In-Car Enforcement Technologies Today

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In-Car Enforcement Technologies Today

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The European Transport Safety Council

The European Transport Safety Council (ETSC) is an international non-governmental organisation which was formed in 1993 in response to the persistent and unacceptably high European road casualty toll and public concern about individual transport tragedies. Cutting across national and sectoral interests, ETSC provides an impartial source of advice on transport safety matters to the European Commission, the European Parliament and, where appropriate, to national governments and organisations concerned with safety throughout Europe.

The Council brings together experts of international reputation and representatives of a wide range of national and international organisations with transport safety interests to exchange experience and knowledge and to identify and promote research-based contributions to transport safety.

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Executive Summary

This ETSC Policy Paper on "In-Car Enforcement Technologies Today" brings together evidence on how the development and introduction of three "compliance enhancing in-car technologies" can contribute to saving lives in Europe. It aims to promote innovative enforcement solutions, amongst manufacturers and policymakers, that help to reduce the collision frequency, maximise casualty reduction and minimise injury risks. The three areas prioritised in the EC Recommendation on Enforcement in the Field of Traffic Law are speeding, drink driving and seat-belt use. This Policy Paper identifies three technologies addressing each one of these areas. These include the further extension of seat-belt reminders to encourage greater compliance in seat-belt wearing, the introduction of alcohol inter-locks to tackle drink driving recidivism and set standards in commercial transport and thirdly, the development of Intelligent Speed Adaptation (ISA), informing or ensuring that a driver does not break the speed limit. As such this Policy Paper forms part of the ETSC "Enforcement Programme"[1], monitoring the application of law in the field of road traffic across the EU 25 Member States since 2004.

EU governments and decision-makers can do a lot to actively influence consumer choice in requesting these life-saving devices.

The Policy Paper outlines the kind of devices that are currently available and their stage of development. It also presents figures illustrating the life-saving potential and cost-effectiveness of each new technology and the state of advancement of acceptance by policymakers, manufacturers and consumers. Efforts made by car-manufacturers to ensure the safe use of their products with respect to issues such as speed, seat-belts and alcohol are also discussed. The level of current introduction of each of the three technologies is also presented with examples of best practice from leading countries. Finally, policy recommendations for the European and national level and for manufacturers are presented, identifying what must happen to bring about the further uptake of these life-saving technologies. The main recommendation recognises that these three major technologies are at different stages of development. However, each one of them should be piloted by specific target groups including public authorities and commercial transport. In parallel, their "stronger" versions (i.e. alcohol inter-locks with a re-testing function, mandatory ISA which prevents a car from exceeding the speed limit, seat-belt inter-locks) should be used in offender programmes. Moreover EU governments and decision-makers can also do a lot to actively influence consumer choice in requesting these life-saving devices.

The Policy Paper comes out at a crucial time ahead of the Mid-Term Review of progress made by Member States in the implementation of the 3rd Road Safety Action Programme. This programme contains measures to be implemented by 2010, with a view to halving fatalities on Europe's roads. May it inspire decision makers on further actions to be taken on achieving this target by 2010

[1] http://www.etsc.be/enforcement-etscprogramme.php

Introduction

The European Commission has set, in its White paper on the European Transport Policy, an ambitious target of halving road deaths by the end of 2010. Police enforcement of rules covering speeding, drink driving and the use of seat-belts alone can help avoid 14 000 fatalities by 2010 in the EU-15 alone, according to Commission estimates (ICF, 2003). The European target of a 50% cut in annual road deaths by 2010 can only be reached if traffic law is enforced more effectively. That is why the European Commission has adopted a Recommendation on how Member States should improve their enforcement policies. Enforcement technologies such as alcohol inter-locks, seat-belt reminders and Intelligent Speed Adaptation devices have an important role to play in securing compliance with key traffic rules. Their implementation requires additional awareness and support from car makers. Their application should work alongside police enforcement to achieve greater compliance of seat-belt use, speed limits and drink driving limits.

1 Seat-belt reminders

Apart from the driver, the seat-belt is the single most important safety feature in the car. In fact, most other safety features in a car are based on the premise that a seat-belt is being used. Using seat-belts is the most effective way to avoid death or injury in a car crash. Despite EU legislation that mandates the use of seat-belts, wearing rates vary considerably within the EU member states, averaging 76% for front seat occupants and 46% for rear seat occupants (ETSC, 2003). Belt use in accidents is significantly lower. Many studies show that in fatal crashes only between 30 - 50% of drivers were buckled (Kamrén 1994, Björnstig et al. 1995, GDV 1998). Approximately 15,200 unbuckled occupants are killed every year in the EU. If the belt use could be increased to 100% approximately 7,600 lives could be saved (ETSC, 1996).

Many studies show that in fatal crashes only between 30 - 50% of drivers were buckled.

Seat-belt reminders are devices that send out a light and/or sound signal to alert the car occupant that he or she is not belted. There are different types of seat-belt reminders – some are just visual warnings while others are using both visual and auditory warnings. Many new vehicles are now fitted with such devices. Seat-belt reminders have been developed for all seating positions in the car, but are to date most commonly fitted only for the driver seat or for both front seats.

Attempts have also been made for retrofit systems to be used on the initiative of the Swedish Insurance Federation. These are low-cost self-contained systems not interacting with the electronics of the car.

1A. LIFE-SAVING POTENTIAL

Field trials in the USA, Australia and in Europe have proven that seat-belt reminders ensure that the occupant uses the seat-belt more frequently (Williams et al 2002, Harrison 2000, Turbell et al 1997). A Swedish study shows that the seat-belt wearing rate was 99% in cars fitted with seat-belt reminders that fulfil the EuroNCAP specification (Folksam, 2005). In the control group without reminders the wearing rate was 82%. The study was conducted by studying the wearing rate in cities during normal traffic. An Australian study has shown that by installing audible and visual seat-belt reminder system, the seat-belt wearing rates could be increased to at least 95% (Harrison, 2000). Australian field trials show that seat-belt reminders help to persuade the occupant to use the seat-belt more frequently (Regan et al, 2004). The percentage of driving time spent unbuckled decreased by 30% and the mean time taken to buckle the seatbelt decreased by up to 75% when the system was active. Reminders are however only effective with regard to occupants who unintentionally forget to use their seat-belt. They are not effective for the small minority of persistent non-users.

Seat-belt reminders have been developed for all seating positions in the car, but are to date most commonly fitted only for the driver seat or for both front seats.

