European Transport Safety Council

PRAISE
Work-Related Road Safety

"PRAISE": Preventing Road Accidents and Injuries for the Safety of Employees

September 09
Report 1

How can In-vehicle Safety Equipment improve road safety at work?

- Seat Belt Reminders
- ISA
- ACC
- Alcolock
- ESC
- EDR
- Following Distance Warning
- Emergency Braking
- Route Planning
- Fatigue detector



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ETSC PRAISE Project

PRAISE is a new project run by ETSC on Preventing Road Accidents and Injuries for the Safety of Employees (www.etsc.eu/PRAISE.php). The project aims to advance work-related Road Safety Management and provide the know-how to employers who have to take on that challenge. This first thematic report aims to present how in-vehicle safety equipment can improve and manage work related road safety. This report addresses all employers managing all types of vehicle from public authorities, vehicle leasing suppliers, small two car delivery companies to large international companies and also vehicle manufacturers.

Road Safety in the work context: identifying the problem and introducing in-vehicle technology

The scope of the problem varies from one organisation to another, the starting point for any employer should therefore always be to undertake a risk assessment and draw up a road safety action plan, based on priorities identified in the assessment and as part of occupational health responsibilities (a European Directive[1] requires every employer in Europe to undertake a risk assessment). This action plan can include in-vehicle safety features and equipment as part of the solution as judged appropriate. The preferred safety equipment to be fitted in vehicles should be identified according to the particular risks. To do that you need to know both the nature and size of the risks:

- The nature of the risks: all risk factors that lead to collisions should be listed. Excessive speed, drink driving and not wearing seat belts are the traffic offences that research suggests most often contribute to traffic injuries and deaths. However, you should also consider more specific risk factors related to the organisation. Organisations supplying and operating fleet vehicles most often find that they face particular risks related to their type of vehicles: for example large goods vehicles rollover at lower speeds than other motorised vehicles because of their height, and most large vehicles have visibility problems when reversing and blind spot problems. Finally, do not forget that drivers are human beings with limited abilities and skills, and biological constraints. Fatigue for example is a very common risk factor in road business, and one that is too often overlooked by organisations asking their people to travel for work purposes.

- The size of the risks: for each type of collision caused by those factors you should know the related amount of asset damage, number of injuries and deaths, and quantify the resulting costs, including material damages, to the organisation. Depending on the size and capacity of the organisation you will have different means to gather such data. The different ways of assessing the size of the risk range from simply asking employees how often particular incidents occur, to analysing collision/ incident records or even fitting vehicles with event data recorders and analysing the resulting information. As a general rule, what gets measured gets improved! For organisations running fleet vehicles, an easy source of data on vehicle damage can be their insurance, insurance broker, accident management supplier, and/or vehicle leasing company.

Once the employer has identified the nature and size of the risk faced, they will be able to assess their priorities and make the relevant cost tradeoffs and business case. Fitting safety equipment or purchasing vehicles fitted with particular safety features and equipment can be an effective way of reducing the risks. However you should always explain the reason for it to employees (a good safety culture should always be shared with all employees instead of seen only as something imposed by the management), but also very importantly you should train employees on how to use that equipment properly. Fitting vehicles with particular safety equipment is just one part of a greater sequence of actions; it is never the only thing that you have to do.

1 Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work.

The Business Case

Duty of care and health and safety compliance are legal necessities in most EU Member States, and an essential consideration for employers. Employers should also make sure that their employees are able to comply with the law for example making sure there are seat belts on all seats. But equally important, it most often makes sound business sense to draw up and implement a road safety action plan. For businesses there is a clear link between safety, quality, customer service, efficiency and the environment. Road safety has a massive impact on society, and for this reason can play a major role in improving – or damaging an organisation's corporate social responsibility (CSR). This can be reflected in different ways:

-Reduced running costs through better driving standards (fuel consumption/vehicle maintenance costs);
-Fewer working days lost due to injury;
-Reduced risk of work-related ill health;
-Reduced stress and improved morale / job satisfaction;
-Less need for investigation and paperwork;
-Less lost time due to work rescheduling;
-Fewer vehicles off the road for repair;
-Fewer missed orders and business opportunities, reduced risk of losing the goodwill of customers;
-Less chance of key employees being banned from driving;

Employers have to identify which safety feature gives what benefit. Each safety feature needs a detailed investment-based business case, linked to the risks they have identified.

Collisions most often have financial implications on a business that stretch well beyond reported costs. This can be illustrated by the following model of a collision's costs[2] :

For this one incident a conservative decision to multiply by 2 the £ 3,000 figure to identify hidden costs was taken. To cover a £3,000 collision cost, £ 60,000 of revenue would be required, equating to sales of 120,000 units of this hypothetical company's product. The company therefore needs to ask itself: "Is it easier to sell 120,000 units of our product or be more proactive in preventing this collision?". In the current economic climate, such models are needed to justify up-front investments in safety programs. They can also be used to project long-term costs and potential returns on investment from adopting a proactive Fleet Safety Policy.

Finally, a proactive road risk program can also keep organisations ahead of and protected from regulations and legal requirements and help them gain a competitive advantage compared to more 'reactive' competitors.

In-Vehicle Technologies: Description, Life-saving potential and Examples of use

This section will present the most important in-vehicle technologies and give examples of their use. The different technologies should be linked to tackling problems[3]. The table on page 4 gives an overview of possible interventions.

Item of cost	Sample data
Own damage costs	**£1,000 (Eur 1,145)**
Third party vehicle damage costs	**£1,000 (Eur1,145)**
Third party injury costs (eg Whiplash)	**£1,000 (Eur 1,145)**
Reported cost of collision	**£3,000 (Eur 3,432)**
Total cost of collision (including hidden costs at 2 times reported costs)	**£6,000 (Eur 6,865)**
Revenue required to fund a single collision at 10% return on Sales	**£60,000 (Eur 68,649)**
Widget sales (at 50p) required to fund fleet safety costs	**120,000**

2 © and Intellectual Property Dr Will Murray, Interactive Driving Systems, all rights reserved, 2009.

3 For a ranking of the life saving potential of vehicle safety technologies see:
- Cost-benefit assessment and prioritisation of vehicle safety technologies (EC 2005) www.ec.europa.eu/transport/roadsafety_library/publications/vehicle_safety_technologies_final_report.pdf
- eImpact: (2008), Socio-economic Impact Assessment of Stand-alone and Co-operative Intelligent Vehicle Safety Systems (IVSS) in Europe www.eimpact.info/download/eIMPACT_D6_V2.0.pdf
- TRACE: Review of Crash Effectiveness of Intelligent Transport Systems www.trace-project.org/publication/archives/trace-wp4-wp6-d4-1-1-d6-2.pdf

Vehicle related interventions in the Prevention Model[4]

Vehicle safety features can reduce the incidence and severity of crashes and the vehicle supply industry developed many technology-based interventions for fleet operators to consider in vehicle specification and purchase decisions. Note that in the Prevention Model passive measures are those that protect individuals automatically without any action on their part, including vehicle design changes. Active measures require individuals to actively participate in their own protection. This definition differs from the commonly used definition of active and passive safety, with active safety referring to interventions before collisions, and passive safety referring to interventions after collision (see ERSO www.erso.eu/knowledge/content/50_vehicle/crash_avoidance_and_crash_protection.htm).

