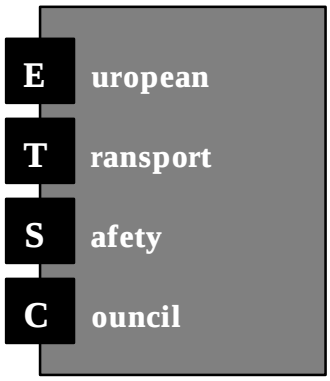

Police enforcement strategies to reduce traffic casualties in Europe

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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 on its Working Parties, and representatives of a wide range of national and international organisations with transport safety interests and Parliamentarians of all parties on its Main Council to exchange experience and knowledge and to identify and promote research-based contributions to transport safety.

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Executive Summary

Introduction

The number of road fatalities in the fifteen countries of the European Union was about 42,500 in 1996. The total number of injured people annually is about 3.5 million taking under-reporting into account. In all EU countries, road collisions are the main cause of death for those aged 45 years and below. The total socio-economic cost of road crashes is around 160 billion euro. A large proportion of these crashes were preceded by one or more traffic offences and, on an aggregate level, traffic offences are the major contributory factor to road crashes and injuries.

Yet, in comparison with other types of road safety activity, relatively little is being done to prevent road users from committing offences. In view of the many other pressing problems facing police forces, road traffic regulation enforcement typically has low priority. While traffic levels continue to rise, several European countries appear to be devoting fewer resources to traffic policing than they were several years ago.

In some cases, the scarce resources allocated are not always used optimally. Much of the knowledge that has been gained through enforcement experiments and demonstration projects carried out over the years has yet not been translated generally into strategies that effectively change road user behaviour, reduce crash risk or reduce injury severity. On the other hand, there is evidence of demonstrably effective policing activity which, if pursued more widely across Europe, could contribute significantly to casualty reduction. A very substantial safety benefit would be achieved if road users were to be deterred from committing traffic law offences. Estimates vary, but it seems reasonable to assume that the magnitude of potential crash savings would be in the order of 50 per cent.

The aim of this ETSC review which has been prepared by experts from across the European Union is to focus attention on the importance of this area of road safety work, to highlight successful strategies and cost-effective enforcement methods and to make recommendations for action at local, national and international levels. A recent study of EU driver opinion found that 70 per cent were in favour of more traffic regulation enforcement being carried out.

The review includes discussion of the key traffic offences which are important for road safety and which need to be targeted in enforcement strategies. This goes beyond the enforcement of speed, alcohol and seat belt offences. Enforcement is not a stand-alone activity. There is ample evidence that enforcement is much more effective if it forms part of a systematic approach to road safety and is backed up by information and engineering measures. There is a large body of information to confirm that traffic regulation enforcement can be highly cost-effective.

What is the purpose of traffic regulation enforcement?

The main objective of traffic regulation enforcement is road safety – achieved by deterring road users from committing offences which are related to road crashes and injuries. It is not to maximise the number of infringement notices issued. Many enforcement activities are still too often directed towards detecting and apprehending the offending driver. Police activities should primarily serve as deterrence for drivers inclined to commit traffic offences through increasing road

users' perception of the risk of being caught. Consistent deterrence strategies, which typically comprise highly visible police or camera activity can bring about lasting changes in road user behaviour and, as a consequence, changes in road users' attitudes which reinforce these behavioural changes.

Excess speed

Excess speed is by far the most frequent road traffic offence. The problem of excess and inappropriate speed is the most common and the most severe road safety problem. Both crash frequency and crash severity increase as driving speed increases. The potential for reducing crash injury, and particularly fatal injury, is substantial. On average, a 4 per cent reduction in crashes is estimated to occur for every 1 km/h decrease in average speed. The benefits are particularly high where vulnerable road users are involved: the probability of a pedestrian fatality reduces from 85 per cent at 50 km/h to less than 10 percent at 30 km/h.

Traditionally, two types of operational policing methods have been used to reduce speeding, but only one of them has proved to be effective in influencing behaviour and crashes. The ***stationary*** method generally involves an observation unit, typically an unmarked police car more or less hidden at the roadside, and an apprehension unit comprising one or more marked police cars, clearly visible, at which point speeding drivers are stopped. ***Mobile*** methods are defined as enforcement of traffic behaviour, and apprehension of individual offenders from a moving unmarked or marked car. Studies that have evaluated experiments with mobile enforcement only, indicate that mobile methods neither have any lasting, measurable effect on speed behaviour, nor on speed-related crashes. Even though it cannot be ruled out that mobile enforcement may have effects on other types of driver behaviour, such as drunken driving, research results clearly indicated that this method is not effective for speed enforcement.

In a recent analysis of 16 studies in which stationary speed enforcement was used alone or in combination with other enforcement methods, the average overall effect was estimated to be a 6 per cent reduction in casualties and a 14 per cent reduction in fatal crashes. Several studies have estimated the benefit-to-cost ratio of stationary speed enforcement to be between 3 and 12. Speed enforcement needs to be prolonged and intensive to obtain optimal effects.

In recent years speed camera technology has been used very cost-effectively. A recent analysis of 11 studies evaluating the effects of speed cameras found an average reduction of 19 per cent in the number of casualties. The reductions were found to be larger in urban areas (28 per cent) than in rural areas (4 per cent). Cost benefit analysis in one Member State found that the investment in speed camera technology generated a return of 5 times the amount after 1 year and more than 25 times the amount after 5 years. Where used widely, public response is favourable. The brother that is watching you seems to be preferred to the brother that may be killing you.

For the future, the possibilities of employing intelligent speed adapters (ISA) are now being explored in several EU countries.

Alcohol

While drink driving is relatively infrequent, compared to other traffic offences, it is highly dangerous. For the EU as a whole a rough average of about 3 per cent of journeys are associated with an illegal BAC, but about 30 per cent of injured drivers are under the influence of alcohol. Alcohol is one of the major causes of crashes and can increase the severity of injury outcomes.

A package of measures is needed in any strategy to reduce casualties in alcohol related crashes. First, the BAC-limit must be set at a level that gives clear guidance to drivers about safe driving practice. Accident analysis supports a limit of 0.5 mg/mlfor the general driving population. Experience shows that lowering the BAC-limit to 0.5 mg/ml has a positive effect on the offence rate as well as on injuries due to road crashes. This is a necessary basis for safety campaigns that set out to explain the regulations in order to influence attitudes. Police enforcement and penalties are concomitant elements.

The key to successful enforcement strategies to reduce alcohol-related casualties is to increase drivers' perception of the probability of detection through programmes that involve the following:

(a) *A high number of persons tested* (at least one in ten drivers every year, one in three drivers if possible, as in Finland). This can only be achieved through wide-scale application of random breath testing and evidential breath testing,
(b) enforcement that is *unpredictable in terms of time and place, deployed in a widespread manner* to ensure broad coverage of the road network and *difficult (for drivers) to avoid* when encountered and
(c) *highly visible police operations*. Targeted policing can be employed to maximise apprehension of persistent offenders. For apprehended drivers, remedial treatment can be offered as an alternative to traditional penalties to reduce recidivism.

Enforcement needs to be accompanied by publicity in order to inform drivers and provide them with feedback. This serves to increase public acceptance of enforcement activity and reduce public acceptance of drinking driving. The development and consistent application of such enforcement and publicity activities has been carried out notably in Finland where the number of excess alcohol offenders has fallen during the past ten years from 33 to 14 per 1000 tested drivers.

Drugs and fatigue

There is a case for defining procedures for detecting driver impairment not only in relation to alcohol but also for fatigue and certain types of drug use. Whilst EU regulations for professional drivers exist defining combinations of driving, working, resting and sleeping hours are permitted, they need to be more sensitive to safety needs. These regulations are also widely flouted. The problem of driving fatigue needs to be addressed for the general driving population.

At the moment, the relationship between drug usage and crash involvement is still largely unclear. Enforcement strategies that can have an impact on drug usage in traffic still have to be developed. As the use of illicit drugs is ingrained in general lifestyles, incidental enforcement is unlikely to have a preventative effect through

increased subjective probability of detection. For prescription drugs, preventative effects are more likely achieved through detailed information to the users.

Seat belt use

Seat belt wearing is mandatory (through EU Directive) in the front and rear seats of passenger cars in European countries. However, in spite of this legislation, usage levels vary widely from one country to the next. About 75-80 per cent of EU passenger car drivers reported using seat belt in the front seats in 1996. In most countries rear seat belt use was substantially less. If every car occupant had used existing seat belts that year about 10,000 of a total of 25,000 killed car occupants in EU would have survived. About 7,000 lives could have been saved had all wearing levels been up to the best achieved internationally.

Many studies show that enforcement increases seat belt use when combined with other activities such as information campaigns. The best way of achieving increases currently is through intensive, highly visible and well publicised enforcement. So-called 'blitz' approaches have been shown to be extremely effective in producing sharp increases in seat belt use. If such 'blitz' enforcement, usually lasting only one to four weeks, is repeated several times a year, high levels of wearing rates can be maintained. The STEP enforcement and publicity campaigns carried out in Canada have also been shown to be most effective. Several studies have estimated that the benefit-to-cost ratio of such seat belt enforcement programmes is of the order of 3 or above.

Alternatively, incentive programmes have been devised in which seat belt use is monitored and seat belt wearers are eligible for a reward – ranging from a free hamburger voucher to a lottery ticket for sizeable rewards such as video recorders or free holidays. In general, these incentive programmes appear to be very effective.

Ultimately, technological solutions will be able to reach the last 10-20 per cent of unbelted occupants who cannot be reached by other means. Intelligent warning systems when the belts are not used provide an acceptable and sufficiently effective method if the warning is made sufficiently aggressive, according to Swedish studies.

Priority or "right of way" offences

Failure to observe red lights or pedestrian crossing lights is a major safety issue in urban areas. The same applies to offences which involve failure to observe the priority or right of way of other road users, which comprise about half of the road collisions in urban areas. However, little enforcement effort is devoted to these types of offences. The same observation applies to offences such as use of restricted lanes, making U-turns or turning left or right where prohibited or overtaking in chevron-indicated areas. All these types of behaviour emerge as disproportionately risky in crash analysis but are rarely the targets of systematic enforcement.

However, camera technology is being used increasingly and very cost-effectively to prevent red light running amongst car drivers. Cost benefit analysis of red light camera operation in one Member State indicates that the return was nearly twice the investment after one year and twelve times this by year five.

Future trends

Traffic regulation enforcement has mostly concentrated to date on the important problems of speeding, alcohol impairment and failure to use seat belts. At the same time, there are other important offences in road safety terms which have yet to be included as priority areas in police work. For example, errors in overtaking or overtaking offences result in very serious crashes. Failure to observe red lights or pedestrian lights is a major safety issue in urban areas. Maintaining short distances (tailgating) substantially increases the risk of rear-end collision. All these types of behaviour appears disproportionately risky but are rarely the target of systematic enforcement. Aggressive driving is a major source of irritation amongst road users. Only when the scope of enforcement is widened to include these offences will the road user be made aware that it not acceptable to violate regulations whatever they concern.

The effectiveness of traffic law enforcement is dependent on the efficiency of the legal system. Traffic law is in most countries part of criminal law. While this may be appropriate for serious offences it is hardly possible to process the myriad of offences without making an exceptional demand on policing manpower or 'clogging up the courts'. In several EU countries, the processing of offences is brought under civic or administrative law in order to increase the efficacy of the law enforcement system.

In several EU countries automatic detection and registration is used for offences such as speeding and red light running. These approaches are very cost-effective and will need to be widely adopted in traffic regulation enforcement strategies.

A further step is to build such devices into the vehicle. A number of EU projects have demonstrated that this is feasible and can apply to a wider range of offences than is achievable through roadside enforcement.

Further developments can incorporate in-vehicle devices that are "aware" of temporary road conditions or driver impairment. These developments will require strategic changes in enforcement policies and judiciary procedures once road user acceptance is assured.