A Swedish study has shown that not all reminders are equally effective (Björnstig et al, 2001). Three different systems were investigated: reminder systems with both audio and visual signals, reminder systems with only a visual signal and no reminder system. A total of 477 injured car drivers

Table 1. Seat belt wearing rates in the EU-15 (ETSC, 2003)

Country	Wearing rate, front seats (%)	Wearing rate, rear seats (%)
Austria	70	35
Belgium	55	25
Denmark	70	33
Finland	87	66
France	85	45
Germany	95	75
Greece	45	9
Ireland	53	10
Italy	50	10
Luxembourg	55	25
Netherlands	75	47
Portugal	45	10
Spain	61	20
Sweden	85	74
UK	93	75

were included in the study. Ambulance personnel made observations regarding the use of seat-belts. Findings concluded that the reminder system with both a light and sound signal was the most effective system. The difference between vehicles equipped with reminder systems with only a light signal and vehicles without reminder system was found to be minor.

Less advanced retrofit seatbelt reminders also have a large potential for casualty reduction. A study performed by the Swedish Road and Transport Institute (VTI) has concluded that a seat-belt reminder for retrofit at driver position would reduce road fatalities in Sweden by about 7% yearly, if fitted into 2 million Swedish cars (Meijer & Roos, 2004).

A Swedish study has shown that not all reminders are equally effective.

1B. USER ACCEPTABILITY

A Swedish study regarding the non-users' motives for not wearing seat-belts (Dahlkvist, 1999) showed that less than 1% of drivers were totally against seat-belt reminders. The majority of non-users had very favourable attitudes to seatbelts. However, the acceptability of seat-belt reminders will probably vary among the EU countries.

Less than 1% of drivers are totally against seat-belt reminders.

The majority of new cars sold in Sweden in the last years have been fitted with seatbelt reminders, and only a small number of negative responses from customers to these manufacturers and importers have been raised.

1C. MANUFACTURERS' EFFORTS

EuroNCAP tests the crashworthiness of new cars with respect to front and side impacts and pedestrian accidents. Results are stated in terms of stars: five stars represent the best performance (four stars in the case of pedestrian ratings), zero stars the worst. In 2004 EuroNCAP started providing added point bonuses for vehicles fitted with seat-belt reminders (see the assessment protocol[2]).

[2] http://www.euroncap.com/downloads/test_procedures/area_3/event_2/Seat%20Belt%20Reminder%20Assessment%20Protocol%20V1-0b.pdf

EuroNCAP promotes installation of seat-belt reminders by extra points for vehicles fitted with them. The system must fulfil a series of conditions. Most of the new vehicles have reminders for the driver seat. Of all vehicles tested by EuroNCAP since 2003, 72 % have seat-belt reminders.

Seat-belt reminders for the rear seat were introduced in the Volvo S40 during the year 2004. Only a few car models are to date fitted with seat-belt reminders for the rear seat. Compared with reminders for the front seat, rear seat systems appear more costly as they are more complicated to install.

Of all vehicles tested by EuroNCAP since 2003, 72 % have seat-belt reminders.

Following a competition organised by the Swedish Insurance Federation and the Swedish Motor Vehicle Inspection Company, an inexpensive retrofit seat-belt reminder system for the driver seat is currently being developed at Autoliv. To date no initiative has been taken for implementation in cars, but discussions have started.

1D. INTRODUCTION SCENARIO

Seat-belt reminders should be introduced in a step-wise approach to all new vehicles. First to all driver seats, secondly to all front passenger seats and then back seats. In parallel retro-fitting of vehicles with seat-belt reminders to all seats should be developed.

The number of seat-belt reminders to be included in all manufactured cars should be increased through a combination of measures. Firstly, fiscal incentives should be provided to encourage their take up by consumers. Secondly, communications and awareness raising on safety benefits of seat-belt reminders and cars which have seat-belt reminders should be undertaken. Thirdly, legislation should aim to achieve a 100% wearing rate amongst EU drivers and passengers. European legislation on type approval and obligatory installation of seat-belt reminders should be introduced.

1d.i Incentives for consumers to choose cars with seat-belt reminders

Governments should provide incentives to consumers to purchase cars with seat-belt reminders. This could take the form of tax breaks on cars that have seat-belt reminders. Governments should also provide information about cars which include seat-belt reminders. This information is covered by EuroNCAP.

Government could also play a role in promoting safety as a criterion for consumers to consider through running consumer awareness campaigns on purchasing safe cars which have seat-belt reminders. Governments and the European Commission should also encourage and support initiatives by the insurance sector for consumers to choose cars with seat-belt reminders.

This should consider that premiums reflect both the first party costs (generally damage to the driver's own vehicle) and third party costs (generally damage to property outside of the driver's vehicle and injury costs for people outside of the vehicle although it will, of course, include injury costs for passengers in the driver's vehicle where the driver is at fault). These new technologies, therefore, need to be able to reduce the casualty rate and the level of severity of collisions. Research and experience is needed to further clarify how this factor works to encourage an up-take of car models with seat-belt reminders. Implications should be considered for use with all three in-car technologies under consideration recognising that insurers will give greater credence to technologies that can not be overridden or deactivated by the driver.

In many countries a large proportion of new sold cars are purchased by non-private customers. For example in Sweden and Germany this figure is approximately 40%. Therefore, all non-private customers, such as governmental bodies, local authorities and companies could play an important role by including seat-belt reminders in their vehicle purchase and leasing policies.

1d.ii Incentives for manufacturers to produce cars with seat-belt reminders

As consumers take more of an interest in purchasing safe cars, manufacturers' motivation to gain full marks by including seat-belt reminders in the EuroNCAP rating rises. Primarily, governments and the European Commission should be encouraged to promote EuroNCAP amongst car manufacturers. At present not all makes and models of passenger cars are tested within EuroNCAP. Secondly, more countries should be encouraged to join the EuroNCAP programme. This will give member countries an enhanced basis for providing the right information to consumers.

Governments and the European Commission should be encouraged to promote EuroNCAP amongst car manufacturers.

Although progress is being made towards greater seat-belt wearing compliance, disparities exist across the various EU countries. Huge differences also exist between front and rear seat wearing rates. Providing for seat-belt reminders in every car would be a big step towards ensuring full compliance and progress towards saving lives and reducing the casualty rate.

2 Intelligent Speed Adaptation (ISA)

Compliance with speed limits is generally poor, and speed limits are often exceeded with relatively little public disapproval of speeding. Drivers readily admit to exceeding the speed limit (SARTRE 3, 2004). Excess or inappropriate speed is involved in around one-third of accidents resulting in vehicle occupant fatalities (ETSC, 1995). This estimation stems from police accident investigation coding of contributory factors. However it is recognised that this methodology tends to underestimate the role of speed in crashes (Carsten & Tate, 2000). Moreover, lower speeds also result in less severe consequences. There is a trend to lower urban speed limits to 30 km/h. However many urban streets which should have 30 km/h speed limits still only have 50 km/h speed limits as some experts maintain that the compliance would be lower. Yet ISA would be a way of guaranteeing speed limit compliance.

Excess or inappropriate speed is involved in around one-third of accidents resulting in vehicle occupant fatalities.