Seat Belts and Reminders

Seat belts are a highly effective way of reducing deaths and injuries with lasting effects to car occupants. Yet, despite the legal obligation to wear a seat belt, seat belts are still not always present in all seats and in all vehicles. Moreover, wearing rates still vary greatly across Europe especially between front and rear seats, different user groups and between urban and rural areas. Although much can be achieved through raising awareness, seat belt reminders can be an efficient way to increase seat belt use.

Seat belt reminders detect occupants and their seat belt use in all seating positions, and then create a series of alarms to alert the car occupant if he or she is not belted. There are different types of seat belt reminders – some issue only visual warnings while

	Passive (protect drivers automatically)	Active (involves driver participation)
Proactive / Primary actions to avoid crashes	Speed limiter/intelligent speed adaption Electronic Stability Control (ESP) Wired in daytime running lights Visible colour Alcohol ignition interlock Self checking/inflating tyres Stronger/safer seats Mobile phones confiscated Automatic ventilation control Automatic reversing brakes EDR vehicle monitoring	Cruise control Antilock braking systems (ABS) Daytime running lights High mounted rear centre brake lights Alcohol policy and testing Tyre check policy Ergonomic seat adjustment Mobile phone use banned Air conditioning Reversing warning devices & cameras Driver near hit reporting
Reactive / Secondary/ At-scene	Airbag including side/head protectors Seatbelt interlock/reminder Crashworthy vehicle (NCAP rating) Heavier vehicle Anti whiplash protection Crush zones and safety cages Fire resistant vehicle interiors Cargo barrier/load restraint Side and frontal impact protection EDR including crash recorders, forward/cab facing cameras and accelerometers	Quality front and rear seatbelts Seatbelt wearing Strong, easy to open doors Seat and head restraint positioning Correct head restraint use Child restraints Fire safety equipment

4 Murray, W., Pratt, S., Hingston, J. & Dubens, E. (2009). Promoting Global Initiatives for Occupational Road Safety: Review of Occupational Road Safety Worldwide (Draft), www.cdc.gov/niosh/programs/twu/global

others issue both visual and auditory warnings. The potential to save lives is most effective when using seat belt reminders that disable ignition. But even audible seat belt reminders have a large life saving potential. Only a few car models are to date fitted with seat belt reminders for the rear seat. Compared with front seat systems, rear seat systems appear more costly because their installation is more complex.

ETSC has undertaken a cost-benefit analysis for the mandatory introduction of audible seat belt reminders for front seats in 2003 (ETSC 2003). 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 Euros. The cost-benefit ratio would be 1:6. The situation of SBR in the EU has improved since 2005, when some 56% of cars were equipped with a SBR for the driver's seat; in 2008, it was 70%. However, big differences persist between particular types of vehicles. Whereas 97% of the Executive Cars sold in 2008 were equipped with a SBR for the driver seat, only 83% of the Multi Purpose Vehicles (MPVs) and 68% of the Super-minis were fitted (ETSC Pin 2009).

Examples of compliance with Seat Belt use

A campaign called "Did it click?" ran by the German Road Safety Council (DVR) and the Statutory Accident Insurance in the Vehicle Operating Trades (BGF) together with other partners including the automotive industry, the haulage sector, and print media ran over 6 years. It led to increases of seat belt wearing rates from 10% to up to 50% in non-urban areas according to Police and DEKRA traffic observation reports[5]. The campaign is made up of personal communication with truck drivers at their rest places on the roadside of highways explaining them the usefulness of wearing seat belts based on results from accident research. A roll-over simulator gives them hands on experience, a film gives additional information, especially on the compulsory use of seat belts for truck drivers. A leaflet and a sticker with the campaign logo are handed out to the drivers. Information about the place of further demonstrations are given also on a campaign Website www.hatsgeklickt.de

Instead of seat belt reminders Scania trucks and Aral introduced a different non technical solution by fitting coloured seat belts. This was coupled with random checks by the employer.

Speed Management Technologies

There is a well documented relationship between speed and collisions resulting in death and injury with lasting effect. The adaptation of driving speed to the prevailing conditions and speed limits is a primary way of controlling the crash risk of the driver. Different systems exist, ranging from informative to intervening systems. Intelligent Speed Adaptation (ISA) is an Intelligent Transport System (ITS) which warns the driver about speeding, discourages the driver from speeding or prevents the driver from exceeding the speed limit (Regan et al, 2002)[6]. Information regarding the speed limit for a given location is usually identified from an onboard digital map in the vehicle. Other systems use speed sign reading and recognition either using already built into the vehicle or aftermarket navigators.

There are two major types of systems – informative and supportive. An informative system gives the driver feedback in the form of a visual or an audio signal. A supportive system works in the form of increasing the upward pressure on the pedal or cancelling a driver's throttle demand if it demands more throttle than is required to drive at the speed limit.

A Swedish large-scale study of the effect of

5 http://www.dvr.de/site.aspx?url=html/presse/informationen/887.htm

6 Note that this definition is very similar to the one given for "speed alert" the term used in the EU ITS Action Plan: "The system alerts the driver with audio, visual and/or haptic feedback when the speed exceeds the local legal speed limit. The speed limit information is either received from transponders in speed limit signs or from a digital road map, requiring reliable positioning information." http://ec.europa.eu/information_society/activities/intelligentcar/technologies/tech_18/index_en.htm

informative and supportive ISA, involving nearly 4,500 vehicles, shows that if everyone had informative ISA fitted, injury accidents could be reduced by 20% in urban areas (Biding 2002). Supportive systems have even greater potential to reduce fatal and serious accidents (Carsten et al 2008). Estimates by Carsten show that a mandatory supportive ISA scheme could lead to a reduction of 36% in road traffic (injury) accidents and 59% in fatal accidents. There would also be benefits in terms of lower fuel consumption (up to 8%) and more effective road traffic enforcement.

Examples of Speed Management technology use

Examples of the implementation of ISA come mostly from Sweden. ISA systems have been installed in about 4,000 of the Swedish Road Administration (SRA) cars. A number of city municipalities have equipped their vehicles with informative ISA. The local buses in Lund for example are today equipped with an ISA system with auditory warning for the driver if he/she exceeds the speed limit. In Sweden ISA is also already used by several companies and between 50 and 60 local authorities, such as Stockholm and Västerås, on the basis of an informative system.

