

Towards safer roads: non-technical measures to improve road safety

Paper presented at the seminar 'Black Spots' in Wisla, Poland, April 15-20, 1996

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Contents of the project: This paper discusses engineering, education and enforcement in relation to hazardous road situations. If a high risk road or road site has been identified, the question is which selection of technical and non-technical measures should be taken to prevent or reduce the danger. The main argument is that engineering, education and enforcement measures should be seen as complementary measures that together often produce better results than in isolation.

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1. Introduction

In the year 1991 16,595 road users died in Eastern Europe . The death toll in Eastern Europe is significantly higher than in Western Europe and according to some studies the number of deaths due to road accidents may double in the period 1991-2001, if no action is taken to prevent it (World Bank, 1995)

Compared with five countries in Eastern Europe (Romania, Slovakia, Bulgaria, Czech Republic, Hungary, the situation in Poland is worse than average. With almost 8000 traffic fatalities in 1991 and 207 traffic fatalities per million habitants Poland scores more than 20% above average. Pedestrians killed in road accidents in Poland account for 2/3 of all pedestrians killed in six Eastern European countries, and for nearly 48% of the total number of deaths due to road accidents in those countries (World Bank, 1995).

It is clear that, in Poland as in other European countries, the toll we pay for our motorised mobility is unacceptable. It is our task, as road safety workers, to choose, implement and evaluate adequate countermeasures.

First, a data base of accident statistics is required in order to be able to develop countermeasures. Such a data base enables researchers to link accident data with road, roadside and road environment data in order to identify black spots. Since the data base contains predominantly technical data about accidents, roads and roadsides, the proposed solutions will often tend to be technical countermeasures. For instance, on the basis of a black spot analysis of Polish accident data the researchers Tracz and Gaca (1994) identified several technical conditions, road design errors and characteristics of road and roadside, that lead to high accident occurrence.

A one-sided reliance on engineering solutions may not produce optimal results. In this paper I would like to argue that in an approach to road safety based on identifying black spots, non-technical measures should also be taken into consideration .

In the first part of the presentation I would like to make some general introductory remarks about engineering, education and enforcement measures .

In the second part of the paper I would like to discuss engineering, education and enforcement specifically in relation to hazardous road situations . If a high risk road or road site has been identified, the question is which selection of technical and non-technical measures should be taken to prevent or reduce the danger. The main argument is that engineering, education and enforcement measures should be seen as complementary measures that together often produce better results than in isolation. Even if an engineering measure constitutes the main component of our solution, non-technical measures may still have an important role to play.

In the last part of my paper I would like to elaborate somewhat further on how road safety depends not only on a sound physical infrastructure, but

also on a good social infrastructure, i.e. on good cooperative relations between different participants in the field.

2. Engineering, Education and Enforcement

In road safety work the distinction between the three E's is well-known:

E - Engineering

E - Enforcement

E - Education

Engineering refers to all physical changes to vehicle, road, road side or road environment. Road safety education encompasses all activities of teachers, educators, publicity agents to inform, advise, teach, or instruct road users. The three main forms of road safety education are: target group publicity, class-room instruction, and driver instruction. Enforcement refers to all activities by the police aimed at deterring road users from committing traffic violations.

2.1. Engineering

Let us first consider in general how Engineering measures may reduce danger on the road. In line with the general subject of black spots I will limit myself to a discussion of engineering measures on road or roadside, and I will not consider vehicle measures.

Physically reduce or remove hazard

In principle, the ideal way of reducing road danger is to adapt the physical road scene in such a way that the situation is better adjusted to the limitations of human decision making and physical tolerance. This means that the road scene becomes less dangerous even if the behaviour of the road user does not change in a positive, more safe direction.

There are a number of ways in which engineering measures may remove the hazard from a road scene. First, engineering measures may reduce in advance the possibility of encounters with implicit risk. Especially the physical separation of different types of road users (motorised versus non-motorised) is important. Second, engineering measures can be applied to prevent large discrepancies in speed, direction and mass. Finally, engineering measures can prevent the occurrence of rare or unusual traffic events, e.g. by enhancing the road's course or the predictability of the behaviour of other road users.