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 A). Information regarding the speed limit for a given location is usually identified from an onboard digital map in the vehicle. In terms of intervention level there are three major types of system – informative, supportive and intervening.

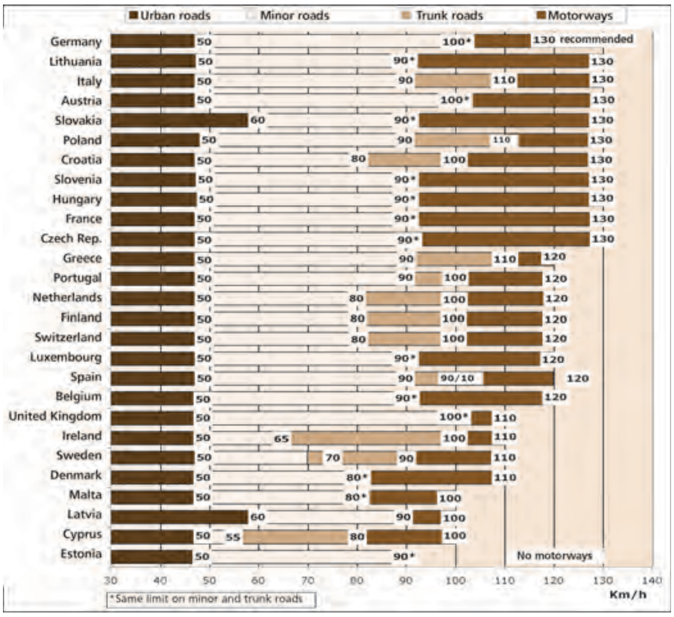


Figure 1. Speed limits in Europe (J-P Cauzard, SARTRE 3, 2005)

An informative system gives the driver feedback in the form of a visual or an audio signal. It activates when the vehicle exceeds the speed limit by 2 km/h or more. A supportive system increases the upward pressure on the pedal. In an intervening ISA, the vehicle speed is automatically limited for example by reducing fuel injection or by requiring a “kick-down” by the driver. The driver is totally prevented from driving beyond the speed limit.

There are three major types of system – informative, supportive and intervening.

”Informative” (or ”advisory”):
ISA gives the driver a feedback in the form of a visual or an audio signal.

”Supportive” (or “warning”): ISA increases the upward pressure on the gas pedal. It is possible to override the supportive system by pressing the accelerator harder.

”Intervening” (or “mandatory”): ISA totally prevents 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.

2A. LIFE-SAVING POTENTIAL - INTELLIGENT SPEED ADAPTATION

ISA reduces the average speed and in particular very high speeds, and makes drivers more compliant with the speed limits. A driver with an ISA system is driving more homogeneously with up to 1.5% lower speed variability (Regan et al, 2004). ISA can also have a positive effect on other road users without the system, although, some road users travelling behind an ISA car may tend to become impatient and “push” the ISA car. The ISA system seems to be most effective in decreasing travel speeds on speed zones with 50 km/h or more in the surrounding areas (Hjälmdahl et al 2002, Mitsopoulos et al 2004). A Swedish large-scale study 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).

So far ISA is voluntary. However estimates by Carsten (Carsten et al 2001) show that a system, made legally mandatory when combined with a dynamic speed limit regime, has the potential to reduce overall injury accidents by 36 %, fatal and serious injury accidents by 48% and fatal accidents by 59%. Another field trial in the Netherlands shows that an ISA, in which the speed limit cannot be exceeded, could reduce the number of hospital admissions by 15% and the number of fatalities by 21% (van Loon et al 2001).

A system, made legally mandatory when combined with a dynamic speed limit regime, has the potential to reduce overall injury accidents by 36 %, fatal and serious injury accidents by 48% and fatal accidents by 59%.

The Hjälmdahl study found that an analysis of speed data logged in the drivers’ own vehicles during everyday driving showed that the test drivers’ compliance with the speed limits improved considerably when driving with an active accelerator pedal (Hjälmdahl et al 2004). ISA seems to be more effective when it is used together with *Following Distance Warning* (FDW) that warns both visual and audible, the driver when he/she is driving too close to a vehicle (Regan et al. 2004). Together, both systems had a positive effect on average speed and speed variability, but FDW alone did not affect either the average speed or speed variability. However, FDW was found to have a positive affect on the driver behaviour. The driver understood and reacted more quickly with this system.

2B. USER ACCEPTABILITY

Different trials using informative and supportive systems across Europe have shown that approximately 60–75% of users would accept ISA in their own cars (Peltola et al, 2004). The Finnish trial results show a positive effect for young drivers using their parents’ cars. Similarly, in the Finnish ISA field trial the companies and their drivers involved accepted the idea of using the recording ISA as a quality control system. “Big brother” fears were not observed, nor were there conflicts between employers and employees (Peltola et al, 2003). The acceptance of ISA in urban areas was as high as 80% of the test drivers in Sweden (Biding and Lind, 2002). The most positive reactions were to the alerting system. In a field trial in Australia the majority of participants were positive to the technology (Regan et al 2002). They answered that they would slow down in response to the warnings and that, in the long term, the ITS would make them safer drivers. The test drivers were willing to pay approximately 100 Euro to purchase ISA in a new vehicle (Mitsopoulos et al 2004).

Different trials using informative and supportive systems across Europe have shown that approximately 60–75% of users would accept ISA in their own cars.

2C. MANUFACTURERS' EFFORTS

In terms of technology, industry has reached a stage where most of the basic technology used in ISA systems is available. More and more cars are fitted with GPS-based navigation systems, either as part of their original fitting or as an aftermarket device. Manual speed limiters are supplied as voluntary add-ons in many new car models.

Technologies for informative ISA systems reached the market in 2005. The German company Continental Temic has announced a system called Active Distance Support (ACDIS) that combines *Adaptive cruise control* with the ability to maintain mandatory or freely selectable speeds. The ACDIS system will be making its first appearance in production models at the end of 2005. Navigon, a producer of nomadic navigation systems, has included an informative ISA function in its latest model which was available as of May 2005.

Digital maps including speed limits continue, however to pose a problem in many countries. Only some countries, including Sweden, Finland, Norway and the Netherlands have made an effort to establish such maps. Even in these countries, mechanisms to keep the speed limit data up-to-date are still mostly missing.

In terms of technology, industry has reached a stage where most of the basic technology used in ISA systems is available.

In some countries the implementation of ISA has been launched as part of public or private sector initiatives. The Swedish Road Administration has decided to equip all their vehicles purchased after April 2005 with informative ISA systems. Also some local authorities in Sweden have decided to fit ISA systems in their vehicle fleets starting 2005. The informative system used in these initiatives will give the driver feedback in form of a visual or an audio signal when the speed limit is exceeded. Information regarding the speed limit is known from the GPS in the vehicle. Digital maps with speed limits included exist for the whole of Sweden, and for example for parts of Finland, the Netherlands and the UK. Such maps are used by the ISA system to identify the speed limit for the current position of the car. In order to get correct speed limit information the maps need to be frequently updated.