Proposals for effective traffic law enforcement in EU countries

While traffic regulation enforcement is a matter for Member States, the EU can play an important role in its road safety programme in encouraging information exchange on effective strategies, disseminating research-based information in EU programmes and carrying out new research. The following recommendations are made, in particular, for action by those responsible for defining, promoting and implementing enforcement strategy at local, national and EU levels.

- On the basis of detailed crash data analysis, set specific targets nationally for compliance with key traffic offences which influence road safety levels – the arrangements for doing so will vary from country to another. These targets specify the offences to be enforced and the acceptable compliance level for each offence after enforcement in quantitative terms (for example, 95 per cent seat belt use). These offences include, as a minimum, the general target behaviours (speed, drinking-driving, and seat belt use) but also other safety-relevant offences relevant for the country.

- For each offence, integrate police enforcement activities into the national traffic safety policy relevant to that offence, at least including publicity activities.
- In each country formulate for each offence, effective and feasible police enforcement strategies. These strategies should take into account the results achieved in experimental or demonstration projects carried out elsewhere, specify the means and methods of police enforcement and specify the allocation of resources. Increase effectiveness of detection by allowing random breath testing and camera evidence for offences such as speeding, red light violations and tailgating.
- In each country identify offences that could be dealt with under administrative or civil law rather than criminal law.
- Develop information and training resources in order to increase awareness and competence of police enforcement staff.
- Obtain explicit agreements between the various actors (legislators, police, prosecuting bodies) about the consequences that follow detection of offenders.
- As part of the EU road safety information system, communicate the results of specific demonstration projects amongst policymakers and police.
- Encourage and support the establishment of an effective network of traffic police in Europe
- As part of the Fifth Framework Programme, set up an EU-wide monitoring project to allow objective comparison of the incidence of specific offences and the incidence of crashes related to these offences.

1 Introduction

The problem

The number of road fatalities in the fifteen countries of the European Union was about 42,500 in 1996. The total number of injured people is about 3.5 million taking under-reporting into account. In all EU countries, road collisions are the main cause of death for those aged 45 years and below. The total socio-economic cost of road crashes is around 160 billion euro (ETSC, 1997).

A large proportion of these crashes were preceded by one or more traffic offences (Rothengatter & Harper, 1991). On an aggregate level, traffic offences are a major contributory factor to road crashes and injuries.

Yet, comparatively little is done to prevent road users from committing offences. In view of the many other pressing problems that police forces face, road enforcement typically has low priority. In comparison to the amount of effort and expenditure spent on other parts of the development and operation of the traffic system, very few resources are devoted to traffic law enforcement. For example, only 6.5 per cent of the total police force in the UK is devoted specifically to traffic policing, which is a lesser proportion than in previous years, despite an increase in the numbers of vehicles registered, (Official Report, House of Commons, 1998, Home Office Police Research Group, 1994).

The resources that are allocated are not always used optimally. Much of the knowledge that has been gained through enforcement experiments and projects carried out over the years has not yet been translated generally into applicable strategies that effectively change road user behaviour, reduce crash risk or reduce injury severity. The aim of this report is to formulate these strategies and to highlight those enforcement methods that have proved to be effective.

The scope of enforcement activity considered extends to other important offences for road safety, in addition to the enforcement of speed, alcohol and seat belt laws - the focus of road enforcement effort, albeit still too limited, in recent years. The report also emphasises that enforcement is not a stand-alone activity. There is ample evidence that enforcement is much more effective if it is integrated into a package of measures, which also include information campaigns and engineering measures.

The main objective of road law enforcement is to increase road users' perception of the risk being caught. It is not to maximise the number of infringement notices issued. However, this is not generally understood. Many enforcement activities are still too often directed towards detecting and apprehending the offending driver. Police activities should primarily serve as a deterrent to drivers inclined to commit traffic offences. Consistent deterrence strategies can bring about changes in road user behaviour and, as a consequence, changes in road users' attitudes towards that behaviour. Since attitudes are an important determinant of road users' intentions to commit road law offences, inducing attitudinal change through police enforcement can have a considerable impact on its effectiveness.

Policing is only a part of the enforcement process. Legislation determines what behaviour can be enforced and also determines how it can be enforced. Here much progress still has to be made in Europe. Random breath testing, for example, is still

not accepted in all EU countries. Modern techniques that allow automatic enforcement of common offences, such as speeding offences, are not accepted in some countries and only with severe restrictions in some others. Clearly, much progress can be made in this area and this report hopes to contribute to this by pinpointing effective enforcement strategies.

The other key component of the enforcement progress is the remedial action taken when a road user is apprehended. The report addresses the question whether criminal law procedures are appropriate when road law offences are committed on a massive scale leading to inevitable congestion in court proceedings. There is increasing evidence that, while most road users occasionally offend, there are large individual differences in the propensity to commit offences and that frequent offenders are, in fact, more often involved in crashes (Parker, Reason, Manstead & Stradling, 1995). Penalty point systems may be a more effective way of deterring the road user from committing road law offences than fines which are in general use. In some cases, as for example alcohol-dependent drivers, alternative measures such as the obligation to enrol in rehabilitation courses or to participate in therapy or to have their cars fitted with alcohol-interlock devices to prevent further re-offending may be more effective than simple punishment.

However, the main body of the report is devoted to identifying effective strategies for road law enforcement for a range of road law offences. Since these vary for different offences, the report is structured accordingly. Speeding, drinking and driving, failure to use seat belts, priority offences including red light offences, insufficient headways and failure to give way at pedestrian crossings are identified as major contributory factors in collisions. For each of these, road law enforcement strategies are identified.

2 Speed enforcement

The term “speeding” is used as a label to describe the behaviour of drivers going at speeds considered too fast for the prevailing conditions (inappropriate speed) or driving at speeds higher than specified by the posted speed limits (excess speed). However, as the context here is law enforcement, the term “speeding” is confined to excess speed. Speeding is by far the most frequent road traffic offence. Speed is one of the few forms of driver behaviour for which a clear and consistent relation between behaviour, in terms of average speed, and the number of crashes has been established.

The problem of speeding is the most common and the most severe road safety problem. Both crash frequency and crash severity increase as driving speed increases. The potential for crash and injury reduction is substantial. The probability of a pedestrian fatality at an impact speed of 50 km/h is about 85 per cent, while at an impact speed of 30 km/h is less than 10 per cent (Anderson et al., 1997). A model proposed by Finch et al. (1994) indicates that for every 1 km/h increase in the mean traffic speed, crashes rise by about 3 per cent. A recent meta-analysis of 36 studies on speed limit changes indicates that at initial levels above 50 km/h (mostly outside buit-up areas) a crash reduction of 2 per cent for every km/h the average speed is reduced (Elvik, Mysen and Vaa, 1997). Speed limit changes from 50 km/h to levels below 50 km/h (mostly within built-up areas) seem to reduce crashes by approximately 4 per cent for every 1 km/h decrease in average speed (Vaa, 1997).

The essence of the problem of speeding is that the individual speeding driver rarely experiences a negative outcome of speeding, and as a result, many drivers have difficulty in accepting that speeding can be dangerous (Corbett, Simon and O'Connell 1998). Moreover, driving fast also has rewarding effects. Travel time is reduced, a lot of drivers enjoy speed, drivers may feel the sensation and excitement associated with higher speeds, and experience rewarding emotions when demonstrating skill and mastery (Fuller, 1991, Zaal, 1994 and ETSC, 1995). Speeding behaviour is sustained as the negative consequences, such as the perceived crash risk, feelings of insecurity, or perceived risk of apprehension fail to outweigh the positive experiences associated with speeding.

2.1 Traffic safety measures influencing speed

A range of measures can influence driving speeds: Speed limits and speed limit zones (for example, traffic calming zones) are applied generally to differentiate road classes in all European countries and specific limits are imposed where circumstances require such.

Physical measures (road humps, elevated crossings, narrowing of road width) and general road design, road alignment and road geometry parameters are implemented such that acceptable speeds are imposed.

Different kinds of feedback techniques providing drivers with information of their own driving speeds, presented individually or collectively are implemented using roadside message signs, while the feasibility of in-vehicle alarm systems are being studied. The enforcement of speed limits and encouraging appropriate speed choice in general still play a vital role in speed management and will remain the case for as long as the individual driver can determine the speed at which he or she can travel. This is particularly the case where physical measures to reduce speed cannot be implemented for other reasons. Speed limits need to be set according to road function. The police have a very difficult task when speed-inviting roads are posted with speed limits of lower levels.

2.2 Speed enforcement methods and their effects

The literature on the effects of police enforcement on behaviour, crashes and injuries has often failed to give precise descriptions of the enforcement methods used. In addition, many studies consider experiments involving the use of more than one method which make it impossible to attribute the effects to any specific enforcement method.

However, a clear finding is that it is necessary to make a distinction in operations between ***stationary*** and ***mobile*** methods of policing. This distinction is important because these two groups of methods seem to have different effects on behaviour and crashes.

A ***stationary*** method generally includes an observation unit, typically an unmarked police car more or less hidden at the roadside, and an apprehension unit comprising one or more marked police cars, clearly visible, at which point speeding drivers are stopped. ***Mobile*** methods are defined as enforcement of traffic behaviour, and

apprehension of individual offenders from a moving unmarked or marked car. Studies that have evaluated experiments with mobile enforcement only, indicate that mobile methods neither have any lasting, measurable effect on speed behaviour, nor on speed-related crashes. Even though it cannot be ruled out that mobile enforcement may have effects on other driver behaviour, such as drunken driving, (Voas and Hause 1987), research results clearly indicated that this method is not effective for speed enforcement.

The literature on speed enforcement with stationary methods, offers much evidence that stationary enforcement has an effect on speed behaviour and crashes. In a recent meta-analysis of 16 studies, in which stationary speed enforcement was used alone or in combination with other enforcement methods, the average overall effect was estimated to be a 6 per cent reduction in casualties and a 14 per cent reduction in fatal crashes (Elvik, Mysen and Vaa 1997). Several studies have estimated the benefit-to-cost ratio of stationary speed enforcement (Roop and Brackett, 1980, Kearns, 1988, Leggett, 1988, Elvik, Mysen and Vaa 1997). These studies found that the benefits exceeded the costs by a factor of between 3 and 12.

2.3 Mechanisms of stationary speed enforcement methods

Speed reduction is not confined to the site of speed enforcement. Drivers generalise speed reduction in time as well as in space – that is, at times where there is no longer enforcement activity and/or at certain distances upstream or downstream from the enforcement site.

There are several mechanisms for measuring the effect of enforcement on speeds. The *time halo* effect is the length of time during which the effect of enforcement is still present after police activity has been withdrawn. The *distance halo* effect is the number of kilometres from the site of enforcement - be it downstream or upstream - in which the effect is maintained. The measure of effect is typically some speed parameter, often the average speed of traffic.

The most frequent distance halo effects are in the range of 1.6 - 3.5 kilometres downstream from the enforcement site, and 0.5 kilometre upstream. In one experiment a considerably longer distance halo effect was achieved (Brackett and Beecher, 1980). In this study the total distance halo effect was as large as 14 miles (22.5 kilometres). This exceptional halo effect may have been created by randomising the choices of site and day of enforcement of the visible, marked car with radar.
Time halo effects range between one day and nine weeks depending on the length of the enforcement period (Hauer, Ahlin, and Bowser 1982; De Waard and Rooijers, 1994; Holland and Conner, 1996 and Vaa, 1997). Time halo effects seem to increase as the periods of enforcement increase. There is clear evidence of speed reduction when drivers understand that there is an increased chance of being caught.

Three types of strategies have been reported as effective. In the first study three different objective levels of apprehension were applied:

Evaluating the effects of speed enforcement during four weeks at three different intensities, that is apprehending every 6th, 25th and 100th speeding driver on motorways, only the level of every 6th was found to be effective in reducing average

speeds (Waard and Rooijers 1994). Average speeds were reduced by 1.0 to 3.5 km/h at most.