Some examples of companies are:
- Transport companies: SITA, Panaxia, Alltransport
- Taxi companies: Gävle taxi, TaxiBil Syd
- Rental car companies: Hertz
- Elevator supplier and service: Kone

Speed limiters have also been used by some companies. These limit the speed and are not as flexible as ISA. In the UK Royal Mail and Centrica have fitted speed limiters (limited to 70mph) on all vehicles including vans and put stickers on the back of all their vehicles to inform other road users of their self imposed speed limit.

Centrica, which owns British Gas, has many excellent initiatives in place for driver safety. In relation to Vehicle Safety Features, Centrica has taken the decision to restrict all future British Gas vans to a maximum speed of 70 mph. 3,400 Speed restricted vehicles were delivered during 2006, followed by 2,200 in 2007. This initiative has positively influenced both road safety and fuel consumption, reducing the potential for drivers to be involved in high-speed incidents. All vans now display a 70 mph maximum speed sticker on the rear doors to advise other road users. With their level of buying power, Centrica has now forced a number of high profile vehicle manufacturers to offer speed limitation as a standard option, contributing to wider road safety in the community.



British Gas has specified that all its new vans will be fitted with speed limiters set at 70 mph

Adaptive Cruise Control (ACC) System

Adaptive cruise control (ACC) enhances classical cruise control and automatically maintains a following distance to the preceding vehicle (Liang et. al, 1999). The distance to the preceding vehicle is measured by radar either with laser radar or millimetre wave radar. When the vehicle ahead is driving more slowly than the adjusted speed the ACC system will control the vehicle speed and follow the lead vehicle at a safe distance. Once the road ahead is clear again, the ACC will accelerate the vehicle back to the previous set cruising speed. Some employers are being encouraged to purchase vehicles with ACC.

Example of ACC Use

The Pöppel Company is a big Southern Germany based transport enterprise which transports dangerous goods, especially liquids. The company has 550 employees and a fleet of 200 heavy goods vehicles. The company focuses very much on improving its efforts for occupational safety and health. About 95 % of the vehicles are equipped with Adaptive Cruise Control Systems to avoid collisions. In the course of the campaign concerning the Driver Assisting Systems the company has obtained a subsidy from the BGF for 10 vehicles (see the BGF Initiative on Page12).

Alcohol and Alcohol Interlocks

Driving whilst under the influence of alcohol contributes annually to at least 10,000 deaths on EU roads. In the EU as a whole around 1% of journeys are associated with an illegal Blood Alcohol Limit (BAC) (ERSO 2006). If the number of alcohol impaired drivers dropped to zero, some 6,800 lives would be saved, representing 16% of road deaths in 2007. Driving under the influence is less common in commercial transport compared to private transport. Yet, alcohol related road crashes in commercial transport tend to result in more serious outcomes due to the vehicle crash incompatibility caused by increased size and mass of commercial vehicles. Besides, the number of people injured in such a crash may be high in case of vehicles operated by public transport companies (Alcohol in Commercial Transport ETSC 2009 A).

Alcohol interlocks (also termed 'alcolocks') are devices that require the driver to take a breath test before starting the car. If the driver fails the test, the device locks the ignition of the car. Commercial use of alcolocks is the voluntary introduction either by public sector authorities or private commercial vehicle operators for a variety of reasons but mainly as a corporate responsibility towards road safety and limiting risk (Alcohol in Commercial Transport ETSC 2009 A). The gradual introduction of alcolocks starting with target groups (commercial drivers and repeat drink driving offenders) could reduce the high toll of drink driving casualties every year in the EU. Crucially in the commercial context alcohol interlocks must not be seen as a stand-alone issue but should be introduced as an integral part of an employer's drink driving policy. Indeed some employers have a zero tolerance to alcohol policy which is also specified in employee contracts. Alcohol interlocks can also be a good preventative tool for deterring drink driving for drivers still affected by alcohol the morning after drinking has taken place.

Example of Alcohol Interlocks use

The most well-known examlpe is the Swedish program (Silverans et al 2006) introduced late 1999 and aimed at increasing the quality assurance in commercial transport. The implementation started with a small-scale demonstration project in partnership with a bus, taxi and truck company and was funded by the Swedish National Road Administration Vägverket (ibid.). One hundred vehicles of each company were alcolock-equipped. To minimise discomfort to the drivers and the risk of economic loss to the fleet owners, all alcolocks were programmed for 30 minutes stall protection, allowing to restart the vehicle motor without providing a breath test. Moreover, the alcolocks had a function that allowed the ignition to be on without the motor being running (for heating purposes, among other things), as well as a reset function for driver changes within the aforementioned 30-minute grace period (ibid.). Various facilities and regular control make fraud very difficult (Beirness, 2001). Finally, the commercial alcolocks did not have a running retest function. A first evaluation of attitudes among drivers, employers, customers and passengers showed that the alcolock was widely accepted as the best alternative to reduce drink driving (ibid., Lönegren 2003). However, it was also reported that there was a lot of mistrust in the beginning regarding the alcolocks due to technical problems with the devices and mistakes with regard to the servicing infrastructure (ibid). The problems need to be overcome as a matter of priority for the application to be effective.

In Belgium a taxi firm started a small alcolock trial in April 2008 supported by the alcolock supplier ACS Belgium. This is within the context of the development of new legislation. N Taxi is based in Mechelen and has a zero tolerance policy towards alcohol and drugs. All taxi drivers have to sign the house rules and commit to this policy on alcohol and drugs. Alongside its their zero tolerance policy the firm had a problem with a driver who lost his job due to an alcohol problem. Preventing a repeat of this was a further motivation for them to take up alcolocks. If a drink driving offence is detected by the alcolock the company director talks to the driver and gives them a warning. There has been a 20% increase in the company´s business since the introduction of alcolocks. The biggest customers of N Taxi have supported the project and have commissioned more work for the small taxi firm. The taxi firm owners will extend the trial by keeping the current locks in the cars and introducing more alcolocks to other taxis (ETSC Drink Driving Monitor 2008).

Electronic Stability Control

ESC acts on the braking or power systems of a vehicle to assist the driver in maintaining control of the vehicle in a critical situation (caused, for example, by poor road conditions or excessive speed during cornering). As well as saving casualties, the widespread use of ESC in vehicles could significantly reduce the traffic congestion caused by accidents involving large vehicles. ESC will become mandatory under the new EU vehicle safety regulation. Large differences in fitment rates within the EU member states make it even more important to have this legislation. In Sweden 96% of all new sold cars were fitted with ESC, while in many other EU countries the fitment rate may be below 30% (ETSC, 2008 A). A further variation of ESC is also on the market which adapts the capability to the load by calculating the vehicle's centre of gravity and its weight. This is particularly relevant for vans. Finally, it is also important to note that studies suggest that the impact of ESC varies with vehicle types. In New Zealand and Australia for example Sculy and Newstead (2008) have suggested that ESC is more effective at preventing single vehicle crashes for SUVs than for passenger cars, given their greater risk of being involved in rollover crashes.