In Ireland, recording ISA is used in a project run by AXA Insurance to stimulate safe speeds among young male drivers (AXA 2002). A GPS data recorder and sender unit were installed in their cars, which registers when speed limits are being broken. The unit also provides the company with a daily report of driver performance against digitally mapped speed limit areas. Young drivers (particularly males) tend to pay more for their motor insurance than any other class of driver and beneficial changes to their driving habits and claims experience will clearly feed through to the level of insurance premium they are required to pay. In the Danish county of North Jutland, a similar initiative has been planned in the framework of a research project. In the course of the three-year project, 300 cars of young drivers will be equipped with recording ISA. In the Netherlands, a small research project has been set up in which drivers of leased cars received a small reward if the recording ISA installed on the car showed that they had adhered to speed limits and kept a minimal distance to the car in front. This project, entitled Belonitor, lasted for six months starting in February 2005.

2D. INTRODUCTION SCENARIO

In a first phase, manufacturers should offer and promote existing forms of informative ISA (which have been shown to be acceptable to a majority of drivers). As the price of these devices is still fairly high, it is important that public authorities and companies are equipping their cars with this type of ISA, as in Sweden. This is also a way of showing private consumers a good example. Producers should however promote ISA among ordinary customers stressing its role as a 'comfort feature'.

Recording ISA (i.e. informative ISA with a recording function) should be used by insurers to promote safe speeds. Transport companies should use them in their fleet vehicles to ensure quality of their services and to safeguard the safety of their drivers. Equally this could be used with young drivers in guiding them to remain within the speed limits. Mandatory ISA (possibly with a recording function) should be included in programmes for repeat speeding offenders, along the lines of alcohol inter-lock programmes.

In this opening phase, a first - and already existing - generation of ISA will be employed that uses static speed limit information from digital maps. In many places, this information will only be available for part of the road network (typically motorways and national roads), and users will be responsible themselves for regularly updating their maps. In this phase, ISA will be mainly provided in the form of autonomous aftermarket solutions.

In a first phase, manufacturers should offer and promote existing forms of informative ISA.

In a second phase, ISA should be offered to customers as an integrated solution available in the majority of car models. By that time, most cars will be equipped with GPS-based navigation systems as a standard. The technology will have reached a stage where speed limit information is available for the whole of the network, and maps are updated automatically. The in-car information will completely match the information coming from roadside speed signs. It is at this point that a legislative framework for the mandatory fitment of ISA into cars will have to be considered. Looking further into the future, in-car devices should be able to calculate the appropriate speed according to the prevailing weather and traffic conditions.[3]

[3] Swedish researchers have carried out theoretical work into appropriate maximum speeds in situations where dynamic speed adaptation can be applied. See http://www.tft.lth.se/publ/7000/7196scr.pdf

3 Alcohol inter-locks

ETSC experts estimate that across the EU about 2% of all journeys are associated with an illegal blood alcohol level (ETSC, 2003). Moreover, many European drivers readily admit to driving even if they feel they could be over the limit (SARTRE 3, 2004). Drivers with an illegal BAC level cause about 30-40% of all driver fatalities and 25% of all driver injuries in Europe (ETSC, 2003). In the three SUN countries (Sweden, UK and the Netherlands), about 10-14% of all fatal accidents are caused by a driver over the limit (Koonstra 2002).

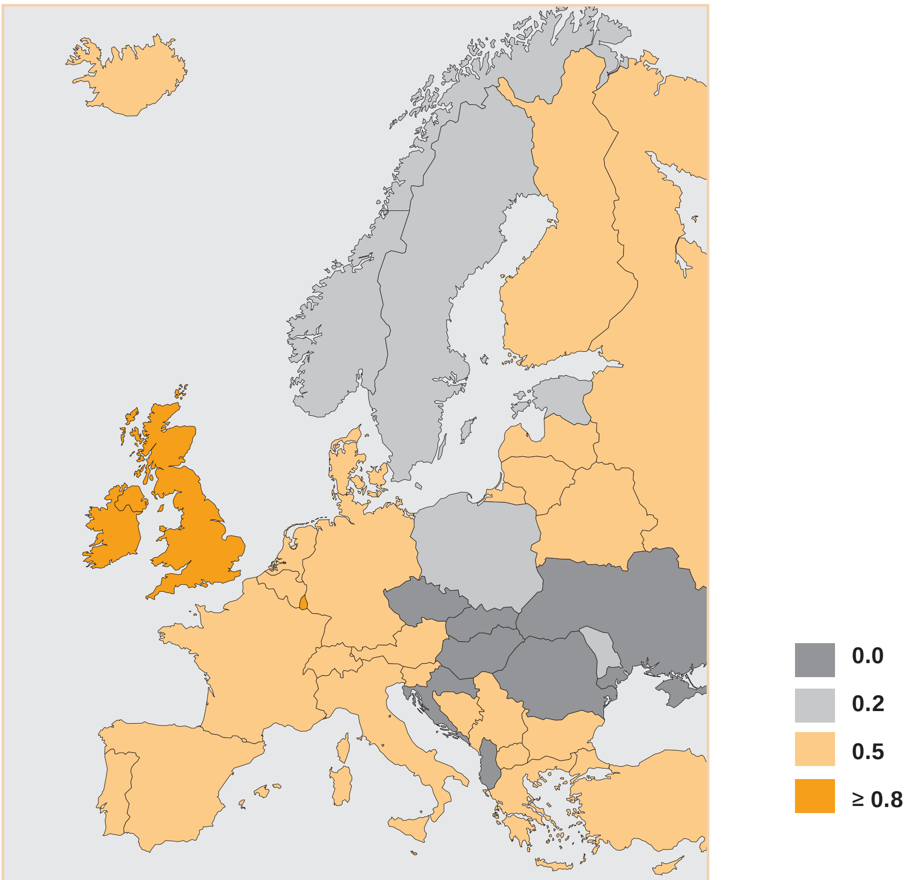
Aout 2% of all journeys are associated with an illegal blood alcohol level.

Alcohol inter-locks could however form part of a solution to reducing the problem of drink driving. An alcohol inter-lock is a breath-testing device connected to the vehicle. It is not possible to start the vehicle unless the driver has done a breath test. The driver has to provide a breath sample every time the individual attempts to start the vehicle. If the system indicates a breath alcohol concentration over the threshold level, it prevents the driver from driving (Willis et al 2004). The alcohol inter-lock can also be set at different levels depending on the particular alcohol limit suited to the different drivers. Some elements are also being developed to ensure that the system cannot be circumvented; for example re-testing after the car has been travelling for a certain distance.

