sufficient time for a driver to respond to a warning before crashing. Because there is insufficient time for reaction to a warning, lane change and merging crashes can probably only be avoided by intervening systems. But these have their own problems: how to detect driver intentions and how to intervene. This may be by taking over the steering from the driver or by providing feedback through the steering wheel. The technical and operational feasibility of such systems has still to be demonstrated. Most existing systems are warning only systems.

4.4 eCall

What is eCall?

eCall is a system that provides an automated message to the emergency services following a road crash which includes the precise crash location. The in-vehicle eCall is an emergency call (an E112 wireless call) generated either manually by the vehicle occupants by pushing a button or automatically via activation of in-vehicle sensors after a crash. When activated, the in-vehicle eCall device will establish an emergency call carrying both voice and data directly to the nearest emergency services (normally the nearest 112 Public Safety Answering Point, PSAP). The voice call enables vehicle occupants to communicate with the trained eCall operator. At the same time, a minimum set of data will be sent to the eCall operator receiving the voice call. The minimum set of data contains information about the incident including time, precise location, vehicle identification, eCall status (as a minimum, indication if eCall has been manually or automatically triggered) and information about a possible service provider (CEC, 2005).

What road safety problem does eCall systems address?
These systems aim to reduce the time between when the crash occurs and when medical services are provided. The aim is to reduce the consequences of injury to prevent death and disability. A Swedish study into survivability in fatal road traffic crashes concluded that 48% of those who died sustained non-survivable injuries. Out of the group who sustained survivable injuries, 5% were not located in time to prevent death, 12% could have survived had they been transported more quickly to hospital and a further 32% could have survived if they had been transported quickly to an advanced trauma centre [27]. Additionally many emergency service providers may receive several calls for each incident, for which they may have to respond several times and it is anticipated eCall may enable them to manage responses more effectively.

How effective?
A prospective Finnish study has estimated that such a system might reduce between 4-8% of road deaths and 5-10% of motor vehicle occupant deaths in Finland [54]. The study assumed that all vehicles were equipped with the eCall terminal and that each terminal would function properly. The study was unable to evaluate the impact of the precise location information given by eCall on the swifter arrival of rescue units at the accident site in the evaluation of decrease in road traffic deaths. The overall impact of the system which involves additional players has not been evaluated.

The Finnish study noted that through "the comparison of the 4–8% decrease in traffic accident fatalities arrived at in this study with the figures of other European studies one can see that the results are similar to the German (5%) and Dutch (7%) estimations. The estimations in Sweden (2–4%) and Great Britain (2%) are smaller and the estimate for the whole 25 member state EU area (5–15%) greater than the estimate in this study. The American estimation for the decrease in traffic accident fatalities based on field studies was smaller (2–3%) than in this study. The estimate made by the doctors was, however, greater (9–11%)".

The European Commission believes that a pan-European eCall is estimated to have the potential to save up to 2500 fatalities annually in EU-25 when fully deployed (COM(2005) 431 of 14.9.2005: Bringing eCall to Citizens [6]. The eMERGE project study estimated that eCall will allow for a reduction of crash response time of about 50% in rural areas and up to 40% in urban areas. When medical care for the severely injured is available earlier after the accident, the death rate and severity of trauma can be significantly reduced.

Benefits to cost?
The benefits to cost ratio (BCR) of eCall in Finland have been found to be in the range of 0.5 (minimum estimate) to 2:3 (maximum estimate). A UK benefit to cost analysis concluded that universal fitment of eCall would result in more costs than benefits [36].