Example of ESC Use

Napp Pharmaceuticals[7], a Cambridge-based company, is one of the first UK fleets to answer calls for companies to take a lead in ensuring the life-saving anti-skid technology is a 'must have' feature. Following the launch of a Europe-wide 'Choose ESC!' campaign, which is designed to speed-up the take-up of the technology by fleets and private motorists, Napp Pharmaceuticals has taken its pioneering stance. The company operates an open choice 340-strong user/chooser company car fleet with Audi, BMW and Volkswagen models making up the majority of vehicles. The company has updated its driver electronic car ordering system to make it impossible for company car drivers - sales representatives visiting pharmacists, hospitals and doctors' surgeries and headquarters' staff - to select a new vehicle that does not have ESC fitted.

Event Data Recorders

Event or Accident Data Recording systems (EDRs/ADRs) are commonly known for their 'black box' type of use and were designed for aircraft or trains. They provide information regarding the circumstances surrounding a crash. A typical example for the use of EDRs is for the authentication of an incident for insurance claims or for the rejection of insurance claims (e.g.: drivers involved in a crash because of allegedly inappropriate speed). EDRs can be used for accident investigation as well as for driver monitoring. But EDRs are typically not designed for recording driving data as a tachograph because the recording is linked to a defined event trigger threshold. This could typically be a collision impact or a harsh driving manoeuvre. This depends on the functionalities required by the customer.

One comprehensive evaluation of the EDR impact on road safety, not limited to professional vehicle use, concludes that under a scenario where the technology would be implemented on a wide scale, there would be an average reduction of collision probability of 10% for deaths as well as for serious and light injuries (European Commission 2005)[8]. Benefits are estimated to outweigh costs by a factor of 7. For all the values used in the sensitivity analyses, benefits exceed costs. Thus EDRs/ADRs figure as number 2 in that evaluation among the most cost effective road safety technologies[9]. The VERONICA projects (2006 and 2009) propose the mandatory implementation of a standardised set of data elements with a defined functionality capable to record most collisions with harmful consequences.

Some stakeholders in Europe propose a solution to determine whether drivers display aggressive driving styles. This works through the use of in-car devices such as sensors and GPS systems that monitor the acceleration, speed, and movement of vehicles. Through these, the

7 www.napp.co.uk/Pages/default.aspx http://www.roadsafe.com/magazine/2007summer/fleet_chief_leads.html

8 Cost-benefit assessment and prioritisation of vehicle safety technologies in particular 142 seq. (144) and p. 8) www.ec.europa.eu/transport/roadsafety_library/publications/vehicle_safety_technologies_final_report.pdf (2005)

9 Another study based on available practical experiences concludes that a reduction in the number of accidents by 20% would generate a reduction of 26,1% of lightly injured, of 36,9% of seriously injured and of 50,4% of killed road users (Bach 2000).

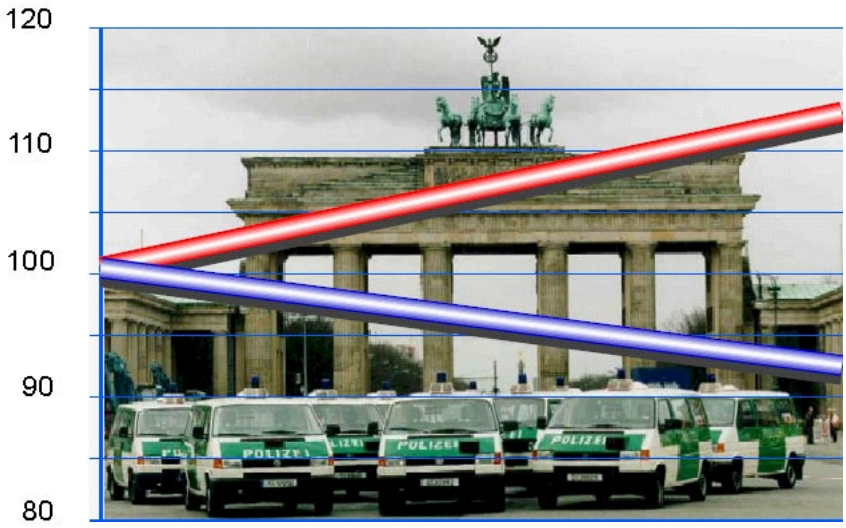
system analyses different types of manoeuvres and identifies for each manoeuvre performed during a trip whether it has been performed correctly or too aggressively (changing lanes abruptly, accelerating suddenly and so on). On the basis of this the system can identify risky manoeuvres, and empower drivers to manage their own safety by giving instantaneous in-vehicle feedback.

The information from the EDR can also be used as a management tool for driver training or to change the times of driving to avoid risky periods or routes. When using EDRs data protection concerns must be considered at an early stage and proper explanation of the appropriate use of data given to staff. It needs to be borne in mind that recorded incidents may go up at the start because collisions that were not reported previously start to get reported.

Examples of EDR use

Event or Accident Data Recorders have been introduced in a number of professionally used vehicle fleets throughout Europe since the mid-nineties. However not all companies want to reveal data as their technology gives them a comparative advantage over their competitors.

A well documented field test was also that of the Berlin Police conducted in 1997/98 (Rau/Leser 1998). Equipping all 380 radio patrol vehicles led to a 20% drop in accidents and a 36% drop in accidents involving emergency trips. It became clear that these positive effects are owed to a change of driving behaviour by those drivers who in the times before EDR implementation did not care sufficiently about the vehicles entrusted to them. It became also clear how important human leadership is in connection with the use of EDRs. Only if the staff and/or its representative body is involved early on and an awareness of the joint responsibility for the operational success can be achieved, which is ultimately in the interest of both, employers and employees, distrust and tensions can be avoided. However, positive impacts tend to fade out if monitoring and management efforts are not strictly maintained on a high level. A thorough analysis of the recorded damage events should be accompanied by appropriate restrictive measures. Negligence and effects of getting used to the system might otherwise discredit the potential enshrined in the implementation of EDR. In other words a framework of institutional rules with incentives and disincentives is recommended.



Damage reduction in EDR equipped Berlin Police fleet 1997-1998: 381 vehicles

Another example involves the Rotterdam-Rijnmond police, which achieved a drop in damage costs of 25.1% with 100 EDR units between 1999 and 2000. This led to the police insurers refunding 45,000 Eur in premiums for 2000 and reducing premiums by 90,000 Eur for 2001. The investment in EDR had paid for itself within a year.