An alcohol inter-lock is a breath-testing device connected to the vehicle. It is not possible to start the vehicle unless the driver has done a breath test.

There is also another system, which allows the driver to start the vehicle as normal. The system analyses the driver's breath during the driving. If trace of alcohol is detected the driver has to blow into a breathalyzer inside the vehicle. If the alcohol concentration is over the legal limit the driver has a

Figure 2. Legal limits for drinking and driving over Europe in 2005 (ETSC, 2005)



few minutes to park the vehicle before the engine stops. Alcohol inter-locks are currently used in driver rehabilitation programmes as well as some commercial transport companies in Sweden and the U.K.

3A. LIFE-SAVING POTENTIAL

Experiences in the US and Canada have shown that alcohol inter-locks can lead to 40-95% reductions in the rate of drink driving repeat offences (ICADTS, 2001). Field trials have shown that there is a 28-65% lower conviction rate if there is an inter-lock installed in the vehicle, where the 65% lower rate is reached during the first year after installation (Beck et al 1999). After some years the impact that an alcohol inter-lock can have as part of reducing drink driving repeat offences in the study by Beck et al (1999) is estimated to be lower. Alcohol inter-locks have been used in Sweden to rehabilitate voluntary drivers that had broken the law by driving with a blood alcohol content over the threshold level (0.2%). The participants in the study had a high risk of recidivism and ran a four times higher risk of being involved in an accident than the average driver. After two years of use there was still no recidivism by the participants of the test group.

3B. USER ACCEPTABILITY

The acceptability of alcohol inter-locks is probably more difficult to handle than for both ISA and seatbelt reminders, but this depends on the design of the system. Existing alcohol inter-locks, possible to buy on the market, are designed so that the driver needs to blow in a unit at every start of the engine and sometimes also at fixed time intervals. In order to reach high acceptability if alcohol inter-locks is to be fitted on a mandatory basis, it is probably beneficial if the systems only have a minor impact on normal driving behavior. Some systems have been tested, like the "Sniffer", which continuously analyses the amount of alcohol in the air of the occupant compartment. Such passive systems only have a minor impact on normal driving, and is probably more likely to be accepted by the drivers. However, for alcohol inter-locks used in company cars and in rehabilitation programmes the problem of acceptability is much lower.

In Sweden several transport companies have fitted alcohol inter-locks in their vehicle fleets. In such cases the acceptability question is not a primary issue. It is often a result of the policy of the company providing an assurance of transport quality for their customers. Alcohol inter-locks have been used in rehabilitation programmes. In these cases acceptability is not a primary issue.

3C. MANUFACTURERS' EFFORTS

In Sweden some car manufacturers, for example, Volvo and Toyota, can fit their vehicles with alcohol inter-locks if their customers wish to do so. Some large fleet buyers have also decided to fit their vehicles with such systems. Another manufacturer has demonstrated a system where a detector is built into the ignition key. The drivers must blow into the key before starting the car. The concept has many advantages, as a simple solution with good usage possibilities. Monitoring is a key factor for a successful program using this technology. Ways of preventing cheating the system such as through re-testing the breath after starting have also been developed and are being further refined.

A great potential exists for implementing alcohol inter-lock systems in company cars. Companies may be the driving force to develop and implement alcohol inter-lock systems on the market due to their policies, strategies and purchasing procedures. More than 5,000 company cars in Sweden are today equipped with alcohol inter-locks and the number is rapidly growing. A transport company in Sweden decided to equip all their 4,000 vehicles with

alcohol inter-lock systems before the end of 2006. Moreover, the Swedish Driving Schools Association decided to fit all their 800 vehicles with alcohol inter-locks.

In 2004 the Swedish government decided that all vehicles purchased or leased in 2005 or later, and intended to be used by the government administration, should be fitted with alcohol inter-locks, and Volvo recently introduced a Volvo V70 Bi-fuel with an alcohol inter-lock which is intended mainly for non-private purchasers.

3D. INTRODUCTION SCENARIO

A first step to introducing alcohol inter-locks to a wider public is to bring them into use with specific target groups including public authorities and commercial transport companies. Sweden has provided a good example for this course of action. It is is planning to introduce legislation mandating alcohol inter-locks in all trucks and buses as of 2010 and on all cars as of 2012. A European research project "Alcohol inter-lock Implementation in the European Union: An In-depth Qualitative Field Trial" (Vanlaar et al. 2004) is currently underway co-ordinated by the Belgian IBSR. This will establish the scope for alcohol inter-locks being used in commercial transport in Spain, Norway and Germany. Alcohol inter-locks are also used on a voluntary basis by some transport and cab companies and a driving school in Finland. With increasing demand, the alcohol inter-lock technology used for this purpose should become both simpler and cheaper.

Sweden has set an example by offering drink driving offender programmes using alcohol inter-locks. In Finland an alcohol inter-lock programme for drink driving offenders started in the summer 2005. Offenders will be offered the possibility to voluntarily take part in the programme and then receive a temporary "Alcohol inter-lock driver's licence". As part of the programme offenders will have to take part in regular tests for alcohol dependency. Other European countries have started to follow these for example (U.K., France). Wide-scale implementation among 'ordinary' drivers will depend on the intrusiveness of the available technology.

Policy Recommendations to the European Commission, Member States and Manufacturers

In conclusion, these three enforcement technologies are at different stages of development but clearly can save lives, lower the casualty rate and reduce the frequency of collisions. Moreover they have shown to be gaining consumer acceptability. Manufacturers are also progressing in developing them as part of their packages. However, further progress remains to be made. ETSC has developed key recommendations to be taken up by the European Commission, EU Member States and vehicle manufacturers.

ETSC RECOMMENDS THAT THE EUROPEAN COMMISSION TAKES INITIATIVES IN THE FOLLOWING AREAS:

Seat-belt reminders

- Promote and ensure high standards for seat-belt reminders.
- Ensure that all cars manufactured in Europe have seat-belt reminders for the front driver, this should then be extended as quickly as possible to the front and rear passenger seats.
- Given the aspiration to achieve 100% use of seat-belts the current EuroNCAP assessment protocol in relation to deactivation of seat-belt reminders should be reviewed. This also recognises the influence that an unbelted driver may have on fellow passengers who may also decide not to use the available seat-belts.
- With the focus on younger passengers (in both front and rear seats) the current EuroNCAP assessment protocol in relation to the trigger weight for the detection of seat occupancy should be reviewed.

ISA

- Ensure high and uniform standards in Europe.
- Promote and ensure that all cars *can* be equipped with ISA systems.
- Encourage EU projects related to the technological development of an EU-wide interface for digital maps and to its incremental updating. This should move to create a pan-European on-line source for the information.
- ISA should play a more prominent role in the European Commission's eSafety Initiative[4], which aims to accelerate the deployment of ITS.
- The use of ISA be promoted in commercial transport across Europe by stimulating the exchange of best practice in this field. This should include the use of safety concerns being included in public procurement procedures, as well as tax and insurance reductions for companies using ISA.