Next steps for implementation?
Various manufacturers supply eCall systems on demand e.g. Volvo and BMW. Various eCall systems have been tested in the EU-supported eMERGE project in Germany, Italy, the Netherlands, Spain, Sweden and the UK. The implementation of a pan-European emergency eCall system for road vehicles requires standardisation activities related to: (1) the communication protocol by which the minimum set of data (MSD) will be sent via the mobile telecommunication network (e.g. GSM) to the public service answering point (PSAP) (expected to be ready by mid 2008), and (2) the content and format of the MSD. A new

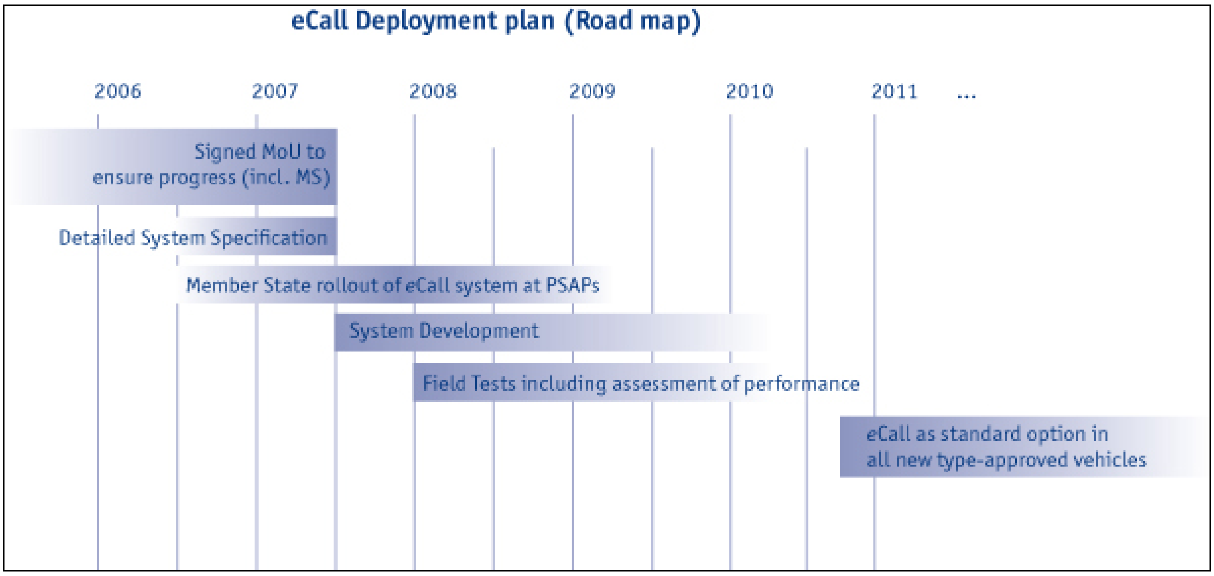
WG15 *eSafety* has been formed within CEN to cover these and other *eSafety* initiatives emanating by the Commission or CEN members countries.

eCall implementation is a high priority of the European Commission – See eSafety Support. According to a recent Eurobarometer study over 70% of the respondents say that they would like to have eCall in their next car. eCall deployment is supported by the industry, European Parliament, user organisations and by some Member States.

A Driving Group on eCall is one of the Working Groups established by the European Commission under the eSafety Forum. The eCall Driving Group released a Memorandum of Understanding (MoU) in August 2004 that called for stakeholders to actively investigate feasible and sustainable eCall solutions and potential business cases. The MoU's key message is that eCall should work in any EU Member State and that eCall should be based on the single pan-European emergency call number 112. The MoU lists the necessary arrangements for implementation of the eCall action plan and sets out the measures to be taken by the European Commission, Member States, automotive industry, telecoms and insurance industries. A road map for eCall deployment has been established and agreed by the eSafety Forum. *e*Safety partners (European Commission, industry, public authorities and other stakeholders) have agreed to introduce eCall as standard equipment in all vehicles entering the market after September 2010 (i.e. models of the year 2011). The road maps call for:

- All key stakeholders to sign the MoU to ensure progress by end of 2006
- Full specification of the eCall system and start of development by mid-2007
- Full-scale field tests should be performed from the beginning of 2008
- Member States should be ready with the upgrade of the PSAPs by September 2009
- Introduction of eCall as standard option in all vehicles type-approved from 1st September 2010 onward

However, the progress planned has not yet been realized.