In all these cases engineering measures are effective because the hazard inherent in the road scene is physically reduced or even fully removed.

Prepare road users for the hazard

In many cases hazard removing measures may not be possible. Due to financial, physical or other restraints, it may not always be possible to physically remove the danger from a road scene. A possible solution may be that the road explicitly warns the driver of any substandard or unusual features and informs the driver of hazardous conditions to be encountered. If a road danger cannot be physically removed and is present all the time,

e.g. a road curve with bad foresight, there are four types of engineering measures that may fulfil this warning or informative function¹:

1. Engineering may clarify the source of the danger, e.g. the track of a dangerous curve may be made more visible and understandable by providing clear road lining.
2. Engineering may warn for impending danger further upon the road, e.g. by markings on the road surface
3. Engineering may increase the sight distance over a section of road so that road users have a better understanding of the length of road
4. Engineering may emphasise safety rules pertaining to a specific road situation by adequate signs, markings etc.

In these four cases engineering has an effect upon road users' behaviour because they have a better opportunity to perceive the danger, to anticipate on the danger or to be guided by behavioural rules that reduce the danger.

Low probability hazards

Until now I have been speaking about existing dangers, some element inherent in the road scene that in itself constitutes a danger to those who drive with high speed or low attention to the environment. In contrast to this, some road scenes are characterised by *potential danger*. This means that the likelihood of the occurrence of the hazard is not a constant, but is variable, dependent upon some rare concurrence of conditions. These kind of hazards are often produced by interactions between different types of road users that do not expect the occurrence of the other. For instance the sudden appearance of a pedestrian or a bicyclist on an empty road, or on a road full with cars.

There are two general types of engineering measures for these kind of situations. Firstly, by way of engineering we may elicit or activate expectations of road users that are more in accord with the existing situation. For instance, the presence of bicycle lanes indicates that bicyclist can be expected on that road. The second type of engineering measure is aimed at stimulating the general driver alertness or driver monitoring of environment. This can be done by measures like rumble strips.

In summary, using the words of Ogden (1996; p. 132), a safe road may be defined as one which is designed, managed or changed so that it:

- warns the driver of any substandard or unusual features
- informs the driver of conditions to be encountered
- guides the driver through unusual sections
- controls the drivers' passage through conflict points and road links, and
- forgives a driver's errant or inappropriate behaviour

2.2. Education

Road safety education encompasses a broad range of activities, such as specific school programmes, driver training for novice drivers, driver

¹ In residential areas where speeds are generally low, engineers sometimes use these four principles in reverse. That is, instead of providing the road user with information that can prepare him or her for the hazard they deliberately employ measures designed to withhold information from the road user. This is done to achieve a greater than normal speed reduction. However, this reverse manipulation is only done in residential areas and only when supported by other physical measures that constrain speeding.

improvement courses for repeat offenders, supplementary training for interested drivers and regional or nationwide publicity campaigns.

2.2.1. *Road safety publicity*

Both class-room instruction and driver education involve interaction between educator and educated. This social process of learning is of the utmost importance in teaching children and young drivers about responsibility in traffic. Compared with active instruction, road safety publicity is more limited in the sense that it is one-sided communication effort which road users may feel free to misinterpret or to ignore.

The biggest problem confronting road safety publicity is that for the majority of road users, the negative consequences of much of their risk behaviour remain probabilities with relatively negligible odds attached, while the positive consequences are often experienced immediately. In addition, in many cases, the desired alternative - safe behaviour in traffic - has the immediate, perceptible effect of increasing costs in the sense that certain positive consequences of risk behaviour disappear or are reduced but are not accompanied by any immediately perceptible effect of increasing benefits; the relatively negligible chance of negative consequences is only further reduced (Rooijers, 1985).