"About fleet", a Swiss magazine focusing on company vehicles and fleet management, reports in its 2/2009 edition (p. 43) about "polyrose", a swiss company specialised in the delivery of medical and pharmaceutical products. The experiences made by PolyRose with its 100 vehicles, 20% equipped with EDRs capable of recording also risky driving maneuvers, revealed that the drivers with the largest number of accidents also had a record of bad driving performance which included high ratios of driving curves on the limit and of emergency brakings. Consequences were a process of direct dialogues with the drivers to raise their awareness, a driver training programme, consultation with ophthalmologists and subsequently a sustainable reduction of the damage frequency and the number of damage claims. Similar experiences were made with Securitas and Post-Logistics.

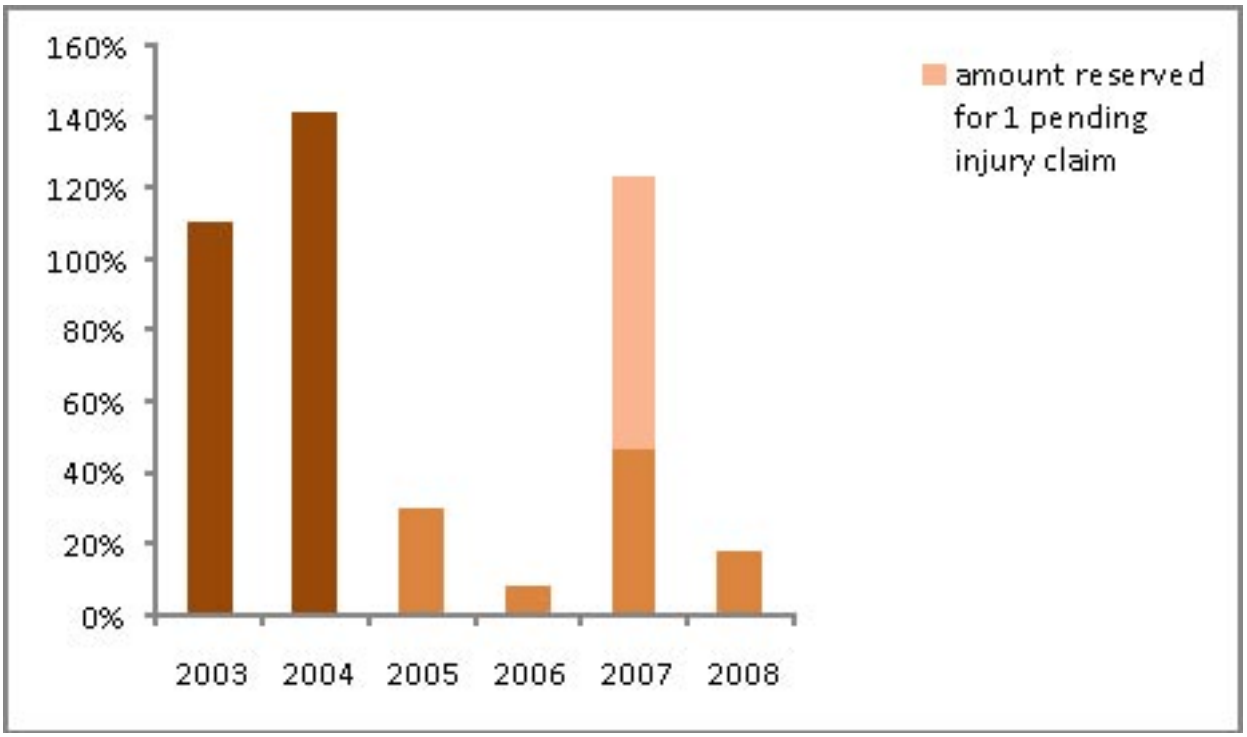
Following Distance Warning

The distance warning system warns both visually and with a sound that the driver is too close to a vehicle. The warning depends on how long the distance is between the vehicle and the vehicle ahead (Regan et al, 2002 A). The level of warning will switch from "safe" to "critical" as distance decreases. Systems with auditory warnings have been proven to be effective warning mechanisms. Driver inattention, or failure to pay adequate attention to the driving task, is the single most common cause of front-to-rear end collision crashes. The following distance warning system was installed in trucks in the US and has the potential to reduce the rear impact by 57%.

Example of Following Distance Warning use

Drivers who took part in a training scheme in Germany including the use of different Driver Assistance systems

Marcel Ziwica, Polyrose Member of Board:
-We want to make our vehilce fleet safer. We work with AXA Winterthur as they can help us achieve that goal.
-Our investment is bearing fruit: the number of accidents in our fleet has fallen considerably. We have increased the safety of our drivers, and reduced direct and indirect costs from damage.



Claims reduction, Polyrose EDR equipped fleet; source: AXA-Winterthur Accident Research

reported that they appreciated the Following Distance Warning as one of the most helpful technologies. The Statutory Accident Insurance in the Vehicle Operating Trades (BGF) offers all companies training in which drivers are first informed about the systems, can try them and can also exchange experience of having used them. So far 400 drivers have taken part[10].

Emergency braking

Emergency Braking is already present in some vehicles. This will be extended to all large vehicles in 2013. The aim of Emergency Braking is to avoid collisions fully automatically or to mitigate them. The system reacts if a vehicle approaches another leading vehicle or obstacle. The system reacts in three steps:

1) Optical and acoustic warning, if the approaching obstacle could lead to an accident.
2) Autonomous partial braking, if the distance is reduced further.
3) Autonomous full braking, if an accident appears inevitable. Input is the distance and the relative speed to a leading vehicle.

The system reduces impact speed in case of immediate danger, which increases passive safety and reduces accident consequences:

- Reduced risk of injuries / collision mitigation through decreased impact velocity
- Reduction of braking distance through immediate braking action and adapted, improved brake assist function
- Support for collision avoidance and collision mitigation

This has an estimated death reduction of 7% on the EU 25 scale with full penetration, and one of the highest benefit-cost ratios there is for driver support systems[11]. The eSafety Forum included it as one of the priority systems in 2008.

Route Planning

Travel behaviour can be affected by ITS applications that mainly provide the traveller with a better basis for decisions in terms of traffic and travel information. In the field of ITS, travel planners have been developed on-line. The typical solution is based on the internet giving the answer of how to get from A to B taking various requirements into account. This can also be complimented by help of in vehicle satellite navigation systems. This may give information on time of arrival, time of departure, travel time, travel cost and be of relevance to route planning at work. Technologies to help with journey planning can also direct drivers along the most efficient routes. They can be linked to technologies used out of the vehicle to do with scheduling of shifts and link to managing fatigue. Some satnavs and journey planners already take into account school times to direct drivers away from schools during peak times.

An EU funded project called "HeavyRoute"[12] has developed tools, systems and collected data to link Europe's road infrastructure via electronic mapping systems to the truck operators and drivers. It is hoped this will contribute to the overall road safety and congestion both giving route information before the trip commences and on-trip.

Fatigue and Drowsiness Detectors

Research shows that driver fatigue is a significant factor in approximately 20% of commercial road transport crashes (ETSC, 2001). Fatigue affects drivers when they start to become tired as they can't concentrate properly on driving and can't respond as quickly and safely as they should.