Several Commission Communications have led to the development of this road map:

Information and Communications Technologies for Safe and Intelligent Vehicles" COM (2003)542 Final, 15.9.2003 focussed on 3 priorities: eCall (Pan-European eCall); RTTI (Real-Time Traffic & Travel Information) and HMI (Human-Machine Interaction).

Bringing eCall to Citizens COM (2005)431 Final 14.9.2005 The Commission invites Member States to promote the EU-wide emergency number 112 and the handling of location information for mobile calls, E112, as pre-requisite for eCall. The aim is to equip all new vehicles with eCall terminals from 2010.

Bringing eCall back on track - Action Plan COM (2006) 723 final Two parallel lines of actions are proposed: Commitment of the Member States by mid-2007, and a negotiated agreement with the industry by the end of 2007. In addition the Commission will carry out a set of actions to facilitate the eCall deployment. The Communication notes that due to delays in various Member States, an additional year's implementation time to the dates cited in the road map would be needed. Actions for the Member States were outlined.

As at September 2007, 12 Member States (Austria, Cyprus, Czech Republic, Finland, Germany, Greece, Italy, Lithuania, Portugal, Slovenia, Spain and Sweden), Switzerland and Norway have already signed the MoU. Finland has been active in the EU in promoting the eCall system. A consortium commissioned by the Ministry of Transport and Communications produced a national eCall pilot programme and implementation plan in June 2004. Finland was the first state to sign the eCall Memorandum of Understanding and realised the eCall terminal transmission test bench taken into production use in the summer of 2005. The on-going renewal of Finnish emergency centres and their data systems are ensuring the swift and widespread implementation of the eCall system [54].

4.5 Electronic driving licences

In Sweden, an Electronic Driving Licence has been developed and tested. The driving licence is a smart card containing personal information about the driver, including which vehicle types or even individual vehicles he or she is authorised to drive. The smart card serves as an ignition key, and the vehicle will only start if there is correspondence between the card and the vehicle unit [24].

A field trial with 15 vehicles has been carried out with support from the Swedish Road Administration. Myhrberg [37] concludes that the concept works in practice and that it could have a great effect on traffic safety by preventing unauthorised driving and car theft. The users have no problems getting used to the Driving Licence and in general their attitude to the new system is positive. There are, however, many practical issues to be solved before a large-scale introduction can take place [41].

5. EC initiatives on eSafety

While the European Commission's Enterprise Directorate has responsibility for eSafety initiatives, the Transport and Energy Directorate leads on road safety strategy.

On June 1, 2005 the Commission adopted the initiative: i2010: European Information Society 2010 for growth and employment. The Intelligent Car is one of the i2010 Flagship Initiatives. The objective is to improve the quality of the living environment by supporting ICT solutions for safer, smarter and cleaner mobility of people and goods. The three pillars are 1) The eSafety Initiative (2) RTD in Information and Communications Technologies and (3) Awareness raising Actions.

The eSafety Initiative is a joint initiative of the European Commission, industry and other stakeholders and aims to accelerate the development, deployment and use of Intelligent Integrated Safety Systems, that use information and communication technologies in intelligent solutions, in order to increase road safety and reduce the number of accidents on Europe's roads.

There have been several European Commission Communications on *eSafety*. Examples are as follows:

Information and Communications Technologies for Safe and Intelligent Vehicles" COM (2003)542 Final, 15.9.2003 focussed on 3 priorities: eCall (Pan-European eCall); RTTI (Real-Time Traffic & Travel Information) and HMI (Human-Machine Interaction).

Bringing eCall to Citizens COM (2005)431 Final 14.9.2005 provides for the fitment of "eCall" from 2010 onwards. This technology will call the emergency services in case of an accident, using 112 to send accident data, including the car's location. Many Member States need to upgrade their infrastructure to enable the emergency services to receive and process the Call data.