Alcohol inter-locks

- Ensure uniform standards in Europe with regard to technical aspects and program related aspects, and a reduced workload for those countries that wish to introduce the technology without having the appropriate legal framework.
- Ensure a highest possible reliability of the device.
- Stimulate further research into the use of alcohol inter-locks in rehabilitation programmes with the goal to set up best practice guidelines.

[4] eSafety Intiative: http://europa.eu.int/information_society/activities/esafety/index_en.htm

- The use of alcohol inter-locks be promoted in commercial transport across Europe by stimulating the exchange of best practice in this field. This should include the use of safety concerns being included in public procurement procedures, as well as tax and insurance reductions for companies using alcohol inter-locks.
- At a further stage, legislation making alcohol inter-locks mandatory might be considered.
- Focus on educational programmes to help drivers physically separate drinking and driving rather than merely controlling their behaviour.

ETSC RECOMMENDS THAT MEMBER STATES, REGIONAL AND LOCAL DECISION-MAKING BODIES TAKE INITIATIVES IN THE FOLLOWING AREAS:

General

- Provide, in co-operation within the EU, tax incentives for users of cars equipped with ISA, alcohol inter-locks, and seat-belt reminders. Motor insurers should also be encouraged to take account of these initiatives in the setting of insurance premiums. This should also include information campaigns targeting drivers on the benefits of these technologies.
- Follow the Swedish example in using ISA, alcohol inter-locks, and seat-belt reminders in commercial transport services. Public authorities should make this a procurement requirement when purchasing such services. They should be encouraged to emphasise seat-belt use and compliance with speed and alcohol limits in their instructions to their employees (both drivers and passengers) and to implement effective monitoring mechanisms.

ISA

- Support the implementation of the existing first generation of ISA systems by ensuring that digital maps of their road network are established including speed limit information. The large majority of European countries have not yet started work on these maps. Once maps are available, Member States should launch the implementation by fitting ISA into their national networks and fleets, following the example of Sweden. They should also encourage local authorities to follow suit.
- Develop programmes for the rehabilitation of high-risk drivers including the use of mandatory ISA, along the lines of existing alcohol inter-lock programmes.
- Develop programmes for use of ISA by young drivers.

Alcohol inter-locks

- Set up alcohol inter-lock programmes for drink driving offenders. Member States should use the experience gained during the European alcohol inter-lock project and that from the U.S. and Canada.

ETSC RECOMMENDS THAT VEHICLE MANUFACTURERS TAKE INITIATIVES IN THE FOLLOWING AREAS:

- Continue to introduce voluntarily seat-belt reminders to new models.
- Ensure all cars *can* be equipped with alcohol inter-locks and ISA and thus provide for the installation of after-market safety accessories.
- Further develop alcohol inter-locks to ensure that they are foolproof.

Annex 1

Annex 1

LITERATURE REVIEW

Intelligent Transport Systems (ITS)

Intelligent Transport Systems (ITS) are vehicle-based technologies designed to increase the driver's attention of the environment surrounding the vehicle thereby reducing motor vehicle accidents. ITS have a great potential to enhance traffic safety (Regan, Biding, 2002) although few systems have entered the European market up to now. Car cockpits are becoming more complex and have the potential to flood drivers with information that will distract them from the primary driving task. Therefore it is important that ITS systems are ergonomically designed to minimise distraction and cognitive load to the driver.

ITS encompass among others Intelligent Speed Adaptation (ISA), Following Distance Warning Systems, seat-belt reminders, Reverse Collision Warning and Adaptive Cruise Control (ACC) systems.

Seat-belt Reminders

Apart from the driver the seat-belt is the single most important safety feature in the car and most other safety features in a car are based on the premise of seat-belt use. Using seat-belts is the most effective way to avoid death or injury in a car crash. The occupants are warned if they are unrestrained. There are different types of seat-belt reminders – some are just visual warning while others use both visual and auditory warnings. Reported front seat-belt wearing rates vary between 53% and 92% in the EU member states (ETSC, 1996). Belt use in accidents is significantly lower. A field trial of fatally injured occupants in Sweden showed that only 40 % were buckled (Kamrén 1994). The frequency of belt use in similar studies in Germany was 50 to 70% (Langwieder et. al., 1994, GDV, 1998). In another Swedish study a 50% use was found for severely injured occupants in rural crashes and 33% in urban crashes (Björnstig et al., 1995). Approximately 15,200 unbuckled occupants are killed every year in the EU. If belt use could be increased to 100% approximately 7 600 lives could be saved every year.

The Bylund and Björnstig (2001) study showed a spread of effectiveness of different seat-belt reminders. Three different systems were investigated: reminder systems with both a light and a sound signal, reminder systems with only a light signal and no reminder system. A total of 477 injured car drivers were included in the study. Ambulance personnel made the observation regarding the use of seat-belts. The reminder system with both a light and sound signal was the most effective system. The difference between vehicles equipped with reminder systems with only a light signal and vehicles without a reminder system was minor.

An observation of drivers' seat-belt use in the US indicates that seat-belt reminders have a positive effect on the occupants' use of seat-belts (Williams et al, 2002). A total of 2, 295 drivers (1, 495 without and 800 with belt reminders) were observed. The rate of use was 71% for the drivers of vehicles without seat-belt reminders and 76% for drivers of vehicle with reminders. The difference was statistically significant ($p<0.01$). Based on this study 700 lives could approximately be saved each year if a seat-belt reminder was fitted to every vehicle on US roads. Studies from Australia and Sweden have shown that by installing audible and visual seat-belt reminder system, the use of belt could increase to at least 95% (Turbell et al, 1997, Harrison, 2000). Australian field trials show that seat-belt reminders affect the occupant to use seat-belts more frequently (Regan et al, 2004). The percentage of driving time spent unbuckled decreased by 30% when the system was active. The average time taken to buckle seatbelt decreased by up to 75% when the seat-belt reminder system was active.

Rear seat reminders

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.

Intelligent Speed Adaptation (ISA)

Intelligent Speed Adaptation (ISA) is an *Intelligent Transport System* (ITS) in which the driver is warned or prevented from exceeding the speed limit (Regan et al, 2002 A). Information regarding the speed limit for a given location is usually identified by the *GPS* navigation system installed in the vehicle. There are three types of systems, informative, supportive and intervening An informative system gives the driver feedback in the form of a visual or an audio signal. A supportive system increases the upward pressure on the pedal. In an intervening ISA, the vehicle speed is automatically limited for example by reducing fuel injection or by requiring a "kick-down" by the driver. The driver is totally prevented from driving beyond the speed limit.