Usually, when weighing up the advantages and disadvantages, especially in the short term, preference is given to risky behaviour, for example, too high speeds. The traffic safety campaigner is faced with the difficult task of profiling the advantages of the desired behaviour and of making them identifiable.

2.2.2. *Road safety education and traffic rules*

In traffic as in other spheres in social life, rules are intended to regulate social behaviour, to streamline the manyfold interactions between individual citizens. Every traffic rule is a compromise between common good and individual freedom. One of the main subjects of road safety education is 'knowledge of traffic rules'. According to a recent survey of driver training in 29 European countries, 'traffic regulations' and 'rules of behaviour' are mandatory subjects for theoretical driver instruction in most countries (Neumann-Opitz, Heinrich, Siebenhaar, & Krumnow, 1995). The factual driver task of 'Taking account of regulations' is a requirement in practical driver training in most countries.

The knowledge of traffic laws is of course a prerequisite for following the laws. Even if road users have a good understanding of the law and the importance of the law for road safety, it may still be difficult to apply the law correctly in a specific situation, or road users may still have misconceptions that lead them to unknowingly or knowingly violate the law. One example is the legal limit in relation to drinking and driving.

In a laboratory study using reactions to hypothetical choice situations, Jaccard & Turrisi identified several misperceptions in the estimation of blood alcohol levels (relative to the legal limit). 'A major source of error appears to be the tendency for individuals to underestimate the impact of a drink at longer time periods of consumption (e.g. 2 to 3 hrs). In addition,

there is a tendency to downplay the effects of beer and wine relative to mixed drinks and to underestimate the consequences of a moderate number of drinks. Subjects in this experiment failed to understand that the impact of increasing one drink remains approximately the same whether the number of drinks is increasing from two to three or from three to four drinks, and also that the impact is approximately the same during early times of consumption as opposed to later times of consumption.' (Jaccard & Turrisi, 1987, p. 141).

The difficulties with applying a law or rule to a specific situation should be specifically addressed by road safety education. To this effect road safety education should aim as much as possible for an integration of theoretical insights and practical exercises.

2.2.3. *Road safety education and responsibility*

Road safety education aims to prepare road users for safe and responsible participation in traffic. In order to achieve this purpose road safety education, should go beyond mere rote learning of traffic rules and stimulate road users to develop an active sense of responsibility for their own safety as well as the safety of others. To this effect road safety education should enhance a social perspective on rule following behaviour. A social perspective means that road users are made aware of the explicit social nature of participating in traffic. Insight into the social nature of traffic participation is a complex cognitive process involving:

- the knowledge of different types of road users with different capabilities and limitations
- an understanding of how to infer intentions from others' road behaviour
- a realisation of how important it is to be seen and understood by other road users
- an understanding of how one's own road behaviour may influence the interaction with other road users

This social perspective on traffic can be stimulated using active learning methods such as role playing, group work and the exchange of experiences through group discussion. Fortunately, these methods are already part and parcel of driver instruction in several European countries (Neumann-Opitz et al., 1995). For young children playful teaching methods and materials should be devised. Ideally road safety education should start at a very young age. As the young child develops into a mature man or woman, road safety education should go hand in hand with the developmental process and use different methods of instruction according to developmental stage.

Of course, there are limitations to what we may expect from road safety education. We cannot expect school teachers or other professional educators to be the sole agents responsible for road safety education. Parents should play a supportive role. Both parents and teachers will need instruction and guidance as to how to proceed with safety instruction. A supportive organisation or project group should be set up that can motivate, direct and help schools to implement road safety. The specific knowledge of police, education advisers, health education officers and road safety officers should be represented in this organisation. A recent example of good practice in

organising road safety education is given by Sykes, Broome, O'Leary (1995).

We cannot expect road safety education as a sole force to overcome the double standards in a society. If schoolteachers teach children safe ways of behaviour, but if they themselves or parents do not strictly adhere to these ways themselves, children will be confused. If young drivers are advised by instructors never to combine drinking with driving, whereas the parents of these young people and their peers are drinking-and-driving, the advice may well be ignored.