In the second study the effects of an average enforcement level of 9 hours a day for six weeks were evaluated (Christensen and Vaa 1992 and Vaa 1997). This level established significant reductions in average speed from between 0.8 to 4.8 km/h. The largest effect lasted eight weeks after enforcement was withdrawn.
In the third study police enforcement on speed was combined with warning signs announcing "police speed check area" (Holland and Conner, 1996). The experiment consisted of one week in which the warning signs were put up on a four-lane carriageway with 40 mph as speed limit, followed by one week of police enforcement by radar controls, and an additional week in which the signs remained after enforcement withdrawal. Fewer drivers broke the speed limit during the 2-week intervention period compared to the before-period. The effects ranged from a limited period up to nine weeks after police activity was withdrawn.

It can be concluded, therefore, that speed enforcement needs to be prolonged and intensive to obtain optimal effects.

2.4 Mobile enforcement with marked and unmarked cars

The documentation of the effects of unmarked police cars is scarce. Several studies (TFD, 1978, Shinar and McKnight, 1985) failed to find evidence of effects and others (Rothengatter, Riedel and Vogel (1985) demonstrated that the effects of mobile enforcement with marked and unmarked cars compared unfavourably with the effects of stationary enforcement on the same road sections. Even though it has to be taken into account that the effects of unmarked cars are relatively difficult to establish, the employment of stationary enforcement posts is recommended.

2.5 Speed cameras

The introduction of speed cameras has offered a new and promising additional contribution to traditional speed enforcement. A recent meta-analysis of 11 studies evaluating the effects of speed cameras found that this measure reduced the number of casualties by 19 per cent. The reductions were found to be larger in urban areas (28 per cent) than in rural areas (4 per cent). Several countries require posted information at the roadside to warn drivers that automatic speed enforcement might be in operation at the given stretch of road. Distance halo effects of ± 500 m from the speed camera have been found in urban areas and ± 1000 m in rural areas (Nilsson, 1992). In a Finnish study, distance halo effects of as much as 4 km and 10 km from the sites of the speed cameras have been reported (Mäkinen and Oei 1992, Mäkinen and Rathmayer, 1994). Knowledge on the spreading of the effects of speed cameras may depend on the evaluation method used.

The degree of social acceptance of speed cameras is considerable in Norway, Finland and England. In Norway 67 per cent of the respondents in a survey were positive about speed cameras (Muskaug and Christensen, 1992), and in Finland nearly 90 per cent (Mäkinen and Rathmayer, 1994). In an English survey, 57 per cent were satisfied with the number of speed camera installations, 24 per cent supported greater use and 16 per cent wanted a reduction in the number of cameras (Corbett, 1995). A Swedish survey identified some degree of resistance as 44 per cent

responded positively to an increase in the number of stretches with speed cameras while 46 per cent were negative (Nilsson, 1992).
Benefit to cost ratios of speed cameras have been reported within the range of about 3 to 27:1 (Mäkinen and Oei, 1992, Brekke, 1993).

Speed camera enforcement is now also being used from unmarked cars moving between different sites on a given stretch of road. The effect of this latter version has so far not been compared to the use of speed cameras from fixed sites.

2.6 Accompanying measures

Regarding speed limits below 50 km/h, and speed limit changes to levels below 50 km/h, as in the cases of traffic calming zones, compliance with such traffic regulations seems especially poor among drivers. Hence, the introduction of physical, speed-reducing measures as road humps, often seems to be a necessity at low speed limit levels.

There is good evidence that feedback techniques which provide drivers with information about their own driving speeds, presented individually or collectively, by posted message signs, reduces speed (Van Houten and Nau 1980, Casey and Lund, 1993, Muskaug and Christensen, 1995). Warning signs announcing “police speed check area” followed by police enforcement have established time halo effects on average speed of nine weeks after the withdrawal of enforcement (Holland and Conner, 1996).

The use of publicity and media, as announcements of speed enforcement on certain roads, in newspapers, radio or TV, enhances the effect on speed compared to speed enforcement alone (Zaal, 1994). The main benefit of using publicity is that it increases the perceived risk of being caught by raising the expectation that enforcement activities will be encountered (Zaal, 1994). In order to have any effect on speed, it seems necessary that the announcement of police enforcement must be realistic. If drivers fail to see speed enforcement in practice, they will soon learn that the reported increase in enforcement does not necessarily mean an increase in the actual risk of apprehension (Ross, 1982, Zaal, 1994). Fildes and Lee (1993, referred by Zaal 1994) conclude that publicity should not be used as the only measure for a reduction in driving speeds, but rather as a supportive measure for other activities.

An important mechanism of the use of publicity is its potential effect on social and community acceptance. Public acceptance of enforcement plays an important role in the process of changing behaviour and media publicity can create a desirable and supportive climate of opinion in which enforcement measures can be introduced (Elliot 1993, Zaal, 1994).

2.7 Randomising speed enforcement

Randomising the site and time of speed enforcement activities works in theory (Bjørnskau and Elvik, 1992), and in practice (Brackett and Edwards 1977, Brackett and Beecher 1980, Legget, 1988).

When enforcing speed by stationary methods, the police need certain roadside sites which enable them to observe and apprehend speeders without difficulty. Typically

the police are only able to use a very limited number of sites because of the constraints put upon them by the road environment and road geometry. Regular and "professional speeders" are believed to use this knowledge of the practical confinements of police speed enforcement. While the use of aircraft and laser has increased the opportunities to observe and measure speeders, the sites on which the police can apprehend drivers are still too few to realise the high potential offered by randomising speed enforcement.

Road authorities should, therefore, take such limitations into account and put some effort into creating new sites when they improve existing roads and construct and build new roads.

2.8 Best practice

There are several examples of successful speed enforcement experiences that can be identified as "best practice". The following examples have been selected partly to illustrate the effects of combining a low-intensity level of enforcement with randomisation, partly the enforcement strategies based on a theoretical framework, and partly also because one of the studies addresses motivational problems among police officers, an issue that is often overlooked. In addition, the examples show the impact not only on speeding behaviour, but also on crashes.

Randomised, long-term, low-intensity speed enforcement on rural roads:
Leggett (1988) reports the use of a long-term, low-intensity speed enforcement strategy in Tasmania, Australia, in which the principle of randomisation was put into practice. The strategy involved the visible use of single, stationary police vehicles on each of three stretches of rural highway, 16-20 km long, selected on the basis of high crash rates. Each stretch of highway was divided into smaller, one-kilometre sections of road, to which the police vehicles, one vehicle for each stretch of highway, were randomly selected for a two-hour period during high crash times of the day. The actual speed enforcement schedule involved two to three site visits per week over a two-year period, on each of the stretches of rural highway. This enforcement strategy was reported to have resulted in a reduction of speeding behaviour and in a statistically significant 3.6 km/h reduction in overall average speed. A large, significant reduction of 58 per cent in serious casualty crashes (fatal and hospital admission crashes), was also reported. Leggett estimated that the two-year enforcement programme had resulted in a benefit-cost ratio of 4:1 (Leggett, 1988).

Stationary speed enforcement with randomisation of site and time of day:
Brackett and Beecher report (1980) a full-scale experiment in Texas based on principles from learning theory. Enforcement of speed by stationary radar was performed on 24 test roads where the enforcement sites and the time of day were chosen at random. The 24 test roads were compared to 24 roads without special speed enforcement activity. The experiment lasted for 18 months. After completion of the experiment, a reduction in driving speed of 1.8 per cent was found, and the number of drivers driving above the speed limit (55 mph) was reduced by 9 per cent. Fatal crashes, injury crashes and property-damage-only crashes were reduced by 15 per cent, 11.5 per cent and 3 per cent respectively. This study is also one of few in which motivational issues among participating police officers were addressed by a separate survey. In general, police officers did not experience any effect on speed

level or crash counts, in spite of quite substantial reductions. The police officers also considered the duration of the experiment to be too long. Brackett and Beecher hence emphasise that the need for feedback of the results, from researchers to the police officers, is strongly recommended as this would improve targeting of efforts and enhance the motivation of personnel. The handling of motivational problems is crucial, because enforcement efforts need to be of some length in order to have effect.

It should be pointed out that there exists good knowledge concerning the initial reduction of speed on the one hand, and also good knowledge on the effect of speed behaviour and crashes of long-term enforcement efforts. There are, however, gaps of knowledge when it comes to the monitoring of speed and strategies concerning the follow-up phase once speed reductions have been established.

2.9 Conclusions

A substantial body of knowledge on the effectiveness of speed enforcement alone, or in combination with accompanying methods, has emerged in recent years, which should enable decision-makers to separate ineffective from effective enforcement methods more successfully. At the same time, there is still potential to increase effectiveness and the research task is not completed in this respect.

The main key to combat speeding behaviour by speed enforcement is to put more effort in increasing the perceived risk of apprehension. The most effective way to increase the perceived risk of apprehension is to use stationary methods, typically involving an unmarked speed registration unit and an obtrusive unit apprehending speeding drivers downstream.

Speed enforcement strategies will need to include prolonged, high intensity enforcement efforts to reach optimal effectiveness. Speed enforcement without such long-term strategic commitments has, at best, transitory effects.

The employment of speed cameras appears to be an acceptable and effective tool to reduce speed and this method can be used to control speed without disproportionate expenditure of manpower. However, the goal of employing speed cameras must be deterrence - to increase drivers' perception of the probability of detection.

In all cases, speed enforcement should always be part of integrated speed management.

3 Alcohol

3.1 The problem

In most countries, driving under the influence of alcohol is not prohibited but restricted in quantitative terms by a Blood Alcohol Concentration (BAC limit). Dose-effect relationships of alcohol on driving performance and crash involvement have been

clearly established, and these strongly support a maximum BAC permitted of 0.5 mg/ml which is under discussion at EU level (see ETSC 1995).

While drink driving is relatively infrequent compared to other traffic offences, it is highly dangerous. For the EU as a whole a rough average of around 3 per cent of journeys are associated with an illegal BAC (ETSC, 1995: overview of different studies), but around 30 per cent of injured drivers are under the influence of alcohol. Alcohol is one of the major contributory factors in crashes and can increase the severity of injury outcome.

Alcohol is also a major cause of crashes in the view of road users. Some 85 per cent of European drivers say that alcohol is often, very often or always the cause of crashes (SARTRE, 1994) although there still are large differences between countries. While, for example, 93 per cent of Swedish drivers express this opinion, in western part of Germany (alte Länder) the figure is about 20 percentage points lower (72 per cent).

3.2 Enforcement methods

Deterring potential offenders and detecting offenders are the two main objectives of police enforcement in relation to excess alcohol. Research and experience suggest that these objectives are most effectively met by a combination of highly visible systematic or random breath testing (to deter) and targeted testing elsewhere on the road network (to detect). Police powers, procedures, and the type of evidentiary equipment used all play a large part in determining the extent to which this objective can be reached.

Increasing the drivers' perception of risk of detection High levels of awareness amongst road users that there is a strong chance of being caught has positive effects on compliance rates. As in the case of speeding, this depends on the actual probability of being breath tested and on the amount of publicity used to increase the perception of police activity. Random breath testing (RBT), where police randomly stop motorists and conduct breath tests increases compliance and is one of the major elements in any effective strategy (Span and Stanislaw, 1995).

Evidentiary aids and procedures. Evidential breath testing devices: while all Member States provide for the carrying out of tests for blood alcohol, the use of evidential breath testing devices has still to be introduced in all Member States. Experience has shown a substantial increase in the number of breath tests.

Penalties for excess alcohol differ across Member States, but in general range from heavy fines to prison sentences and are often combined with periods of disqualification. Experience with severe penalties such as prison sentences in Scandinavian countries, the USA, Canada and Australia indicates generally their lack of success in deterring drinking drivers or reducing recidivism. Research indicates that disqualification from driving after failing an evidentiary breath test or failure to take a breath test may deter drinking drivers, probably for reasons of the swiftness and certainty of the punishment (See ETSC, 1995).

Driver rehabilitation courses: In several EU countries driver rehabilitation courses have been available to offenders for a number of yearsThe actual assignment of

offenders, the approach, content, instructor, price and length of the courses differ widely. The limited number of studies evaluating the incidence of reoffending after participation in a drink-driving rehabilitation course generally show a positive influence on the amount of recidivism (See ETSC, 1995)

Automatic control systems that do not allow drunken drivers to start their cars have been applied and evaluated mainly in the USA as an additional measure to reduce the recidivism rate of convicted drunken drivers. So-called ignition interlock systems seem to lower conviction rate by 28 to 65 per cent (Beirnes, 1996). Although interlocks are not 100 per cent effective and there are methodological problems of evaluation, this measure clearly demonstrates high potential as a tool to support offenders and should be developed.