Research has also been undertaken to track the drowsiness of drivers and advise them to take a break if alertness starts to fade. One of the technolgies includes tracking the pupil. Tests have been carried out

10 www.fahrer-assistenz-systeme.de/2008/index.php?id=57

11 eIMPACT Project Results www.eimpact.eu/download/eIMPACT_D6_V2.0.pdf

12 www.heavyroute.fehrl.org

by Volvo Trucks in Sweden in 2008 involving 68 drivers. Mercedes has developed a system which is already on offer in E-Class cars called 'Attention Assist' which observes driver behaviour such as speed, lateral and longitudinal acceleration and steering wheel movement. If the system detects typical indicators of drowsiness the driver will be alerted by an audible signal and flashing message to take a break.

Of course, the bottom line here is always that the most effective countermeasure for fatigue is sleep. Fatigue detectors will only therefore be effective in so much as they are used to ensure drivers take some sleep.

Example of the promotion of driver assisting systems

In Germany the Institution for Statutory Accident Insurance in the Vehicle Operating Trades (Berufsgenossenschaft für Fahrzeughaltungen BGF) has set up a scheme with a Eur 2,000,000 budget available to transport sector enterprises to invest in their heavy goods vehicles with driver assisting systems. An employer can apply for Eur 2,000 per vehicle as an investment aid if the new truck is equipped with the following three driver assisting systems:

ACC: Adaptive Cruise Control
LDW: Lane Departure Warning
ESC: Electronic Stability Control

The BGF plans to assess the effectiveness of these measures up to the year 2010 by comparing accident data for 1,000 vehicles that are equipped with the systems, with data for another 1,000 vehicles without the assisting systems. Driver training concerning the advantages and risks associated with the systems is also part of this campaign. The campaign is a joint venture of various partners (BGL, KRAVAG), car manufacturers (IVECO, MAN, Mercedes Benz), with different levels of engagement. The campaign was launched on 23rd May 2008 under the patronage of Mr. Günter Verheugen, Commissioner for Enterprise and Industry (EU-OSHA 2009).

Existing EU Level Initiatives

At present there are a number of EU initiatives including legislation and information campaigns that will promote the use of in vehicle technologies although none specify prioritising them within the work related road safety context.

"Type Approval requirements for the general safety of motor vehicles" (COM 2008/316)

The new regulation on the "Type Approval requirements for the general safety of motor vehicles" (COM 2008/316) advances the deployment of a number of in-vehicle technologies. ESC for new car series and commercial vehicles will be phased in from 2012, with all new cars being equipped by 2014. Advance Emergency Braking Systems will be in all large vehicles from 2013. Lane Departure Warning systems will also be introduced to all large vehicles by 2013. The Regulation also foresees the compliance with the provision of visual and audible seat belt reminders for the driver's seat by the 1st of November 2012. This could particularly help raise the seat belt wearing rates amongst HGV drivers.

Directive on Intelligent Transport Systems (COM 2008 887) and Action Plan (COM 2008 886)

The EU ITS action plan suggests a set of concrete objectives and a Directive laying down the framework for the implementation of ITS stressing that they can contribute to making transport safer, more efficient and competitive, more sustainable and more secure. The EU ITS Action Plan also includes a number of proposed measures specifically related to in-vehicle technologies (ESC, ACC, lateral support, emergency braking, eCall, Speed Alert and alcohol interlocks) for safety. Under Area 1 of the ITS Action Plan and in the Directive there are provisions for the optimal use of road, traffic and travel data. This includes the definition of procedures for the provision of EU-wide real-time traffic and travel information services and optimisation of collection and provision of road data and traffic circulation plans, traffic regulations and

recommended routes. This also includes definition of procedures for accurate public data for digital maps. The provision of such a digital database of all speed limits on the network is an important prerequisite for the implementation of ISA. the driver's seat by the 1st of November 2012.

eSafety Forum and the Intelligent Car Initiative

These initiatives were both launched in 2006 to promote the use of information and communication technologies for smarter, safer and cleaner road transport. The eSafety Forum, is the first pillar of the Intelligent Car Initiative, and is a joint initiative of the European Commission, industry and other stakeholders. It aims to accelerate the development, deployment and use of Intelligent Vehicle Safety Systems that use information & communication technologies to increase road safety. It also coordinates the stakeholders and meets regularly. The Intelligent Car Initiative aims to support research into intelligent vehicle and cooperative systems and take up research results. Information dissemination is the other activity field of the Intelligent Car Initiative and it ran the first awareness rasing campaign: Choose ESC!

Recommendations to the EU

4th Road Safety Action Programme

- Recognise the contribution of in-vehicle technologies by employers in improving road safety and contributing to the EU target of reducing deaths on Europe's roads beyond 2010.

- Encourage employers managing fleets (also those of EU institutions) to purchase vehicles with in vehicle technologies which have high life saving potential.

Public Procurement

- Adapt the EU Directive on the promotion of clean and energy-efficient road transport vehicles[13] to include in vehicle technologies for safety in public procurement.

Seat Belt Reminders

- Adopt legislation to ensure that every new vehicle has as standard equipment an enhanced seat belt reminder system for all occupants with audible and visual warnings. This is of particular relevance to increase seat belt wearing rates of drivers of commercial vehicles who tend to have low average seat belt wearing rates.

Speed Management Technologies

- Encourage further roll out of speed management technologies including ISA amongst particular user groups such as government vehicle fleets, public buses and company vehicle fleets including those of rental car companies. In the medium term adopt legislation for the mandatory fitting of all fleet cars with speed management technologies including Intelligent Speed Assistance systems.

Alcohol Interlocks

- Support the development of uniform standards and a high level of reliability for alcolocks in Europe to pave the way for legislation in the medium term making alcolocks mandatory for commercial transport drivers.

Event Data Recorders

- Contribute to the development of harmonised standards of in-vehicle "Event data recorders" functionalities to record collisions with most harmful consequences. Encourage the wider use of in-vehicle "Event data recorders" in fleets.

13 Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles.

ITS

- Within the context of the EU's ITS Directive and Action Plan, regularly monitor developments in passive and active safety technologies for fleets for standard setting followed by market penetration or eventual legislation for their deployment.

Road Safety Charter

- Recognise specifically the use of in-car technologies by employers who have implemented successful programmes within the scope of the Road Safety Charter.

Research

- Influence the development of in-vehicle technologies in fleets which are linked to tackling the biggest causes of road death by allocating additional research and development budget.

EU Member State Level Legislation and Policies

Some Member State governments have taken action to improve work related road safety and a number of these have also specifically promoted in-vehicle safety technologies as part of their policies. Beyond the Risk Assessment required by EU legislation some governments have legislated further that employers should take specific action on improving road safety at work. In the UK, Health and Safety at Work legislation includes the requirement of ensuring health and safety of all employees while at work and not putting others at risk by work-related driving activities[14] (DfT 2003).