ISA can be voluntary or mandatory. In the voluntary version, the driver can turn the system on or off. The system is activated when the vehicle exceeds the speed limit by 2 km/h or more. In a mandatory system, whereby the fitment of ISA is required by law, the system can't be turned off. A mandatory system will have a bigger impact on the reduction of speed related road accidents.

Research on ISA has been conducted in a number of European countries. In a large trial study in Sweden, financed and coordinated by the Swedish National Road Administration, 5, 000 vehicles were equipped with an ISA system (Biding, 2002). More than 10, 000 drivers drove these vehicles. The vehicles were equipped with informative or supportive systems. The test area consisted of urban areas; included 30, 50 and 70 km/h speed limits and the system was activated automatically when the vehicle was within the test area. The results from a field study in Sweden show that the ISA system had positive effects on road safety (Biding, 2002). The average speed was lower and the driver with an ISA system was driving more homogeneously. The results from Umeå, one of the test areas in Sweden, indicate that ISA had a positive effect on other road users. If every vehicle was equipped with ISA, the number of injuries in urban areas could be reduced by 20%. The Swedish National Road Administration recommends therefore that the public and private sectors work in partnership to launch the system on the market.

A system with active accelerator pedal with kick-down was analysed in one of the test areas in Lund, Sweden, (Hjälmdahl et. al, 2002). Data about how the driver was following the speed limit was logged in the vehicle before the test period and two times during the test– one after a short time and another after a longer time use. The study showed that the ISA system seems to be most effective on 50 and 70 km/h roads in the surrounding area. ISA system could approximately decrease police-reported injury accidents in this area by 12–17 %, on the main street by 5–
9 % and on central streets 11% (Várhelyi et. al, 2002).

A total of 28 out of 284 test drivers in Lund were observed when they were driving both within and outside the test area (Hjälmdahl et. al, 2004 A). The drivers were only supported with the system within the test area. The system had a positive effect on the driver behaviour such as giving pedestrians the right to cross the way. There was a negligible difference in time between driving with or without the system.

Hjälmdahl's study (2004 B) shows the differences in attitude and use of the ISA system between the different types of drivers. ISA was effective in reducing the speed for drivers who also without the system drive at or just over the speed limit. The system had a small effect on drivers who deliberately exceeded the speed limits. The system was less effective for drivers of fleet cars compared to drivers of private cars. The driver's attitude to the system has a huge influence on the result. If they were negative to the system they had a higher average speed. The conclusion from this study is that the safety potential for the ISA system varies a lot for different groups of drivers.

The life saving potential of this system has also been evaluated by Carsten and Tate (2001). Their study indicates that ISA with supportive feedback system has a very large potential to reduce fatal and serious accidents. This system will reduce injury accidents by 36 % and fatal accidents by 59 %. A similar study in the Netherlands shows that ISA could reduce the number of hospital admission by 15% and the number of fatalities by 21% (von Loon et al, 2001).

Another relevant field trial in Australia looked at the combination of different ITS technologies. The trial had 23 test drivers who each covered at least 16,500 kilometres in a vehicle equipped with four different types of ITS technologies: Intelligent Speed Adaptation, Following Distance Warning, Seat-belt Reminder and Reverse Collision Warning (Regan et al, 2004). The systems were analysed separately and together. When the ISA system was activated the drivers' average speed was reduced by 1 km/h and by 1.5 km/h when ISA was active together with FDW. The drivers spent 2% of their driving time at or below the speed limit. When ISA and FDW were active the drivers spent up to 30% less time driving at or above the speed limit in the 60, 80 and 100 km/h zone. ISA was more effective when it was used together with FDW. The driver with an ISA system was driving more homogeneously with up to 1.5 % lower speed variability. The average trip time did not increase when ISA was active with or without FDW. The difference was statistically significant, $p<0.05$.

Several other studies indicate that ISA has little influence on average trip times (Regan et al, 2004, Mitsopoulos et al, 2004, Várhelyi et al, 2004, Biding, 2002). The participants in the trial in Australia thought that ISA would result in a decreasing of the travel speed in 50, 60, 80 and 100 km/h speed zones (Mitsopoulos et al, 2004). The system also has a positive effect on fuel consumption and emissions (Várhelyi et. al, 2002). The fuel consumption was decreased by 1% and the emission volumes per vehicle decreased by 11% for CO 7 % for NOx and 8% for HC.

Of those studies which included public acceptance in their investigations, the positive reactions were high. Approximately 60–75 % of users would accept ISA in their own cars (Peltola et al, 2004). The acceptance rate of ISA amongst test drivers in Sweden in urban areas was as high as 80% (Biding, 2002). They were most positive about the alerting system. They were willing to pay approximately 100 EUR to purchase ISA in a new vehicle (Mitsopoulos et al, 2004).

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.

Forward Collision Warning – 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 B). 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. Graham (1999) shows that the driver understood and handled more quickly if the sound was like the sound of a car horn compared to a simple tone or a voice. Driver inattention, or failure to pay adequate attention to the driving task, is the single most common cause of front-to-rear crashes. The following distance warning system was installed in trucks in the US and has the potential to reduce the rear impact with 57%.

In a field trial in Australia Intelligent Speed Adaptation and Following Distance Warning was used separately and together (Regan et. al, 2004). Both systems together had a positive effect on average speed and speed variability but FDW alone did not affect either the average speed or speed variability.

The reactions and acceptations of the system are high. Most of the participants in a field trial in Australia thought that they would use the system frequently if it were installed in their own vehicle (Mitsopoulos et al, 2004). They were going to use the system on freeway, rural, low traffic density, during poor visibility and at 50, 60, 80 and 100 km/h speed zones.

Reverse Collision Warning

The Reverse Collision Warning System warns the driver if s/he is likely to collide with an object behind the vehicle. Sensors in the rear bumper reveal the vehicle. The rate of warning becomes more rapid if the distance between the vehicle's rear and the object decreases. Studies made in driving simulators indicate that the reverse collision warning system could help the driver to react more quickly (Lee et al, 2002). Rear-end collision avoidance system with early and late warning was compared with no-warning condition. The early warning system reduced the number of collisions by 81% and the late warning system reduced collisions by 50%.

Lane Keeping Device

The Lane-Keeping Device is an electronic warning system that is activated if the vehicle is about to veer off the lane or the road. Lane changing represents 4 to 10 % of all crashes. Studies made in the US show that the Lane Keeping Device could reduce the number of impact by 37% (Olsson, 2002). Times to collision during dangerous lane changes are normally much less than one second.