Table 1: Legislation, enforcement possibilities and enforcement parameters in different European countries (examples)

Country	Legal BAC-limit pro-mille	RBT	Eviden-tial Breath testing	% of drivers over the legal limit	% of drivers who think they will not be breathalized on a typical journey (SARTRE)	Number of breathtests per licenced driver
Finland	0.5	Yes	Yes	0.2 (1990s)	11	4 drivers in 10
France	0.5	Yes	Yes	1.7 (1996; BAC-limit 0,5) 2.4 (1990., BAC-limit: o,8)	26	1 driver in 4
Netherlands	0.5	Yes	Yes	4.3 (1997)	32	@ 1 driver in 16
Sweden	0.2	Yes	Yes	0.2 (1996)	19	1 driver in 5
United Kingdom.	0.8		Yes	1 (1990s)	49	1 driver in 30
Switzerland.	0.8	No	No	4.4. (weekend night, 1987)	41	Not known

3.3 Best practice and demonstration projects

Australia provides a good example of the effectiveness of RBT, allowing breath tests without needing suspicion that the driver has been drinking and thus a high level of control. New South Wales was among the first States to carry out random breath testing on a regular basis. During the first 12 months of RBT operations in New South Wales, one million tests were carried out, which is equivalent to one test for every three licensed drivers. The evaluation of the Australian programme revealed a net reduction of over 20 per cent in night crashes, which has persisted for more than

10 years (Homel, McKay and Henstridge, 1995 and Span & Stanislaw, 1995). There is no doubt that this success is also due to the extensive media campaign that accompanies random breath testing in New South Wales.

A Dutch experiment in 1988 shows that intensive, random alcohol controls by the police can have a marked effect on the alcohol consumption of road users and that this effect lasts for more than half a year (Mathijssen & Noordzij, 1993). In the city of Leiden the effect of the following, comprehensive enforcement strategy was tested:

- High enforcement level at the start of the intervention, followed by a slow reduction;
- controls by small control teams (2-4 policemen);
- random breath testing (1 test per 14 motorists in 12 months);
- very conspicuous enforcement at times and places with a lot of traffic but small proportion of offenders;
- unobtrusive controls at places and times with low traffic but a lot of offenders;
- continuity in enforcement;
- extensive publicity (information abut 'conformity level', information about the legal limit, information which increases the perceived risk of getting caught).

The percentage of drivers with a BAC-level of more than 0.5 pro mille dropped from 8.1 per cent to 6 per cent. Due to the application of these measures (including evidential breath testing) in the long run the proportion of drivers over the legal BAC-limit dropped to 3.9 per cent in 1991. After that date, reorganisation of Dutch police had the effect that random breath testing dropped nearly to a zero level in 1994 (Mathijssen, 1997) and, as a consequence, the incidence of drink-driving again increased. This experiment and the following real life experience show the need for a comprehensive strategy including random breath testing activities on a continuous basis.

When interpreting results, programme designers agree on the fact that RBT works if it increases the perceived probability of detection. This is the case if random breath testing is conducted at highly visible roadblocks, is unpredictable in location and gives the impression of ubiquity (Homel, 1993).

Another interesting case, showing the effect of strategically planned random breath testing enforcement on offence rates, is Finland. In this country, the risk of being caught for drunken driving has increased considerably since 1977 when the police were first empowered to carry out random breath tests. The number of tests exceeded 0.5 million in 1985, doubled over the three following years and has now stabilised at a level of about 1.4 million tests annually. This means that in Finland 40 per cent of the drivers are tested every year. Over the years, the enforcement strategy has developed. The share of visible enforcement increased and has reached 70 per cent of all enforcement on drunken driving. On the whole, 15-30 per cent (15 for local, 30 for national police) of total enforcement is targeted at drunken driving. This process is accompanied by two forms of information activity:

- voluntary crash reporting and mass media coverage, and
- targeted government information mainly from the police and Central Organisation for Traffic Safety (Liikennevetura)

The application and development of these enforcement- and publicity activities was followed by a positive trend in the incidence rates of drunken driving: The number of those caught for drunken driving has fallen during the past ten years from 33 out of 1,000 to 14 out of 1,000 (Mäkinen and Veijalainen, 1997).

A recent Swiss study results has shown that random breath testing is amongst the most cost effective safety measures that can be taken (Eckhardt and Seitz, 1998). The study analysed the cost-benefit ratio of 22 safety measures, amongst which was random breath testing A model was developed to assess the economic efficiency and feasibility of the measures. The model took into account crash statistics as well as expert opinions, the anticipated effect, the degree of implementation, and the cost of implementing the measure. The benefit-to-cost ratio was estimated at 19:1, resulting in overall national saving of 215 million Swiss Franks.

3.4 Conclusions

The nature of non-compliance with BAC-limits is not similar to the nature of non-compliance with speed limits or other regulations. Drink-drivers can be characterised mainly by their drinking behaviour and their psychological reasons for drinking (Krüger, 1995).

A package of measures is needed in any strategy to reduce casualties in alcohol related crashes. First, the BAC-limit must be set at a level that gives clear guidance to drivers about safe driving practice. Accident analysis supports a limit of 0.5 mg/mlfor the general driving population. Experience shows that lowering the BAC-limit to 0.5 mg/ml has a positive effect on the offence rate as well as on injuries due to road crashes (Homel, 1994, Mathijssen & Noordzij, 1993). This is a necessary basis for safety campaigns that set out to explain the regulations in order to influence attitudes. Police enforcement and penalties are concomitant elements.

In order to create social pressure aimed at keeping drinking and driving separate, non-offenders must also be treated as a target-group: the level of compliance must be communicated and offenders must be supported in trying to reduce their alcohol consumption.

The main function of police control is to demonstrate that the law is being enforced and to detect high-consumption groups. Because car drivers have to be stopped in order to detect non-compliance, random and evidential breath testing are important elements as road users' perception of the risk of apprehension depends on the objective risk of detection. Both, RBT and evidential breath testing make it easier and less time consuming for police to control drivers for alcohol, these measures therefore enhance the objective and the subjective risk of detection.

In order to improve the effects of enforcement, the following supporting measures are necessary:

- Drivers must be informed at local level about police activity (frequency and detection rate) and the level of compliance.
- Attitude-oriented campaigns must be conducted, showing that safety is the main reason for the regulation in question. Combine media advocacy efforts with increased enforcement level.

- Introduction of strategies to prevent alcohol abuse, such as the promotion of low-drinking attitudes.
- Communication of the levels of traffic safety and potential enforcement.
- Feedback to police officers concerning the goals and effectiveness of control activities.

The positive effect of combining media advocacy efforts, which increase drink-driving news coverage, and greater police activity (officer time, training, equipment, and checkpoints), which increases the enforcement level, are experimentally proven (Holder, Voas, and Gruenwald, 1997). This combination results in a higher perceived risk of arrest for drinking and driving, in a reduction in self-reported drinking and driving as well as in a statistically significant reduction in crashes.

Effective enforcement of drink driving laws needs to be targeted primarily at optimising the road users perception of the risk of apprehension when driving with a BAC above the legal limit. Accompanying measures are required to reduce social acceptance of drink driving and change public attitudes. In northern European countries this has already been achieved to a large extent and enforcement activities in those countries should primarily aim to maintain this situation. In several southern European countries, alcohol usage is very much a part of daily social life. As a consequence in these countries a process of social change has to be initiated resulting in public awareness that alcohol usage and driving need to be strictly separated.

Essentially elements of successful strategies are:

- Increasing perceived probability of detection through programmes that involve (a) a high number of persons tested (at least one in ten drivers every year, one in three drivers if possible). This can only be achieved through wide-scale application of Random Breath Testing and Evidential Breath Testing,
  (b) enforcement that is unpredictable in terms of time and place, deployed in a widespread manner to ensure broad coverage of the road network and difficult (for drivers) to avoid when encountered and
  (c) highly visible police operations.

- Targeted policing can be employed to maximise apprehension of persistent offenders.

- Enforcement should be accompanied by publicity in order to inform drivers and provide them with feedback which will serve to increase public acceptance of enforcement activities and reduce public acceptance of drinking driving.

- Finally, the enforcement process has to be monitored carefully and corrected where necessary. This requires close and continuous contacts between police, researchers and policymakers.

4 Driver Impairment (other than by alcohol)

4.1 Prescription and recreational drugs

The extent of the "drug-driving" problem

Evidence is accumulating of increased psychoactive drug use in car drivers. For example Mørland et al. (1995) found a psychoactive drug other than alcohol in every third case under suspicion of driving under the influence in Norway, where apprehensions for suspected drug influence in drivers have increased more than 300 per cent between 1983 and 1996 (Christophersen et al. 1997). In a random sample of 1,237 drivers in Italy, Zancaner et al. (1995) found 2.2 per cent to be under the influence of drugs of abuse or psychoactive drugs (for other examples see Appendix 1). However, the role of most drugs in contributing to crash frequency is still unknown.

Prescription drugs may be taken for legitimate medical purposes or may be abused; illegal psychoactive drugs may be taken for recreational or other purposes (for example, to avoid or escape a deprivation state). Under all of these conditions, some drugs may impair road-user performance and safety. Although the recreational use of drugs is not immediately associated with car usage, there may be a particular problem with travel from such venues as discos where drugs have been taken.

It is noteworthy that, with the notable exception of alcohol, popular minor tranquilizers and perhaps tetrahydrocannabinol (cannabis), it is generally unknown which drugs under what conditions may impair road-user performance and safety (for example, for antidepressants see Linnoila and Seppala, 1985). Epidemiological evidence clearly demonstrates that benzodiazepine users are over-represented in injured and fatally injured drivers (Ellinwood and Heatherly, 1985). Although controlled laboratory and driving task studies support the notion that cannabis induces impairment (Moskowitz, 1985), and a growing incidence of cannabis in the blood of fatally injured drivers is found in some countries, the evidence for its relationship with crash causation is ambiguous (Moskowitz 1976, 1985; Robbe, 1994).

Determining the relationship between drug dose-level and increased crash risk is a complex issue for epidemiological and experimental research. Evidence that "drug driving" constitutes a road safety hazard is lacking. Impairment in this context needs to be defined in terms of the safety of the task to be performed. Thus, for example, although extensive experimental research in the Netherlands (de Gier, 1997) has shown that frequently prescribed hypnotic drugs (for example, tranquilizers) can affect a driver's variation in lateral position ("weaving") equivalent to an alcohol BAC of 0.8-1.0 per cent, the implication of this finding for crash involvement is unclear.

Other problems which confound interpretation of the relationship between drug levels (however measured) and driving safety include:

- most drugs are unlike alcohol in that they do not exhibit a simple relationship between drug blood level and impairment level (Moskowitz, 1985 and Ellinwood and Heatherly, 1985);

- drugs within a particular category, e.g. antidepressants, can vary widely in their influence on driver behaviours such as braking distance;
- medically impaired drivers may be safer driving with their drugs than without (for example, antipsychotic drugs with schizophrenic patients (Judd, 1985). It should be noted in this respect that laboratory studies tend to use young, healthy subjects in evaluating drug-induced effects;
- there are large individual differences in response to particular drugs;
- short-term effects may differ from long-term effects. The crash risk of elderly patients using long half-life benzodiazepines (defined as those that take more than a day for half the dose to be eliminated from the body) is increased by 45 per cent. This drops to 25 per cent after one year of use (Hemmelgarn et al., 1997);
- there are many drugs in current use and several are often taken at the same time. Combinations of drugs may have synergistic (for example, codeine and antipsychotic drugs with alcohol) or antagonistic effects. The number of possible interactions is astronomical (McKenna, 1982);
- blood levels of some psychoactive drugs (for example, cannabis) drop very sharply after uptake and yet the behavioural effects often occur only when blood levels of the psychoactive constituent have returned to a very low level.