Others take the non-legislative approach and encourage employers to take action via different initiatives such as in France. Governments can bring about change by setting an example. They can influence demand through their own public procurement policies. There is in fact great potential to do this. All non-private customers, such as governmental bodies, local authorities and companies can play an important role by including specific requirements on minimum safety levels in their vehicle purchase and leasing policies. In doing so, public authorities and companies contribute to the market penetration of safer cars by supporting the demand for such vehicles and for safety technologies, which hopefully in turn help lowering the price of safety technologies.

Swedish Road Administration leads the way with Safety Requirements for their vehicles

Since the 1st of February 2009 Sweden introduced compulsory rules for governmental authorities concerning environmental and traffic safety requirements when purchasing a vehicle. The goal is that 75% of governmental authority vehicles (11, 000 vehicles or 0.23% of the vehicle fleet in Sweden) shall be fitted with alcohol interlocks by 2012. Some governments also take a specific interest in promoting EuroNCAP ratings and in-vehicle technologies to employers. Moreover there are NGOs active in some of the leading countries that are running different initiatives to promote work related road safety by directly working with business. Within this context some action is also taking up the issue of specifically promoting the use of in-vehicle safety technologies amongst employers.

As part of its travel policy, the Swedish Road Administration has set up strict requirements for cars used on official business. Requirements are regularly updated and will continue to be in order to raise the standards on energy efficiency, vehicle emissions and safety[15]. Cars rented for less than 6 months must meet specific requirements such as:

- Be awarded 5 stars for occupant protection by Euro NCAP
- Be equipped with Electronic Stability Control (ESC)
- Be equipped with a seatbelt reminder on the driver seat that meets Euro NCAP requirements

14 The Corporate Manslaughter and Corporate Homicide Act Newer legislation adopted in 2007 in the UK introduces an important new option for certain very serious senior management failures which result in death.

15 www.vv.se/Andra-sprak/English-engelska/Facts-about-the-Swedish-Road-Administration-/Policy-documents/Travel-policy/

Cars rented for more than 6 months must also meet additional requirements such as:

- Be awarded at least 2 stars for pedestrian protection by Euro NCAP
- Be equipped with an alcohol ignition interlock
- Be equipped with an informative or supportive Intelligent Speed Assistance system.

Those requirements are also used by other public bodies and private companies. A brand new national law requires all government bodies to buy or rent only 5-star Euro NCAP cars for occupant protection ("government specification" as is the case for environment standards). This also has another overspill effect as rental companies, such as Hertz, Avis and Europcar, are upgrading their whole fleet to offer 'SRA recommended cars' to all their customers (PIN Vehicle Flash 13 ETSC 2009).

Driving for Better Business Initiative in the UK

In the UK the Department for Transport runs a Driving for Better Business outreach programme. This supports business leaders who have successfully managed driving for work in their companies to take the message, at high level, to business more widely. Roadsafe is the Department's partner in delivering the programme. Its main activities have been to recruit 'champions' from the business community, identify partners for pilot project; and engage a wide range of other commercial and road safety interests. Roadsafe has worked closely with the Department and its driving-for-work campaigns and has developed links with the National Business Travel Network (also DfT sponsored).

France: Committee to Prevent Road Risk Amongst Professional Transport

In France the Government took the initiative to set up the "Steering Committee to prevent road risk amongst professional transport", an organisation responsible for advising a number of government bodies and putting forward proposals on work related road safety. The work of the Committee has the potential to reach 22 million employees in France. The Committee also disseminates information to all stakeholders involved in work related road safety, including the private sector.

The Committee underlines that both road safety 'at' work and road safety 'to' and 'from' work (commuting) should be addressed, and in this light in 2008 the French Interministerial Committee on Road Safety has asked the various Ministries to consider whether it would be possible to define motor vehicles a piece of work equipment.

The Committee is also involved with the private sector actors, a number of which have signed charters declaring that road safety is one of their key concerns. The Committee also organises an awards programme to congratulate and encourage companies concerned with road safety to continue investing efforts. One of the awards concerns fleet management. When it comes to fleet management the Committee is especially concerned with Light Commercial Vehicles (LCVs), and publishes the following recommendations in terms of in-vehicle equipment: Airbags, ABS, ESC, a visual display in the dashboard in case of vehicle overload, and tyres fit for the professional use of vehicles.

Germany –"Best Co-Driver": Campaign of the German Road Safety Council

Three years ago the German Road Safety Council (DVR) has launched a campaign on Advanced Driver Assistance Systems including ACC, ESC and Lane Departure Warning. It is mainly focused on reaching media message multipliers such as the print media and radio stations to inform the general public about driver assistance systems. In the course of the campaign, employers and politicians have been invited to demonstrations and training for the use of ADAS. An easy to use brochure has been developed (also in English) about the different technologies and their life saving potential. DVR has also created a database where purchasers of vehicles including employers can find the availability and cost of the technologies for each vehicle type[16] . This campaign is connected to the EU's eSafety Aware Initiative.

16 www.suche.bester-beifahrer.de/result/

Initiatives of Employers to introduce In-Vehicle Technology

Private sector awareness and engagement in road safety is increasing, and is essential for the alleviation of the injury and death toll in road transportation at large. Indeed private sector actions can help protect not only professional drivers but all road users. The private sector is nowadays expected to be socially responsible, which in the field of fleet management very often means going beyond legal requirements. Innovations in vehicle safety equipment are developed and hit the markets at a very fast pace (much faster than the time it takes to legislate on their use) and fleet vehicles are most often the quickest route to get vehicles fitted with such innovations on the roads. Large fleet operating organisations can also literally influence the market by using their strong purchasing/consumer power and dictate what sort of vehicles and equipment hit the market. The vehicle industry has already started responding by marketing vehicles such as the "safety van" which includes the latest safety features in their state of art vehicles[17]. As such they have a moral obligation to provide not only their employees with safe vehicles but also help profit road safety at large.

In terms of vehicle safety and in-vehicle equipment what employers can do ranges from purchasing safer vehicles to fitting very advanced safety equipment to their fleet.

Recommendations for Employers

Getting started

- Undertake a risk assessment and draw up a road safety action plan. Based on priorities identified in the assessment and as part of corporate/organisational transportation and occupational health responsibilities include in-vehicle technologies as part of the solution as appropriate.

Vehicle selection

Fleet vehicle purchase decisions have the potential to have a dual impact on road safety: there is some evidence that fleet or company vehicle drivers may be more at risk than private vehicle drivers (Bibbings, 1997), and the penetration rate of ex-fleet vehicles in the second-hand vehicle market is very large, providing a penetration of new technologies into the vehicle market at a rate faster than there otherwise might. Over 50% of new vehicles are initially purchased for commercial purposes. Most of these vehicles will be integrated into the wider vehicle pool within two to three years. This means that the more safety features fleet buyers specify, the more they help the general vehicle pool to become safe relatively quickly.