Bringing eCall back on track - Action Plan COM (2006) 723 final

CARS 21
New Commission strategy for long term viability of European car industry 7.2.07.

Safe and efficient in-vehicle information and communication systems: Update of the European Statement of Principles on human machine interface, Commission Recommendation of 22 December 2006. The updated European Statement of Principles (version 2006) summarises the essential safe design and use aspects to be considered for the human machine interface (HMI) for in-vehicle information and communication systems. Member States should perform a continuous evaluation and monitoring of the impact of the European Statement of Principles of 2006 and report to the Commission about the dissemination activities carried out as well as the results of the application of the 2006 Principles within a period of 18 months from their publication.

The *eSafety* Initiative was launched in 2002 as a joint initiative of the European Commission, industry and other stakeholders. It aims at accelerating the development, deployment and use of Intelligent Integrated Safety Systems that use Information and Communication Technologies (ICT) in intelligent solutions, in order to increase road safety and reduce the number of crashes on Europe's roads.

The eSafety Forum provides a platform for consensus among stakeholders (currently over 150 members), High-Level Meetings with Industry and Member States defining strategy and Working Groups: Solution-oriented, reporting to the Forum.

An eSafety effects database lists a variety of studies which have attempted to identify the effects of new technologies.

Current EC funded research projects related to *eSafety* include Prevent**,** eIMPACT, TRACE, AIDE.

While the European Commission has been active in the *eSafety* field since the late 1990s, recommendations of EU road safety experts (Rumar ed, 1999) continue to be valid and similar recommendations have been expressed in recent times:

It is clear from the current situation that the European Union needs to establish a long-term strategy on ITS with a view to road safety. It also needs to develop its role in giving advice to industry with regard to design, development, implementation and evaluation of new products. It is important to ensure that the potential benefits to the community are maximised and that any disadvantages are minimised. The key issue is how such a process should be developed and designed [41].

Summary of recommendations for EU actions [41]

1. It is clear from the current situation that the European Union needs to establish a long-term strategy on ITS with a view to road safety. It also needs to develop its role in giving advice to industry with regard to design, development, implementation and evaluation of new products. It is important to ensure that the potential benefits to the community are maximised and that any disadvantages are minimised. The key issue is how such a process should be developed and designed.
2. Priority should be given to the development of ITS that address identified road safety problems, rather than to promoting technologies for their own sake. Other general aims than safety are, of course, legitimate as long as safety is not hampered.
3. The EU should encourage the early European-wide implementation of those ITS which have proven safety benefits.
4. The EU should give priority in long-term development to systems that have a significant potential to improve safety.
5. The EU should ensure that ITS introduced on the market is monitored and evaluated from a safety point of view.
6. The European Statement of Principles on Human Machine Interface for In-Vehicle Information and Communication Systems, as presented by the European Commission in 1998, represents an initial, non-mandatory approach to design and installation. The Statement of Principles needs to be made more specific and should define a procedure that should be followed to ensure compliance with these principles; a certification process through which products can be shown to have complied with these principles; an EU certification process for ITS functions which are very critical from a safety point of view. Steps to move beyond the current knowledge embodied in the Statement of Principles are recommended below.
7. A mandatory certification procedure to approve ITS applications in terms of system safety should be developed at a European level (reliability issues and the availability of adequate fallback procedures need to be addressed, as a system failure might put the road user in a very dangerous situation). The existing procedures for ensuring system safety should also be adopted at the international standards level, through ISO.
8. Specifically, the need for standardisation and quality assurance of relevant control algorithms and protocols should be addressed.
9. Implementing ITS requires special consideration for safety in the transition phases - which may last several decades- during which car fleets, driver abilities, and ITS functions and interfaces will be very varied. The EU should establish a monitoring system to evaluate the design, development and implementation of ITS and their short, medium, and long-term impacts on traffic safety, that is, the overall safety effect of ITS on the traffic system.