Because of these problems, behavioural testing may have to become the critical means of documenting intoxication, rather than assessing drug levels directly. However the development of sensitive and reliable behavioural test batteries, operable in field conditions and sensitive to both drug and alcohol impairment, has not been accomplished.

If drug levels are to be assessed, how should this be done?

The technology for drug assays is currently very expensive (for example, in the UK it is about 400 euro per lab analysis) and there is no acceptable comprehensive roadside screening device yet. Drugwipe devices are one approach being developed. These take a specimen of sweat from the forehead. Drug traces result in a visible colour change on the strip. Drugwipe devices are drug type specific: separate devices are needed to test for different drugs. Drugwipes are currently available for cannabis, amphetamines (including Ecstasy), cocaine and opiates (ROSPA, 1998). However in a Dutch pilot study Drugwipe appeared insensitive to (meth) amphetamines compared to urine analyses using Triage and Accusign (Matthijsen). An alternative approach is saliva testing which involves instrumentation which provides a digital read-out from detected colour changes and separate identification of five drug groups: cannabis, amphetamines, cocaine, opiates and benzodiazepines. Trials of the device in the UK using 4500 voluntary and anonymous drivers to assess practicability and acceptability of forehead sweat drugwipe and saliva testing have proven that the devices are acceptable and usable (Tunbridge, 1998).

Enforcement

Information to drug users

Drug regulatory authorities need to improve warnings on prescribed drugs and through dispensing agencies to inform road users of potential threats to safety. The 1992 *Note for Guidance on prescribing medicinal products* empowers such a development based on a three-tier categorisation system. Medicines can now be classified according to their risk of impairment: unlikely, moderate or severe. Standardised symbols corresponding to these categories for effects on driving competence (such as those introduced in Australia, the Netherlands and some Scandinavian countries) are recommended. Regulatory authorities have been slow to apply this system, however. Furthermore, some drug manufacturers provide warnings of possible impairment effects to protect themselves against future litigation, even where no such effects are known for the drug in question. Such practice will ultimately make appropriate labelling ineffectual as users learn that warnings are meaningless.

Legal requirements

Legal requirements for police powers to execute testing vary. Powers to carry out a blood test exist in for example Belgium (Peeters, 1996), Denmark, Germany, Italy, Netherlands, Spain and the UK. Powers to carry out a urine test exist in Denmark, Italy and the Netherlands. However, to require a test in Belgium, Spain and Ireland, police have to have evidence for law infringement. In Denmark, Germany, the Netherlands and UK there has to be suspicion of some agent other than alcohol (for example, in the UK: “driving while unfit through drugs”. Conviction for driving under the influence of illegal drugs carries an automatic disqualification for at least one year).

Issues

Given evidence for a contributory role of particular drugs in crash frequency, a number of issues arise for most jurisdictions:

- should police need to suspect impairment before stopping and assessing a driver?
  - -if so, what criteria should be used for an impairment decision?
  - -how should police be trained and assessed?
- should a permissible limit be set for each drug?
  - -if so, should dose-equivalence with various levels of alcohol be established?
- should there be zero illicit-drug tolerance?
- should limits apply to drugs whether used legitimately or illicitly?
- should there be better control over availability of relevant safety information for drug users?

At the moment, the relationship between drug usage and crash involvement is still largely unclear. Enforcement strategies that can have an impact on drug usage in traffic still have to be developed. As the use of illicit drugs is ingrained in general life styles, incidental enforcement is unlikely to have a preventative effect through increased subjective probability of detection. For prescription drugs, preventative effects are more likely achieved through detailed information to the users.

The costs involved in drug screening and the disproportionate amount of manpower required effectively prohibit the allocation of enforcement resources to this issue.

4.2 Fatigue

At present insufficient information is recorded about crashes to determine the role of fatigue. However, some investigators (for example, O'Hanlon, 1978) conclude that around 10 per cent of road crashes may be attributable to falling asleep at the wheel, and that fatigue contributes to an even larger proportion of single vehicle and commercial vehicle crashes (Harris and Mackie, 1972). Implementation of improved crash reporting systems is needed so that better data are available for judicial purposes and for research into crashes in which fatigue may be involved (Hartley, 1996).

Driver fatigue arises not only from hours spent at the wheel but also from many other causes (see Table 2) such as length and regularity of work and duty spells, available rest and continuous sleep time, and the location of duty, rest, sleep and driving periods within the 24 hour diurnal cycle (Brown, 1994). There are also individual differences in susceptibility to fatigue under various conditions. Despite this body of knowledge, current EU regulation of working time in the haulage industry (Regulation 3820/85) refers exclusively to daily and weekly hours of driving and rest periods, although this is currently under review. Thus limiting driving hours (for example, through enforcement of tachograph measures) does not address all the other causes of fatigue although it may be the most practicable strategy to ensure that drivers have adequate time for continuous sleep during each 24 hour period. Effective fatigue management however will require that other causes of fatigue are also addressed.

Table 2. Factors which predispose a driver to fatigue (Hartley, 1996)

Drivers at risk of fatigue	Temporal factors Causing fatigue	Environmental factors in fatigue	Sleepiness Factors
Young drivers Up to 25 years old	Dawn driving 0200-0500	Driving in remote areas with featureless terrain	Driving with sleep debt
Drivers over 50	More than 16 hrs Wakefulness before trip	Monotonous roads	Driving with a sleepiness condition
Males	Length of work period before trip	Main arterial roads	Driving when normally asleep
Shiftworkers	Length of time since start of trip	Long-haul driving	Drivers disposed to nodding off
Those for whom driving is part of job	Irregular shift work Before trip	Unexpected demands, Breakdowns, etc.	Driving after poor-quality sleep
Those with medical Conditions (such as narcolepsy)	Driving after successive nights of shift work	Extreme climatic conditions	
After consuming alcohol	Driving under time Pressure	Driving an unfamiliar route	
Driving after inadequate rest & sleep	Some drivers are drowsy in the afternoon		

In the domain of commercial vehicle driving, limiting driving hours is difficult to enforce and alternative strategies such as the development of industry-based Fatigue Management Programmes should also be pursued. According to Hartley (1996):

- appropriate legislation must be enforceable. It must produce an expectation that breaches will be prosecuted at all levels of the organisation and will not be restricted to the driver. Non-compliance with the legislation must not produce the expectation of commercial gain.
- an appropriate framework to control fatigue is the Occupational Health and Safety legislation. The development of an industry-wide Fatigue Management Plan is considered an appropriate mechanism to regulate fatigue. The introduction of fleet management systems and other in-vehicle technology will increase the effectiveness of such industry self-regulation, as long as records are auditable.
- consideration needs to be given to in-vehicle technological systems for fatigue control that are self-enforcing, i.e. that constrain illegal vehicle usage.
- the industry has a duty of care for its workers and must provide a safe work environment in accord with the Occupational Health and Safety legislation. This includes

    - setting reasonable trip schedules;
    - regulating the driving and working hours of workers;
    - providing adequate arrangements for rest and recovery at the depot and elsewhere;

- providing appropriate education on fatigue and other occupational health matters such as drug-use to workers and their families.

In the final analysis, both commercial and non-commercial vehicle drivers have responsibility for managing their own fatigue. In the commercial setting it is the responsibility of employing agencies to provide the conditions in which drivers can do this effectively, efficiently and safely and it is the responsibility of regulatory authorities to monitor this provision. Since self-assessment remains the only method currently available to detect fatigue (Hartley, 1996), education about the causes, signs and consequences of impending fatigue is needed to support self-assessment. Automatic monitoring devices, developed in part in the EU Transport Telematics Programme, may also provide additional information support regarding fatigue-state to the driver. At the present time, there is no single, unequivocal, direct measure of fatigue by which affected drivers may be identified. So as to the critical means of documenting incapacity due to fatigue, perhaps the only viable way forward is through the development of behavioural testing, just as recommended for the enforcement of drug-driving.

Since driving while fatigued is at present very difficult to establish, enforcement can only be effectively employed to target professional drivers whose failure to comply with EU and national regulations concerning working, driving and resting hours can be demonstrated on the basis of tachograph readings. Moreover, these drivers are particularly prone to driving while fatigued due to economic pressures. In some EU countries, such enforcement activities are combined with vehicle inspection, custom checks verifying load and weighing vehicle configurations to detect overloaded vehicles. However, such general checkpoint approaches do require considerable manpower and have as disadvantage that HGV drivers rapidly communicate the fact that such checks are in progress.

In the absence of empirical data about the effectiveness of various possible enforcement strategies relevant to fatigue, the recommendations concerning the enforcement of drinking and driving are deemed to apply to fatigue in commercial vehicle drivers: random checkpoints employing a methodology optimising the number of drivers contacted. As only a subset of drivers is targeted high enforcement levels can be reached with relatively little manpower.

5 Dangerous driving and other offences

5.1 Driving too close (Time-headways)

Short time-headways are associated with a large number of rear-end crashes and also with some other types of crashes - and rear-end collisions are the most frequent crash type in several countries. Although, the consequences of rear-end collisions are usually not as severe as with other types of collision, the total number of them causes great economic losses and disturb traffic flow. On the other hand, the severe crashes which take place infrequently on motorways and which involve a large number of cars are caused by a combination of factors including driving too fast for conditions, keeping too short a time-headway and adverse weather conditions.

Finnish insurance company data shows that the proportion of rear-end crashes leading to a claim was 21 per cent (VALT, 1995 and VALT, 1996). The proportion of rear-end crashes in Norway has been close to 15 per cent of all police-reported injury crashes in the 1990s (Norway, 1998). The respective figure in Sweden in 1996 was 10 per cent (Nilsson, 1998). Liebermann, Ben-David, Schweitzer, Apter and Parush (1995) report that in Israel, tail-gating is considered to be the primary cause of 18 per cent of all road crashes involving serious injuries. It can be concluded that about 60 per cent of all rear-end collisions are very closely linked to close following (Nilsson, 1997).

In light of these figures, few motor vehicle drivers will avoid a rear-end crash during their lifetime. Moreover, close following is a source of irritation for many drivers.

The risk of rear-end collisions may increase in the near future, since the number of in-vehicle information devices is rapidly increasing. The emerging in-vehicle driver support-technology is aimed at solving the problem of following too closely, but it will take years before their potential is translated into a decrease in the number of rear-end collisions.

There is no unanimity as regards the definition of too short a time-headway and its relation to crash risks, but in most countries time-headways less than 1 second are regarded illegal. However, 3 seconds outside urban areas and 2 seconds in urban areas are generally recommended as safe driving distances. This difference in time limits is due to the fact that the consequences of crashes outside urban areas are usually more severe than in urban areas. A general safe driving distance perceived by the driving public is 3 seconds (Hämäläinen, 1993; Nilsson, 1997).

The causes for too short headways are several:

- high traffic volumes cause turbulence in the form of sudden decelerations in the traffic flow, which in turn decreases the reaction time available,
- drivers are not aware of safe driving distances,
- driving faster than the median speed of traffic cause situations where overtaking is necessary and those waiting for an opportunity to overtaking are often following too closely,
- drunk driving or driving under time pressure,
- short headways are used often as a means for aggression, for example, "punishing" or pushing other drivers for driving either too slowly or for some other misconduct.

The reasons for driving too close imply that no single measure can improve the situation. There are at least the following steps needed to tackle the problem effectively (see for example, Hunter et al., 1976 and Hämäläinen, 1993).

- use driver supports such as electronic feedback to indicate the recommended distance. Combined with the presence of the police, the effects may even be increased.
- use information to increase both the awareness of drivers of the problem and of the activities of the police concerning close following,
- focus enforcement on specific conditions, such as adverse weather, where close following is likely to increase the risk of a rear-end crash. Video-techniques may be used for monitoring and for producing evidence of close-following.

For enforcement of short time headways to be effective, it is important that the objective risk of detection is considerably increased and combined engineering measures and information are used. Modern traffic enforcement equipment is now capable of registering both speed and following distance automatically. The large-scale deployment of such equipment can substantially increase the subjective probability of detection and thus traffic law compliance.