Purchasing safe vehicles is therefore an excellent way for employers to provide a safe working place to their employees; however some evidence suggests that other considerations still outrank safety in fleet vehicle purchase selection (Koppel et al., 2007). Koppel et al. (2007) compared both Spanish and Swedish fleet managers' responses to vehicle purchase questionnaires and found that vehicle safety is not the primary consideration in both countries, but is outranked by factors such as price, running cost, reliability, size, and fuel consumption. Interestingly vehicle safety did not appear to be significantly more important to Swedish fleet managers. Regarding how to find safety information, EuroNCAP ratings were only cited by a small proportion of Swedish fleet managers and no Spanish fleet managers as the most valuable source of information. Overall this suggests a need to increase the profile of vehicle safety, and provide information about where to find objective safety information, such as EuroNCAP, to fleet managers (rather than letting them rely on manufacturers' information: manufacturer website / dealership etc.).

Providing passive protection through product or environmental design is a good strategy. Thus employers anticipate human failure and specify passive safety features on vehicles, as this does not require any difficult behavioural changes. The counter argument is that it lowers driver concentration and skill levels. In reality, a combination of both is generally implemented in organisations (see Prevention Model table above).[18]

17 www.mercedesbenz.co.uk/content/unitedkingdom/mpc/mpc_unitedkingdom_website/en/home_mpc/van/home/vans_world/innovation/safety_van.html

18 Adapted from © and Intellectual Property Dr Will Murray, Interactive Driving Systems, all rights reserved, 2008

- Include safety criteria when purchasing vehicles, including 5 star Euro NCAP cars and vehicles using in-vehicle safety technologies.

- Include pre-crash features to help reduce the chances of a crash and at scene and post crash safety features which are designed to prevent or minimise injury to the vehicle's occupants in the event of a crash. Active features involve driver action, Passive features do not.

- Specifying as many safety features as possible, to avoid collisions (ABS or ESC) and reduce injury (quality front and rear seatbelts) can improve safety and increase vehicle resale values.

Guides to select safer vehicles are also provided at:

www.landtransport.govt.nz/vehicles/

www.monash.edu.au/muarc/about/RS040134.pdf

Managing staff and use of in-vehicle safety technology

- Safety features are not an excuse for ignoring the wider fundamentals of fleet risk management. For example, employers should ensure that employees always wear their seatbelts – as well as just having them in the car.

- Communicate vehicle safety technologies purpose (i.e.: this is for your own good and we value you and are concerned for your wellbeing!) to employees and train them to use equipment properly.

- Apply in-vehicle safety technology criteria to the management of "grey fleet" (grey fleet vehicles are employees' own, 'private', vehicles when used for work) and lease vehicles.

- Try to encourage "ownership" of vehicle and driver as much as possible (1 vehicle = 1 driver) as experience has shown greater care in looking after the vehicle and included technological equipment benefits from such use.

Working with third parties

- Choose contractors who also apply road safety to their work and fit safety equipment to vehicles safety as part of the supply chain.

- If possible influence vehicle manufacturers through high purchasing consumer power.

Event Data Recorder Use

Based on experience so far employers should:

- Develop a contractual and binding system of incentives and sanctions to generate and maintain the necessary level of cooperation between the insurance company and the fleet operator.

- Instruct the staff about the use of EDR, its data and possible consequences; set up also here a system of incentives and sanctions.

- Download and evaluate EDR data regularly for taking practical measures within the fleet.[19]

Downsides of technologies, potential barriers and how to overcome them

In-vehicle technological features are welcomed only after verifying their life saving potential. They must be implemented carefully with proper training to avoid a number of downsides. One major downside is the so-called risk compensation effect. This is an effect whereby individuals may tend to adjust their behaviour in response to perceived changes in risk. There is evidence to suggest that such an effect can be linked to the use of safety features in vehicles. This is particularly compelling for the case of antilock braking systems (ABS). There have been experiments asserting that drivers adapt to the safety benefit of ABS by driving more aggressively,

19 A comprehensive study on what is necessary in practical and organisational terms to make successful use of EDR in fleets was presented by Christian Nasca for Winterthur Versicherungen (Accident Research), [Investigations on the use of Accident Data Recorders in fleets].

and there is empirical evidence that collisions occurred after the introduction of ABS because of people testing the system's thresholds (Aschenbrenner and Biehl, 1994).

Technologies like ABS place over emphasis on reactive safety, rather than proactive safety and careful driving. Drivers must drive carefully at all times (ABS is designed to help the driver maintain control of the vehicle during emergency braking situations, not make the car stop more quickly). To gain any safety advantage from ABS, drivers must learn how to operate it correctly (Murray 2008).

Data security and protection, and liability issues

The handling of data (notably personal data) in in-vehicle applications raise a number of issues, as citizens' data protection rights are at stake. At the same time, data integrity, confidentiality and availability must be ensured for all parties involved, especially citizens. Finally, the use of applications create additional requirements in terms of liability. These issues can be a major barrier to wide market penetration of some technologies if citizens' rights are not shown to be fully protected. The EU's ITS Action Plan proposes to assess the security and personal data protection aspects related to the handling of data in ITS applications and services and propose measures in full compliance with Community legislation. Furthermore it also aims to address the liability issues pertaining to the use of ITS applications and notably in-vehicle safety systems (EC 2008 ITS Action Plan).

Who is responsible if a system fails and the car is involved in a crash? The usual case when a crash occurs is that the driver is responsible for an accident. However, in the case where a failure of technical equipment is in part responsible for a crash, it has to be determined whether the crash would have been avoidable if the system was functioning correctly, and whether the driver had the chance to overrule the system. Collisions rarely meet all the conditions to determine that the failure of a technological component alone is responsible. In Germany for example Menzel (2004) notes that there are no cases known in which an unavoidable accident occurred only because of a failing ADAS (advanced driver assistance system). The liability argument is often put forward when technological advancements hit the markets, however many of the handling and engine management packages currently on offer in vehicles intervene in some way between the driver and the controls of the vehicle. However with all these, the driver does remain in control of the driving task (ETSC, 2006). Furthermore, manufacturers of in-vehicle equipment tend to protect themselves with disclaimers in their manuals, so that it becomes very difficult for customers to prove that the damage has been caused by system failure.

Conclusion

In conclusion in-vehicle technologies can make a life saving contribution to improving road safety at work. Crucial to their effectiveness however is that they are integrated into management structures that address the greatest risks. Employers should make every effort to apply them but also train staff on their use and monitor their implementation. At a European level the deployment of life saving technologies should be prioritised in the upcoming ITS Action Plan and Directive. Their use within the context of improving road safety at work should also be included in the new 4th Road Safety Action Programme. They should be prioritised by all according to their greatest life saving potential.

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