6. eSafety - evaluating measures

Systematic evaluations

There have been various attempts to record and classify *eSafety* measures by their impacts e.g. studies included in the eSafety effects database[25][1][45]. However, various problems need to be addressed both in the assessment of existing and new systems. No systematic methods currently exist to evaluate new systems. While systems are under development, they are not yet mature. It is not possible to predict eventual casualty reduction on the basis of experimental studies, field trials or simulators for most new systems [47].

HMI issues

While the European Statement of Principles [12] was updated in 2006, there is a need for a test regime to provide *objective* assessment and guidance. A test regime needs to be defined that:

- Is technology-independent, i.e. does not depend on a particular technology being employed in a system design
- Uses safety-related criteria
- Is cost effective and easy to use
- Is appropriate for a wide range of HMI
- Is validated through real-world testing

At the same time, many driver assistance technologies are vehicle specific. That is, they apply to the vehicle in which they are fitted without knowledge of the level of assistance afforded to the surrounding vehicles.

In a market-driven implementation of new vehicle technologies, it is likely that nomadic devices would be freely available for purchase without the device being tried and tested in every vehicle in the fleet. The implications of retrofit of such devices could be problematic since the response of the vehicle to the technology in question could not be predictable. There needs to be a clear policy for handling nomadic devices such that no gross assumptions are made to the effect that any single device will offer the same benefit to all vehicle types and make/models and they will not interfere with vehicle systems or add to the load on the driver.

A clear framework is needed urgently to identify, evaluate, deliver and monitor technologies which improve safety and to identify and discontinue work on those which cost lives. Before measures are described as being *eSafety* measures, they need to demonstrably effective in their safety performance before they are introduced widely.

Some proposals shown below have been made to identify key needs of an assessment framework and evaluation tools (VSRC, 2008, unpublished) [49].

Assessing the effectiveness of existing eSafety systems (VSRC, 2008 unpublished)
Key questions:

- Has the system introduced any new problems into the driving task?
- How many crashes and deaths are expected to be avoided using the system?

1. A prerequisite for monitoring is to be able to easily identify the systems that are standard and optional on each vehicle model. Currently there is no central source of this information and there is a need to collate information to form a comprehensive list and corresponding functionality of systems that are available in the current vehicle fleet. A central data base listing details of active safety systems by vehicle make and model according to year of manufacture or if necessary by the Vehicle Identification Number (VIN) would be a valuable tool. A method is required that takes account of systems that have been requested as 'optional extras' as well as those that are standard to a make, model and variant.
2. There is a need to examine the available evidence relating to the effectiveness of currently available technology. This would involve consultations with suppliers and reviews of statistically robust studies.
3. The evaluation of existing systems in the fleet is conducted by considering the crash involvement rates of cars with and without the system under evaluation. Since this requires sufficient fleet penetration before a significant evaluation can be made, multi-centre approaches may be necessary to bring data together from a wide international, geographic area to provide sufficient data for analysis.
4. Exposure data relating to the prevalence of the comparison vehicles on the road is also required for robust accident involvement rates to be calculated and a methodology would need to be established.
5. Using crash data and risk of crash involvement for post-evaluation of a new technology presents an immediate problem, since there may be more than one vehicle safety measure continuing to the outcome.
6. Experimental work in the form of Field Operational Trails could go some way towards predicting the likely HMI effects of new technologies. Such trials allow for driver adaptation to be monitored over an extended driving experience during which the driver normally comes to ignore the presence of monitoring equipment. Simulator studies could be used to generate hypothesis about changes in driver behaviour that could then be validated and quantified in a larger Field Operational Trial.

Predicting effects of new and proposed eSafety systems (VSRC, 2008 unpublished)

Key questions:

- Will the system introduce any new problems into the driving task?
- How many crashes and deaths are expected to be avoided using the system?
- Can the system be expected to operate as specified under all driving conditions?