2.3. Police enforcement of traffic rules

Police enforcement of traffic laws is intended to influence the behaviour of road users in such a way that their risk of becoming involved in an accident or causing an accident decreases. It is generally accepted that traffic law enforcement influences driving behaviour through two processes: general deterrence and specific deterrence. General deterrence can be described as the impact of the threat of legal punishment on the public at large, while specific deterrence can be seen as the impact of actual legal punishment on those who have been apprehended. Thus, general deterrence results from a perception of the public that traffic laws are enforced and that a risk of detection and punishment exists when traffic laws are violated (Armour, 1984). Specific deterrence arises from actual experiences with detection, prosecution and punishment of convicted offenders.

In short, police enforcement is aimed at the behaviour modification of road users and deterrence is seen as the central influence process. Aside from deterring road users from committing violations, the police may also increase the acceptance of traffic laws in a number of other ways. They may give the right example in traffic and may actively inform the public about police policy in matters of road safety and the reasons behind specific police activities. Furthermore, the police should invest some time in informal communication with road users and pay attention to complaints or suggestions about road safety. Also, they can give practical or symbolic support to actions or activities of other road safety organisations. Last but not least, the police may substitute traditional punishment with alternative sanctions that may appeal to the public and encourage them to change their attitude.

Several of these points hint at the important role of good and informal relations between police and public. The 'hidden agenda' of many police decisions about involvement in traffic campaigns concerns relations with the general public. Expectations of how the public will react to enforcement activities often play a pivotal role in the minds of police decision-makers. Undoubtedly, social acceptance of an enforcement campaign can support and enhance its safety effects; through publicity and good communication with road users, the police can take responsibility for improving this acceptance.

2.3.1. *Mix of general and specific deterrence*

The operational strategy of police enforcement should always be based on a wise mix of general and specific deterrence activities. An example is the preferred strategy of enforcement of drinking-and-driving in The Netherlands.

In The Netherlands the legal alcohol limit is set at 50 mg alcohol/100 ml blood. A reliable indicator of the overall incidence of drink-driving in The Netherlands is provided by roadside surveys of drivers' BACs. These data are obtained from police checkpoints at which drivers of all randomly stopped vehicles are breathalysed.

In a general sense, the strategy is intended to convey the message that all drivers, irrespective of age, sex, race or status, may be stopped by the police for a breath test. If stopped, the certainty is 100% that they will be tested for the use of alcohol. If the result of the test is positive, the certainty is 100% that they will be taken to the police station for further testing that will serve as legal evidence for prosecution. The point is to impress upon every driver that he cannot do very much to avoid controls, except to trust on luck; if he has drunk, a test by the police will inevitably lead to prosecution.

There are clear operational guidelines for street controls (Goldenbeld, 1995). In hours of known low alcohol consumption, the level of resources (including associated costs) allocated to alcohol enforcement activities - while not excessive (2-4 testing officers) - is highly visible, thus creating general deterrence. In hours of known high alcohol consumption, when the percentage of drink drivers in traffic is greatest, the level of enforcement is increased (10 or more testing officers divided into smaller teams to increase exposure), the emphasis being on the detection and deterrence of drink drivers through both specific and general deterrence mechanisms.

Thus, in The Netherlands the focus of increasing the acceptance of drink-driving laws has been on improving police enforcement procedures, rather than on strict punishment.

2.3.2. *The additive value of education*

It has been shown that enforcement campaigns related to alcohol-impaired driving, seat belt use and speeding became more effective when accompanied by educational or public information campaigns educating the public on the importance of the enforcement (e.g. Zaal (1994)). Educational or public information programmes that precede actual enforcement can lead to short-term behavioural change that is later consolidated by actual experiences of enforcement and social modelling.

Educational and public information programmes can support enforcement and acceptance of traffic laws in the following ways (Williams, 1994). First, they may transfer knowledge about the existence of laws, their provisions, and their penalties, in ways that increase their deterrent effect. Second, they may transfer substantive knowledge about the problem behaviour (e.g. drinking-driving or speeding) and its potential negative consequences (e.g. accident, punishment). Third, they may contribute towards bringing about a change in social standards.