5.2 Priority or “right of way” offences

Junctions are the most frequent crash sites in urban areas. Typically, the proportion of casualty crashes ranges from 40 per cent to 50 per cent in European cities. In addition to rear-end crashes, many other types of crashes occur at junctions such as:

- collisions with intersecting traffic including non-compliance of right hand rule, yield sign, stop sign and traffic signals,
- crashes when changing a lane,
- crashes involving unprotected road users,
- single vehicle crashes (drunk driving).

The causes for these crashes vary considerably. Very often, they are associated in one way or another with excess speed or inappropriate speed. Another significant factor is the over-involvement of elderly road users in these crashes. A typical junction crash involves both of these elements. There is large safety potential in improving behaviour at junctions.

Enforcement to influence behaviour at junctions has received relatively little attention. There are only a few experiments using conventional enforcement And these concern mostly automated enforcement methods at signalised junctions (Zaal, 1994). The results indicate that these can result in a substantial decrease in mean speeds, ranging from 5 - 10 km/h, and the number unnecessary and prohibited lane changes at junction areas (Anila & Mäkinen, 1997).

As there is little known about enforcement methods specific for behaviour at junctions, only general recommendations can be given. It has been shown over the years that usually most forms of traffic behaviour can be affected through enforcement, but these effects are usually short term in time and space (Syvänen, 1971; Spolander, 1977; Rothengatter, Bruin and Rooijers, 1989; Mäkinen, 1990 and Zaal, 1994). When enforcement is repeated and combined with information, the effects show at least some sign of permanency (ibid.). Accordingly, junction enforcement should include the following elements:

- make known to the public what is done in terms of enforcement,
  repeated enforcement and publicity campaigns at junctions are needed,
- concentrate on speeds,
- concentrate on interaction of cars and unprotected road users,
- monitor the observance of yield signs - consider especially the problems of elderly road users,
- use camera enforcement,
- make enforcement sufficiently visible,

- increase the awareness of unprotected road users in terms of visibility (use of reflectors).

In developing enforcement strategies it should be realised that not all law infringements in this respect are necessarily wilful offences. In the case of older drivers, for example, priority offences may result from errors due to age-related problems in information processing. Obviously, remedial action needs to take this into account.

5.3 Offences at pedestrian crossings

Both motorists and pedestrians cause safety problems at pedestrian crossings. Pedestrian risk taking and inattention and in some countries intoxication increase the risk of being run over by cars considerably. Moreover, adverse conditions such as rain and darkness or the two combined create favourable circumstances for crashes. Risks for pedestrian crossing crashes are highest in darkness and during the rain. Very often crashes at pedestrian crossings are caused directly or indirectly by speeding vehicles driving free, that is, outside queues (Pasanen, 1991).

Firstly, it is of vital importance that speeds at pedestrian crossings are maintained as low as reasonably possible. The following figure very clearly shows what are the effects of speed change on the probability of a pedestrian death (Pasanen, 1991).

Figure 1. Pedestrian fatality risk as a function of the impact speed of a car (Pasanen, 1991).

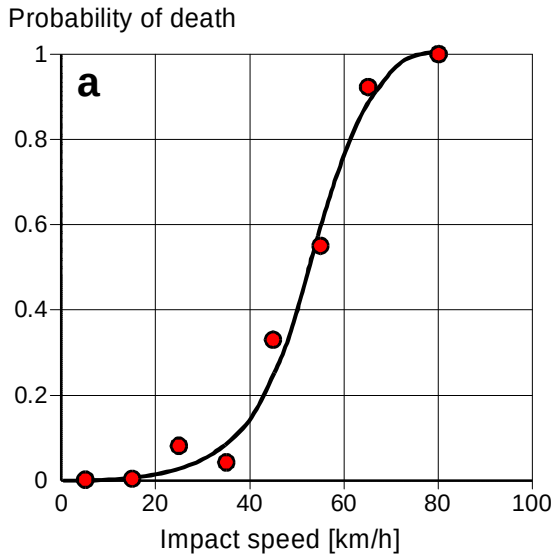

Figure 1 shows clearly how the risk of death for pedestrians rapidly increases when the impact speed exceeds 40 km / h. By decreasing the speed level of cars from 50 km / h down to 40 km / h the probability of a pedestrian death in a collision can be more than halved.

Two factors that can be affected effectively by enforcement and combined measures are speed enforcement and information concerning improving the visibility of pedestrians by means of pedestrian reflectors.

Red light enforcement has been an area mainly neglected in enforcement before the introduction of enforcement camera techniques. In many European countries the police enforce only the red light offences of vehicles, but not those of pedestrians. This is mainly due to the difficulty of checking violators' identification needed for issuing the ticket. One of the findings of the effects of enforcement is that more important than just monitoring is police intervention with offences. Intervention need not always be ticketing but also verbal or written warnings have been shown to work.

For reasons associated with stopping vehicles, conventional enforcement of red light offences is difficult at signalised junctions. It seems that currently the only effective way of enforcing cars at signalised junctions is camera technology. Cost benefit analysis of red light cameras in the UK (Hooke, Knox and Portas,1996) indicates that the return was nearly twice the investment after one year and twelve times this by year five.

When enforcing red light offences at pedestrian crossings, the following measures are recommended:

- intervene also with offences made by pedestrians; use warnings, since they are effective in controlling behaviour,
- take action when vehicles pass a car stopped in front of a pedestrian crossing,

- use camera techniques having both red light and speed monitoring capabilities,
- keep cameras operational especially in adverse conditions, and make it known to the driving public,
- repeat enforcement as often as possible and develop tactics for covering areas rather than single crossings e.g. by using portable cameras mounted on a tripod.

5.4 Road rage

"Road rage" has received increasing attention in the media and from motoring organisations. Road rage can be defined as inappropriate violent reactions of road users to incidents involving other road users. Incidents in which drivers performed aggressive manoeuvres "to teach the other driver a lesson" and which result in a crash involving the victim and incidents in which drivers physically attack fellow drivers for unclear reasons are making the headlines. The frequency of such incidents is very difficult to establish and the only empirical evidence available is from a study carried out on behalf of the UK Automobile Association (Ward et al., 1998).

Less extreme, but more frequent than road rage is aggressive road user behaviour. Shinar (in press) distinguishes between instrumental aggression (that serves to gain advantages such as jumping a queue) and hostile aggression (that is directed towards the driver evoking the aggression). Parker, Lajunen and Stradling (1998) further distinguishes between initiated aggression and retaliatory aggression and found that aggressive behaviour is relatively frequent and that incidence of this behaviour is not strongly related to that of other offences. Particularly worrying is that fact that drivers feel justified to commit retaliatory aggression.

Aggressive driving is experienced by many drivers as threatening and anti-social and for this reason alone should be a subject for enforcement. Analogous to the zero-tolerance approach in social deviant behaviour and crime, police enforcement units can crack-down on aggressive behaviour, even this is not the target behaviour of their enforcement and in the Netherlands special teams are now conducting enforcement on motorways during peak hours to prevent instrumental aggressive driving. If anything, such activities in response to public demand will produce a larger degree of acceptance of enforcement of more traditional offences.

5.5 Conclusion

There is no single measure that can solve safety problems caused by illegal and dangerous driving manoeuvres. There are several engineering measures that should be used in the elimination of risky driving manoeuvres. This applies especially to junctions. Where these measures have not been used, enforcement is needed - and these instances are still too many. It may be concluded that selective focusing of speed enforcement is effective also in this context. Moreover, the use of automated enforcement measures, especially where continuous monitoring and strong site-bound effects are needed.

Repeated enforcement activities combined with information and publicity have more chances of changing driver behaviour than enforcement alone.

Due to scant resources the police have to make clear strategic choices. This means that it is of no use to focus on the innumerable number of isolated infringements prescribed by various European traffic laws. The key enforcement areas have to be defined and enforcement executed in these areas in the way that has a deterrent effect on driving manoeuvres.

Accordingly, focusing on speed enforcement especially outside urban areas has a potential for reducing overtaking related offences such as close-following and other features of reckless driving. In urban areas, speed enforcement has a potential for improving driver - unprotected road user interaction.

Road rage and aggressive driving are perceived by the driving public as an increasing problem but remain elusive as regards policing strategies. Enforcement units focussing on such behaviour are being employed in response to public demand but the effectiveness of such approaches is still unclear.

6 Seat belts

International research and experience show that the use of occupant restraints is a highly effective way of reducing serious and fatal injuries to car occupants. The injury reducing effect of seat belts is around 50 per cent for fatal and serious injuries; the serious injury reducing effect of child restraints is around 90 per cent for rearward facing systems and around 60 per cent for forward facing systems (ETSC, 1996). The seat belt not only reduce the forces on the body but also keeps the body in its position in the car in an crash, so preventing ejection and contact with other parts of the vehicle.

Seat belt wearing is mandatory in the front and rear seats seat of passenger cars in European countries. However, in spite of this legislation, usage differs a lot between countries. About 75-80 per cent of EU passenger car drivers used their front seat belt in 1996. Rear seat belt use was much lower. If every car occupant had used available seat belts that year about 10,000 of a total of 25,000 killed car occupants in EU would have survived. About 7,000 would have survived had all wearing levels been up to the best achieved internationally.

Research has found that the higher the use among drivers, the higher the use among passengers. Seat belt usage by passengers is treated independently of the driver in most legislation, although in some countries drivers have legal responsibility for the passengers seat belt usage. Even if it is left to passengers themselves to use the seat belts, the driver has the responsibility to make the seat belts available and fit for use and used by children in any case.

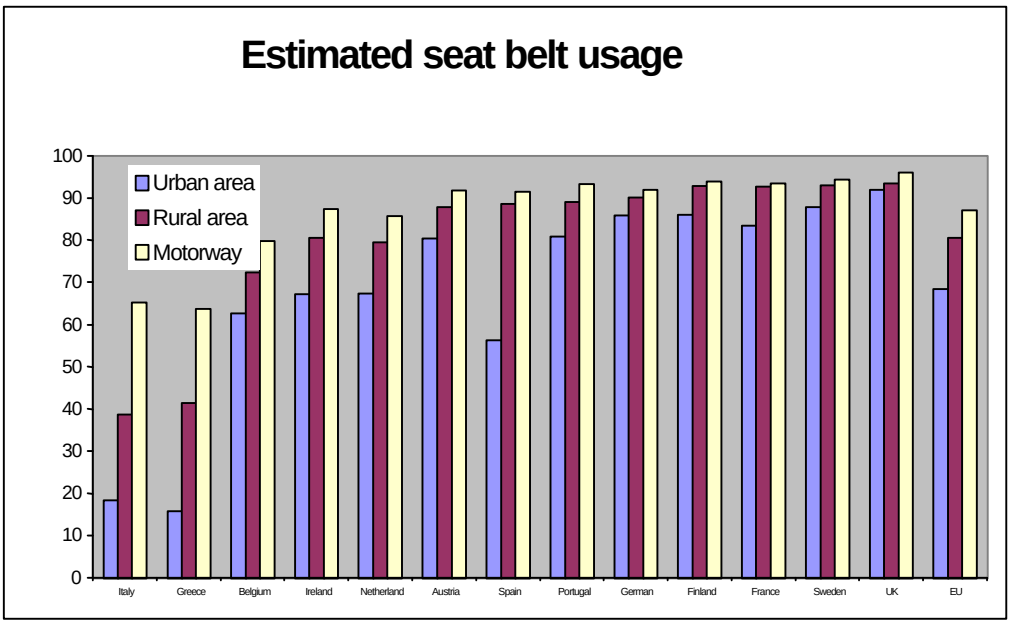

Figure 2 Estimated front seat belt usage among drivers in some European countries on motorways, other rural areas and urban areas. (SARTRE, 1998) and car occupants who very often or always use seat belts in the different countries.

Usage among drivers in some countries tends to be high on motorways but low in urban areas. Acceptance among car occupants varies a lot between different

countries, which is hard to explain as the vehicle fleet and the road network is very similar.