A structured approach is needed to predict the benefits or disbenefits offered by new systems.

1. *System operation*: An assessment should be made of the functioning of the technology. For example a collision avoidance system should demonstrate the capability to avoid collisions. Sometimes these systems will be simple and only one test or field trial may be necessary but systems that are more complex may need to have their performance confirmed under several test conditions. In general this assessment is likely to have been conducted by the system developer as part of the engineering process and there will probably be sufficient information available.
2. *Introduction of new crash risks*: The use of the system in the car by the driver must not cause additional risks e.g. through distraction or conflicting information being presented to the driver (HMI issues).
3. *Driver adaptation:* The issue of driver adaptation needs to be explored in the context of the system specification and functionality. For example, will the introduction of the technology promote an element of 'risk taking' or induce complacency within the driving task? A further issue for consideration is 'information overload'
4. *Predicting crash and fatality reductions:* Prediction of casualty reduction will incorporate the following steps.
    - Accident analysis to estimate the total number of crashes that take place in conditions relevant to the technology. A system that prevents crashes in situations that only occur rarely will not have a big impact on casualty numbers, for example an icy road detector will have only a small value in many Mediterranean countries. More detailed accident data will support more accurate assessments;
    - Development work and field trials to evaluate the likely system effectiveness in each of these situations. A system may have a limited functionality and perhaps only prevent high proportions of crashes under ideal conditions that are relatively rare;
    - Estimation of consequences of any driver adaptation. Drivers may use more risky driving behaviour in vehicles equipped with safety technologies and the overall casualty reduction may be less than anticipated.

A simple checklist has been proposed to check the safety performance of systems.

Checklist for System Validity [47]

1. Does the system address frequent or infrequent accident causation factors?
2. Does the system reduce these by a large or small amount
3. Does it address all crashes/injury crashes/fatal crashes?
    - How do drivers change their behaviour?
    - Beneficially?
4. Adversely?
5. Are there any introduced risks?
6. What are the benefits compared to the costs?
7. Where's the evidence?

	Rare	Frequent
Small reduction	*	**
Large reduction	**	***

Evaluation tools

- Multi-centre studies are a powerful tool
- On Board "black boxes" should be used
- Powerful statistical techniques should be applied
- Screening studies using mass data should be used more extensively
- Getting rid of strange statements such as "you cannot evaluate crashes that have not occurred" and alike

Tingvall, SafetyNet Conference, Prague 2006

7. eSafety - consumer information

The European Commission has initiated a major action to inform the public about the new vehicle technologies (eSafety Aware 2) and to encourage new car buyers to choose them. However, there is no information source that is readily available to the public who have no means to decide whether a system will in reality offer them large safety benefits or whether the system addresses other aspects of driving. A new consumer information programme would be useful.

Need for a consumer information programme on eSafety

The purpose is to provide the consumer with standard information about in-car systems that may have some safety impact. This would involve the development of standard assessment methods, a consistent website for information and the application to both existing and new technologies. This programme would involve a number of steps as follows.

Technology Watch

The Programme would oversee the development of a Technology Watch. This process would identify new technology in the pipeline at an early stage through consultations with the vehicle manufacturers and suppliers. There should be a requirement for all new technologies to be registered with the Technology Watch.

Information Dissemination

The Programme would advise on any obvious pitfalls in the new technologies. System functionality, benefits and disbenefits would be determined and this information would be provided to consumers.

Subsequent impact Assessment

A post-implementation evaluation should be carried out in both the short- medium- and long-term.

8. eSafety - knowledge gaps

A variety of knowledge needs has been identified.

- Conduct research into the causes of crashes and injuries and the methods improved vehicle functions can prevent or reduce their severity
- Ensure the range of crash and safety data resources is future proof
- Develop standardised methods for evaluation of new technologies before widespread introduction
- Improve understanding of driver response to new systems over longer periods of time
- Study how systems are used and abused
- Study any driver training needs

VSRC, 2008, unpublished

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