Intelligent Night Vision System

The Intelligent Night Vision System is developed to avoid accidents between vehicle-pedestrian, vehicle-animal and also vehicle-vehicle at night time driving (Tsuji et al, 2002). There are two different types of night vision types – Near Infrared Radiation (NIR) and Far Infrared Radiation (FIR) (Bellotti et al, 2004). NIR sensors are active illumination and detect the radiation reflected by the object. FIR sensors operate at wavelengths that detect passive radiation emitted by objects at temperatures of 300 K. Cold objects will therefore appear dark. Systems based on FIR technology have been on the market since the year 2000. A pedestrian can be detected by using FIR infrared stereo cameras in front of the vehicle. The distance to the high temperature object will be calculated and the object will turn up on the display in the dashboard just in front of the steering wheel. The system helps the driver to detect everything in the surrounding that emits heat (Olsson et al, 2002). Therefore critical situations beyond the normal head light range can be detected. Since the object is detected sooner with the night vision system the driver will also have more time to react. Schreiner (1999) states that the driver has up to five times longer time to react with the night vision system. This system has high safety potential as 50 % of all traffic fatalities occur when the daylight is limited therefore this system has a high safety potential (Bellotti et al, 2004).

Alcohol inter-locks

An alcohol inter-lock is a breath-testing device connected to the vehicle. The vehicle cannot be started unless the driver has done a breath test. The driver has to provide a breath sample every time the individual attempts to start the vehicle. If the system indicates a breath alcohol concentration over the threshold level it prevents the driver from driving (Willis et al, 2004). The system is effective in preventing driving after drinking. The inter-lock is most often used as a secondary prevention to prevent high-risk alcohol-impaired drivers. Beck et al (1999) have shown that there is a 28% to 65% lower conviction rate if there is an inter-lock installed in the vehicle. Coben and Larkin (1999) also show in a literature study that alcohol inter-locks are a very effective solution. They noted 15% to 69% fewer recidivists. Experiences in the US and Canada have shown that alcohol inter-locks can lead to 40-95% reductions in the rate of drink driving repeat offences (ICADTS, 2001).

Saab Automobile has built a detector into the ignition key. The drivers must blow into the key before starting the car. The concept has many advantages, mainly it provides a simple solution with a good level of usability.

Drowsiness and Fatigue warning systems

The effect of drowsiness on accidents is still inadequately understood: 25% of fatal motorway accidents in Germany and 26% in France were caused by drowsiness (Maycock, 1995). Drowsiness is overrepresented in single vehicle accidents: 3% of all single vehicle accidents reported by the police were fatigue related (Anund et al., 2002). It is however difficult to prove that the accident is caused by drowsiness. Sagberg (1999) indicate that drowsiness was a contributing factor in 3.9 % of all accidents. More male drivers were involved in sleep-related accidents.

There is no single indicator that can be used to identify drowsy driving. Therefore a combination of different measures is needed. A number of systems exist or are at different stage of development. Kircher et al recommend a combination of analysis of lateral control performance and eye blink patterns. A warning system for drowsiness must be able to handle different driving behaviour and also identify several symptoms since symptoms of drowsiness are very individual.

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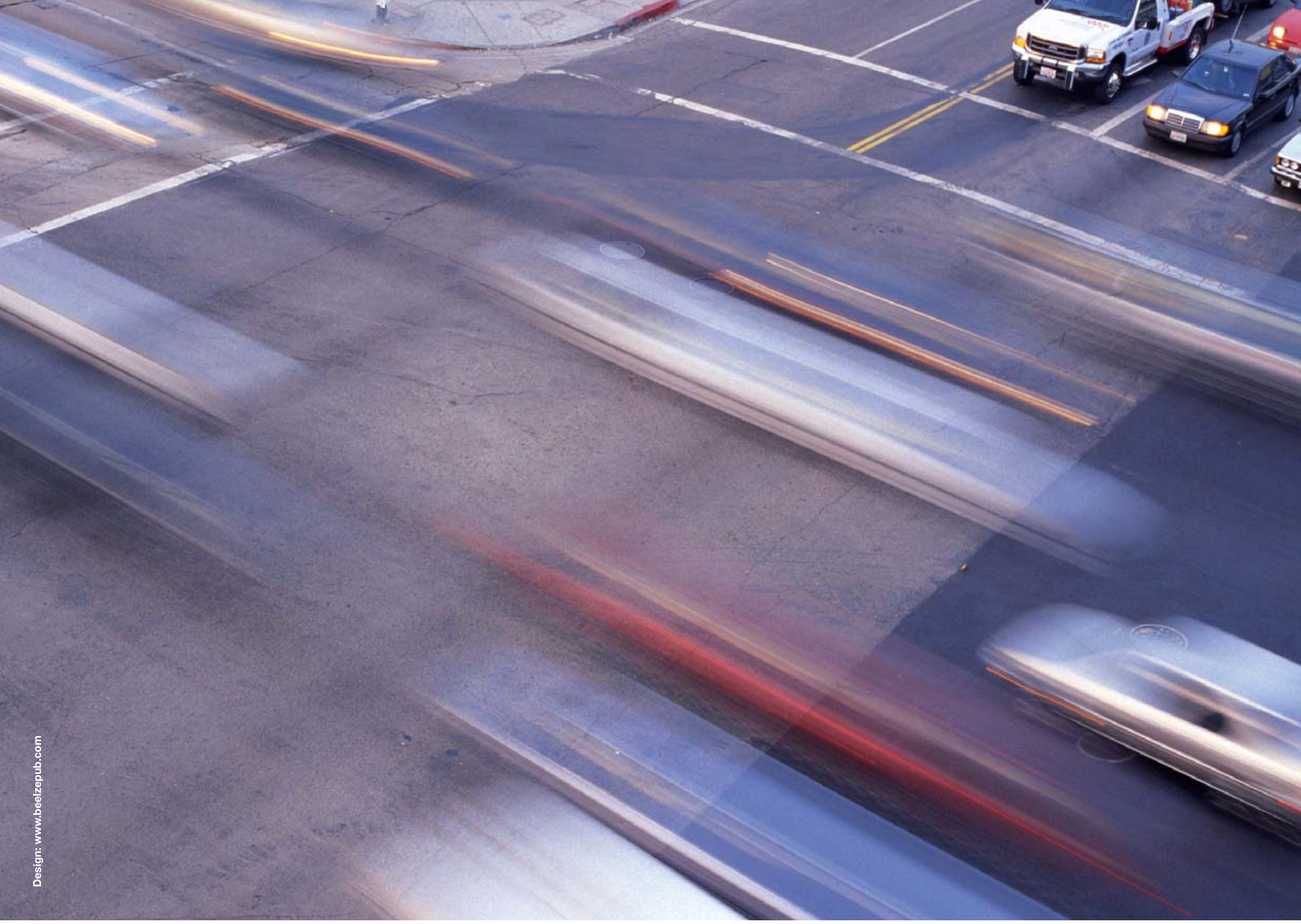

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