Of note is the fact the proportion of fatally injured car occupants not using seat belts is (much) higher than the proportion of occupants not using the seat belt in traffic. This is probably due to the fact that drivers not using seat belt are overrepresented in crashes. Young male drivers, for example, use their safety belt less often than other groups and are more often involved in crashes (Van Kampen, 1985). Moreover, negative attitudes towards using seat belts are associated with positive attitudes towards traffic law offences such speeding that increase crash risk.

Compared to drivers and front seat passengers, seat belt usage amongst rear seat passenger still is very low in some EU countries (see Figure 3). In general, a higher use among drivers results in higher use among passengers. Drivers alone in a car uses the seat belt less than if a passenger is present, which explains why front seat passengers on average have a somewhat higher usage then the average driver.

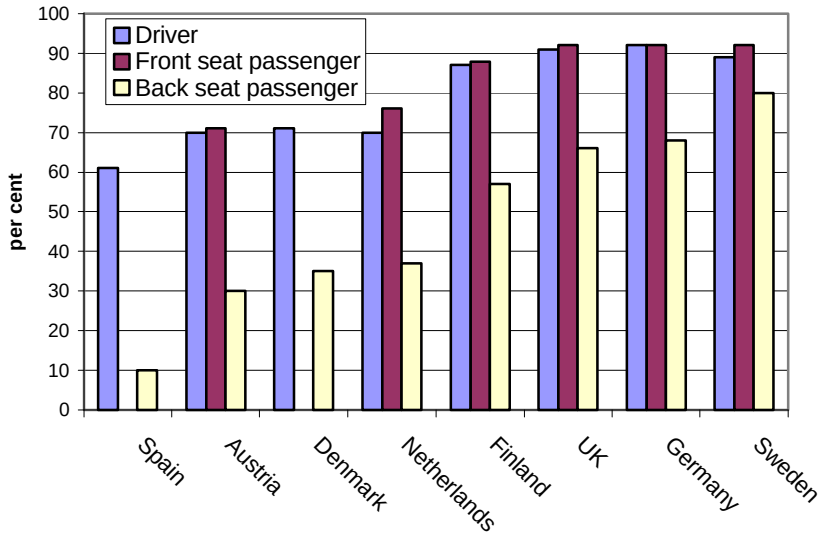

Figure 3 Seat belt usage for drivers, front or back seat passengers in some countries 1992- 1995. ETSC 1996.

Seat belt usage is influenced firstly as to whether a legal requirement exists to use seat belts and secondly the degree to which enforcement complemented by publicity campaigns are carried out.

The former was amply demonstrated in Switzerland where in the 1980´s the seat belt laws were temporarily withdrawn due to legal problems. During the period the law was withdrawn, seat belt usage dropped significantly, while seat belt usage increased after the law was reintroduced even though no major enforcement activities were undertaken. Seat belt usage by passengers is treated independently of the driver in most legislation, although in some countries drivers have legal responsibility for passenger seat belt usage. The driver has the responsibility to make the seat belts available and fit for use and has the responsibility that these are used by children.

Many national and local studies show that enforcement increases seat belt use and especially if it is combined with other activities such as information campaigns. Substantial increases have been achieved in studies reported by, for example, Jonah, Dawson and Smith (1982), Jonah and Grant (1985) and Gundy (1988). The best way of achieving increases is through intensive, highly visible and well publicised enforcement. So-called 'blitz' approaches have been shown to be extremely effective in producing sharp increases in seat belt wearing. If such 'blitz' enforcement, usually lasting only one to four weeks, is repeated several times a year, high levels of wearing rates can be maintained. In some studies (for example, Gundy, 1988), wearing rates after two years still remained above the original baseline level. The STEP enforcement and publicity campaigns carried out in Canada (see ETSC, 1996) have also been shown to be most effective.

Alternatively, incentive programmes have been devised in which seat belt use is monitored and seat belt wearers are eligible for a reward – ranging from a free hamburger voucher to a lottery ticket for sizeable rewards such as video recorders or free holidays. In general, these incentive programmes appear very effective. Hagenzieker (1997) carried out a meta-analysis of 34 studies investigating the effects of incentives on seat belt use and found the effect size to be related to a number of variables such as target population, initial baseline rate and the immediacy of the rewards. Incentives programmes, moreover, generally have a higher level of acceptance than strict enforcement programmes.

Ultimately technological solutions will be able to reach the last 10-20 per cent of unbelted occupants who cannot be reached by other means. Intelligent warning systems when the belts are not used provide an acceptable and sufficiently effective method if the warning is made sufficiently aggressive according to Swedish studies. Once public acceptance is sufficiently high an even better result could be reached by compulsory interlock systems.

Cost effectiveness

Gundy (1988) carried out a simple cost/benefit analysis and concluded that the combined awareness/enforcement programme is very cost effective: an expenditure of less than 1 euro per inhabitant resulted in an increase in wearing rate of more than 15 percentage points, leading to a net "profit" of almost 1,5 euro per inhabitant. Even if the programme had been 2.5 times as expensive it still would have paid off. Laundry (1991, quoted in Zaal, 1994) estimated that in Canada a one per cent increase in seat belt usage rates would result in 18 fewer road fatalities and 500 fewer injuries each year. Zaal (p. 131) concluded that these (and other) estimates "clearly demonstrate the potential cost saving which could result from an increase in the level of seat belt use enforcement activity".

In conclusion, seat belt use is crucial to safety. Even if wearing rates are high, improvements in wearing rates reduce crash fatalities as non-wearers are usually disproportionately at risk of being involved in a fatal crash. Enforcement appears effective in increasing wearing rates, so-called 'blitz' involving very high levels of enforcement over a short period of time can, when applied repeatedly, result in long-term effects. High levels of publicity are crucial for optimising the effects of enforcement. Incentives programmes are a viable and effective addition to

enforcement. There is ample evidence that activities to increase wearing rates are highly cost-effective.

7 Future trends

7.1 Extending the scope of traffic regulation enforcement

Traffic regulation enforcement has mostly concentrated to date on the important problems of speeding, excess alcohol impairment and failure to use seat belts. The scope for securing further reductions in casualties through continued attention to these areas is very large and has been outlined in previous sections.

At the same time, there are other important offences in road safety terms which have yet to be included as priority areas in police work and which should receive greater attention.

There is a case, for example, to define procedures for detecting driver impairment not only in relation to alcohol but for fatigue and certain types of drug use. Whilst EU regulations for professional drivers exist defining combinations of driving, working, resting and sleeping hours are permitted, these regulations are widely flouted. The problem of driving fatigue needs to be addressed for the general driving population. The incidence of crashes associated with certain types of drug use has been discussed previously. The conclusion is warranted that procedures for detecting driver impairment, due to causes other than alcohol, needs attention.

Errors in overtaking or overtaking offences result in very serious crashes. In general, overtaking must be considered an extremely risky behaviour that should receive more attention in general police enforcement.

Failure to observe red lights or pedestrian lights is a major safety issue in urban areas. The same applies to offences which involve failure to observe the priority or right of way of other road users offences, which comprise about half of the road collisions in urban areas. However, little enforcement effort is devoted to these types of offences. The same observation applies to issues such as use of restricted lanes, and illegal movements such as making U-turns where prohibited, turning left or right where prohibited and making use of chevron-indicated areas to overtake. All these types of behaviour appear disproportionately risky in crash reports but are rarely the target of systematic enforcement. Since these types of behaviour are difficult to enforce systematically, they are best addressed in combination with safety information campaigns.

The type of offences subject to traffic enforcement needs to be broadened. Only when this is achieved will the road user be made aware that it is not acceptable to violate traffic regulations, whatever these may concern.

7.2 Aggression and violence

There is a growing concern with regard to the increasing likelihood of road users displaying uncooperative, aggressive or violent behaviour towards each other. For a large part, this can be attributed to media-hype emphasising exceptional incidents. However, this may not be the only explanation of this phenomenon. Society, in general, is tending to become more competitive. The reliance on informal rules in traffic, was perhaps efficient when these were evident to all road users but with the growing cultural diversification and cross border traffic, this is no longer the case. Finally, the rapid increase in traffic intensities not only augments the number of interactions and conflicts between road users, it is also likely to increase frustration and, thus inappropriate, emotional reactions to conflicting situations. This poses a new challenge for policing activities and traffic regulation enforcement.

7.3 From criminal to administrative law

Traffic law is in most EU countries largely part of criminal law. While this seems appropriate in view of the very serious consequences of offences in terms of injury and death, it does pose severe constraints on evidentiary and judiciary procedures. The requirement of proportionality as well as budgets limit the policing effort that can be allocated to the detection of offences. Evidentiary requirements exclude many simple and efficient policing techniques. Judiciary procedures can allow extensive appeal procedures which may take years and disproportionate effort for police and courts. While this may be appropriate for exceptionally serious traffic offences or crimes, it is hardly possible to process the myriad of minor offences without making a devastating demand on policing manpower or clogging up the courts.

For this reason, several EU countries have experimented with and, in part, implemented laws that allow traffic regulation infringements to be treated under adminstrative law with accompanying simplification of procedures and possibilities of appeal. In the first instance, this has been applied to parking offences but is now being extended to other traffic offences that are committed on a regular basis. In the Netherlands, this change from criminal to administrative law has resulted an increase in penalty notices being issued but also a drastic decrease of appeal cases and of cases being dropped because of errors in evidentiary procedures. Such a change is thought to be a major issue in improving the efficacy of police enforcement.

7.4 Automatic detection and registration

In principle, it is possible to automate all police enforcement activities that are related to objectively observable behaviour. Devices for the automatic detection and registration of speeding offences are now used, albeit in too infrequently, in most EU countries. Likewise, devices for red light running are being installed more and more. In principle, it is possible to develop devices for a wide range of easily observable offences.

While earlier devices were cumbersome in the sense that they relied on radar detection of speed and required stills photography to produce proof, it now is possible to use laser or piezo-electric detection – which increases reliability – and use video-registration – which allows automatic transmission and automatic licence plate recognition – to improve efficiency. Massive employment of such devices will undoubtedly increase traffic law compliance and will have to become part of rational traffic regulation enforcement strategies.

One step further is to build such devices into the vehicle. A number of EU projects have demonstrated that this is feasible and can apply to a wider range of offences – for example, tail-gating – than is achievable through roadside enforcement. Moreover, experiments with fully instrumented vehicles have demonstrated that such in-car devices capable of providing feedback to the driver have a large deterrence – rather than just detection – potential in terms of offences such as speeding, tailgating and ignoring stop signs. Further developments can incorporate in-vehicle devices that are “aware” of temporary road conditions – such as variable speed limits in case of congestion -- or are “aware” of the drivers state of impairment. The employment of such in-vehicle devices will require a significant change in police enforcement policies and substantial adaptation of evidentiary and judiciary procedures.

When in-vehicle devices are capable of detecting offences by comparing the required behaviour of the driver with the behaviour that is actually displayed, it is also possible to limit the driver’s options of committing traffic law offences. The possibilities of employing intelligent speed adapters (ISA) are now being explored in several EU countries. These developments will drastically change the possibilities of enforcement and need to be taken into account in the development of future strategies.

When the drivers’ options to commit traffic law offences are forcefully limited, resistance is likely to occur and the social acceptance of such measures is likely to be questioned. This is certainly a point of concern in the development of future strategies, but early studies to this effect indicate that the majority of road users are capable of seeing the advantages of a more restrictive system over the disadvantages. In a recent survey of drivers’ opinions in Europe (SARTRE, 1998), 54 per cent of the respondents stated to be in favour of a restriction of the maximum speed of vehicles. The major advantage that drivers acknowledge is that traffic will become less strenuous and dangerous and that drivers who habitually ignore all regulations will be prohibited to do so with as advantage more predictable and safe traffic conditions for all. The brother that is watching you seems to be preferred to the brother that may be killing you.

7.5 Detection and punishment

There is a growing recognition that the standard response of fining the offender may not be optimal. In some EU countries (most notably in Germany) elaborate systems are being developed to correct offending drivers rather than punishing them. Elements of such schemes are provisional licensing for young drivers, driver improvement and remedial courses for offending drivers and demerit point systems.

While such schemes have had notable effects on for example the recidivism of alcohol-involved drivers, the main issues to be addressed are which factors influence the effectiveness; how such schemes can be incorporated in the traffic regulation enforcement strategies and judiciary procedures. Further research is necessary in this respect.

The same observation applies to the integration of enforcement activities with road user communication strategies. There is ample empirical evidence that publicity about the target behaviour and about the planned enforcement activities augments the effects of the enforcement and thus increase cost-effectiveness.

Moreover, combined enforcement and publicity not only are effective in changing drivers' behaviour, it also appear to have an effect on drivers' attitudes towards traffic law offences. When police enforcement is targeted to a specific offence – such as speeding – the attitude towards that offence becomes more negative, thus reinforcing the effects of enforcement. This is an important phenomenon as it can contribute to achieve a lasting behavioural change and supports public acceptance of effective enforcement actions.

8 The role of police enforcement in road safety strategies

8.1 The importance of traffic regulation enforcement for traffic safety

In 1902 the House of Commons in the United Kingdom declared that "speeding offences are the most important threat to orderly traffic". There is now overwhelming empirical evidence to support this declaration. Moreover, it also is evident that this not only applies to speeding offences but a range of other offences as well. The relation between traffic law offences and traffic safety has been documented on an aggregate level (Nilsson, 1990) and on an individual level (Parker et al., 1995). Simply stated, roads where many offences are committed are more dangerous and drivers who regularly commit offences are more often involved in crashes.

A very substantial safety benefit would be achieved if road users were to be deterred from committing traffic law offences. Estimates vary, but it seems reasonable to assume that the magnitude of potential crash savings would be in the order of 50 per cent. There is no single crash prevention measure that comes anywhere near in terms of potential saving of crash costs. Moreover, traffic law enforcement scores very high in cost/benefit terms. A recent economic analysis, carried out in Switzerland concludes that no crash prevention measure is more cost-effective than effective enforcement of drinking-driving laws and this analysis comprised all types of crashes, including those occurring at home, work or during leisure activities. The cost-effectiveness of enforcement programmes related to excess speed, drinking and driving and seat belt use is invariably positive (Zaal, 1994).

8.2 Organisational aspects of police enforcement

The organisation of police forces varies widely within the European Union. Firstly, in some countries (e.g. Belgium, France, Spain and Italy) military police bodies have a role to play in traffic regulation enforcement alongside the civic police bodies. These military police bodies are generally organised centrally, whereas the civic police bodies – often operating in the same area – are organised decentrally and have relative autonomy, although centralised civil police bodies also operate. Furthermore, in some countries separate traffic police forces are operative (e.g. Britain) whereas in other countries traffic surveillance duties are part of the general surveillance, but this may dependent on the jurisdiction (motorways or state road versus secondary roads) and on the question whether community level policing is separated from regional or national policing (as in Germany, for example). Finally, there is a great variety in the level of strategic authority. In Britain, for example, each chief constable has operational independence to police as he or she sees fit, whereas in other countries police activities are co-ordinated at central level (e.g. by the Ministry of the Interior). Obviously, this dispersal of authority and operational activities does not allow transparent, consistent traffic enforcement strategies on a European level. In some countries initiatives have been taken to co-ordinate and standardise traffic policing activities (e.g. the UK National Road Policing Strategy) but similar initiatives on an European level are urgently required in view of the increasing trans-border traffic volumes.

Police enforcement of traffic law offences in Europe has generally low priority. There are several reasons for this. The first is the organisation of police forces. Traffic regulation enforcement requires professional skills different from other types of police work, because of the complex nature of regulation in traffic law and because of the emphasis on deterrence rather than detection of offences. Yet, in view of societal developments in many European countries, the tendency has been to integrate traffic policing into general policing work. Also, the tendency has been to direct police manpower towards the many other societal problems that are prevalent in Europe.

As a consequence, traffic law enforcement has been diminished both in terms of status and in resource allocation. As traffic law enforcement is not considered a core policing activity, the career prospects for police officers active in this area have diminished, and as traffic law enforcement is not seen to be a political priority, the allocation of resources has dwindled. In the assignment of available manpower, traffic enforcement now has to compete with other societal issues – increase in violence, crime, and environmental problems – that also demand attention of police forces. As a result, traffic law enforcement is unattractive to the actors involved and in many European countries the allocation of resources is not in line with growing traffic volumes.

8.3 Enforcement as part of the legal system

Enforcement is only one, albeit essential step, in the enforcement system. The first is legislation. Most EU countries have a set of laws that specify the behavioural requirements which road users have to fulfil. Yet the degree of specification varies from general rules to detailed descriptions of the specific behaviour required in specific situations. The more specific the behaviour specified in law, the more

efficient enforcement can be. Traffic law that is insufficiently specific hinders effective enforcement. Formulations such as ”inappropriate speed”, ”behaviour maladapted to the prevailing circumstances” or ”reckless or discourteous driving” may be convenient for allocating post hoc blame to crash-involved road users, they are useless for an enforcement system that has to deal with traffic law offences committed on a massive scale. The introduction of speed limits and specification of blood-alcohol limits are good examples of the type of legislation required to render traffic enforcement efficient. Unequivocal specification of the behaviour required of road users is essential for efficient traffic law enforcement.

Detection and deterrence can only be achieved if the law is specific about its sanctions. This principle goes against the principle of ”discretionary powers” to police officers – who can decide to fine or issue a warning – as well as to all other actors in the legal system – prosecutors can (and do) dismiss charges to reduce their workload, while judges may be lenient or chose ”to set an example”. The uncertainty that an offence, even when detected, will indeed result in a fine, greatly reduces enforcement effectiveness. Moreover, the burden that millions of traffic law offences impose on criminal court has induced many countries to adopt alternative procedures ranging from ”summary procedures” (still under criminal law) to a shift to administrative procedures that curtail the possibilities of appeal. However, these changes have been inspired more by the need to reduce the workload of courts than the need to reduce workload and increase effectiveness of policing manpower. In some countries – notably German-speaking—the emphasis has shifted from imposing fines to rehabilitating the offending driver. This approach has demonstrably increased the effectiveness of drinking-driving deterrence (as measured in terms of recidivism) and can be extended to other offences as well. Demerit point systems have been adopted by many EU countries as an adaptation to traditional sanctioning and may increase police enforcement effectiveness by increasing deterrence.

The above observations also apply to the enforcement activities that are sanctioned by law. Here there still are disparities between European countries as is for example apparent in the case of random breath testing and the employment of speed cameras. Random breath testing still is not permitted for gathering permissible evidence in several EU countries even though the method is of proven effectiveness. The employment of speed cameras is considered to be contrary to the principle of ”proportionality” in some countries, as a result of which speed camera registrations are not admissible evidence in court cases, while in other EU countries, owners are by default responsible for offences committed with their car without proof being required that they drove the car at the time the offence was committed. Obviously, these legal disparities determine to a large extent the effectiveness of the enforcement activities.

8.4 The organisation of enforcement activities

As with any activity, enforcement activities gain in effectiveness if they are problem-oriented, targeted, goal-oriented, have specified objectives and success criteria and are monitored in terms of process and product. At present, the majority of enforcement activities are not. Normally, no analysis of crash occurrence precedes enforcement activities, no quantitative targets are set, no specific methods are selected, and no monitoring is carried. That this state of affairs seriously hinders effectiveness goes without saying. The exception to this rule may be found amongst

specialised traffic police forces but, at present, they are in a minority in performing enforcement duties.

Moreover, across the EU as a whole, it is not common for police enforcement activities to be considered as an integral part of traffic safety policy. In general, there is little co-ordination between road safety experts and police staff. It has been demonstrated that the integration of enforcement activities with publicity is more effective in changing road user behaviour than enforcement or publicity activities on their own. Yet, in practice, very few enforcement activities are accompanied by targeted publicity.

8.5 Proposals for effective traffic law enforcement in EU countries

While traffic regulation enforcement is a matter for Member States, the EU can play an important role in its road safety programme in encouraging information exchange on effective strategies, disseminating research-based information in EU programmes and carrying out new research. The following recommendations are made, in particular, for action by those responsible for defining, promoting and implementing enforcement strategy at local, national and EU levels.

- On the basis of detailed crash data analysis, set specific targets nationally for compliance with key traffic offences which influence road safety levels – the arrangements for doing so will vary from country to another. These targets specify the offences to be enforced and the acceptable compliance level for each offence after enforcement in quantitative terms (for example, 95 per cent seat belt use). These offences include, as a minimum, the general target behaviours (speed, drinking-driving, and seat belt use) but also other safety-relevant offences relevant for the country.
- For each offence, integrate police enforcement activities into the national traffic safety policy relevant to that offence, at least including publicity activities.
- In each country formulate for each offence, effective and feasible police enforcement strategies. These strategies should take into account the results achieved in experimental or demonstration projects carried out elsewhere, specify the means and methods of police enforcement and specify the allocation of resources. Increase effectiveness of detection by allowing random breath testing and camera evidence for offences such as speeding, red light violations and tailgating.
- In each country identify offences that could be dealt with under administrative or civil law rather than criminal law.
- Develop information and training resources in order to increase awareness and competence of police enforcement staff.
- Obtain explicit agreements between the various actors (legislators, police, prosecuting bodies) about the consequences that follow detection of offenders.
- As part of the EU road safety information system, communicate the results of specific demonstration projects amongst policymakers and police.
- Encourage and support the establishment of an effective network of traffic police in Europe
- As part of the Fifth Framework Programme, set up an EU-wide monitoring project to allow objective comparison of the incidence of specific offences and the incidence of crashes related to these offences.

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APPENDICES

Speed limits in European countries (Source: SARTRE 2).				
	Built-up areas km / h	Secondary / Regional roads km / h	Highways / main roads km / h	Motorways km / h
Austria	50	100	100	130
Belgium	50	90	90	120
Czech Republic	60	90	90	110
Germany	30 / 50	100	100	no limit
Finland	50	100	100	120
France	30 / 50 / 70	90	90 / 110	110 / 130
Greece	50	110	110	120
Hungary	50	80	80 / 100	120
Ireland	48	96	96	112
Italy	50	90	110	130
Netherlands	30 / 50 / 70	80	100	100 / 120
Poland	20 / 60	90	90 / 110	110
Portugal	50	90	100	120
Slovakia	50	90	90	110 in 1997: 130
Slovenia	60	80	80 / 100	120
Spain	50	90	100 / 120	120
Sweden	50	70 / 90	90 / 110	110
Switzerland	50	80	80	120
United Kingdom	30 / 48	96	96	112

European countries by legal alcohol limit and alcohol consumption per capita.		
Legal limit for the general driver	Alcohol consumption per capita	
	< 9	>= 9
0,8	Italy 8,6 UK 7,3	Greece 9,2 Ireland 11,2 Switzerland 10,0
0,5	Finland 6,6 Netherlands 8,0	Austria 9,3 France 11,5 Germany 10,4 Belgium 9,6 Portugal 10,4 Slovenia 11,2 Spain 10,3
0,0-0,02	Czech Republic 8,9 Poland 8,5 Slovakia 7,9 Sweden 4,2	Hungary 10,5

Year of introduction of compulsory use of front and rear seat belts and of child restraints in private cars in European countries (Source: ETSC, 1996)			
	Front seat belts	Rear seat belts	Child restraints
Austria	1976 without fine 1984 with fine	1984	front seats: 1974 < 12 yr and 150 cm: 1994
Belgium	1975	1991	
Denmark	1976	1990	3 years and older: 1990 less than 3 years: 1992
Finland	1975 without fine 1982 with fine	1987	front seats: 1982 rear seats: 1987
France	1973 rural areas 1975 urban areas at night 1979 all areas day & night	1990	less than 10 years: 1992
Germany	1976 without fine 1984 with fine	1984 without fine 1986 with fine	1993
Greece	1979	pending	pending
Ireland	1979	1993	1993
Italy	1989	1990	1992
Netherlands	1975	1992	1992
Portugal	1977 outside urban areas 1993 inside urban areas	1994	1995
Spain	1975 outside built-up areas 1992 inside built-up areas	1992	1992
Sweden	1975	1986	1988
United Kingdom	1983	1991	1983 under 1 in front 1989 under 14 in rear 1993 under 3 in front