It is not only the case that the deterrent effect of law is enhanced by educational or public information programmes. It is also important to note

that in the absence of such programmes, the effect of laws may be limited or even absent.

2.3.3. *Factors that determine the success of police enforcement*

The police organisation is responsible for road safety. The police, however, are not solely responsible, but share this responsibility with others, e.g. national and local authorities, schoolteachers, parents, road safety organisations, public health organisations, road users themselves. The police can improve efficiency of its enforcement operations by working together with other experts and organisations. In an earlier article (Goldenbeld, 1995) I have pointed out five keys to successful police enforcement: joint problem-solving, productive cooperation, realistic aims, inside publicity and feedback and regular evaluation.

- Joint problem-solving

A proper problem analysis should be the first step in any enforcement project. Accident statistics may give the impression that a certain road constitutes a 'safety problem'. However, the exact nature of the problem should be investigated before any far-reaching decisions concerning police input are taken. For particular 'problem roads', it may well be the case that not speeding in itself, but specific manoeuvres such as overtaking, turning left etc. account for a large proportion of accidents. In that case, the decision to enforce the speed limit on those roads may not be well-considered. If road design intrinsically induces road users to drive at high speeds, then engineering solutions should be considered.

The decision to allocate scarce police resources to improve road safety should preferably be based on a joint focusing by different parties on the problem of road safety. A road safety problem may always be viewed from different perspectives. Different parties with different knowledge and views may fruitfully complement each other and thereby avoid one-sided or biased solutions.

The police, as the alert 'eyes and ears' of society, should make its own active contribution to this problem-solving phase. A possible outcome of such a problem-solving exercise may be that police enforcement is not the most suitable instrument.

An important condition for joint problem-solving is that the parties involved (police, road authority, local government) take time to analyse the local road safety problem and to inform each other about recent results or developments in this area. If parties have different views on any matters, time should be taken to find out what exactly constitutes common ground and what are the points of disagreement. A hastily cooked-up compromise often results in the worst possible solution.

- Productive cooperation

Before and during enforcement, the police have to cooperate with the other parties involved. It has often been said that the problem of productive cooperation is 'getting the right people together at the right time'. An important condition for effective cooperation is that each of the parties takes upon itself a well-described task for part of the project. After the problem orientation phase, decisions about a campaign and an enforcement strategy should be made. Clearly, a requirement for this is that the participa-

nts have the specific know-how for this and are authorised to make budget and policy decisions for the project.

- Clearly described and realistic aims

A road safety project should have a clearly described aim, such as bringing about an increase in the seat belt use of drivers by 15 percentage points. A precisely formulated, realistic aim directs the attention to the methods and intensities of enforcement to be used, motivates the police personnel on the street and enables a clear evaluation of the project.

- Inside publicity

The police personnel who carry out actual enforcement operations on the streets should be involved in the project at a very early stage. Special education or information programs may be called for if low motivation of police personnel is to be expected. Furthermore, police personnel should preferably be informed about the different aspects of the project, they should receive regular feed-back about the effects of their efforts and, ideally, they should have some flexibility as to the planning of their enforcement operations. Police officers will presumably be more motivated to give their best efforts if they have some input into the planning process of the total strategy. Of course, this element of flexibility of planning should not interfere with the general principles of effectiveness to which the enforcement strategy should conform.

- Evaluation

An effect evaluation is necessary to determine how effective the enforcement has been and whether the aim has been realised. A process evaluation is necessary to establish whether planned activities have been carried out and whether coordination has been effective. In the light of practical considerations, it cannot be expected that every evaluation conforms to strict research criteria (e.g. use of preliminary and follow-up measures, statistics of 'matched' control area). Often, evaluations have to be fairly straightforward and be limited to incomplete and/or simple statistics. Nonetheless, even simple, straightforward evaluations usually do have a clear instructive value and often save time for the next project.

3. Dangerous situations and countermeasures

In this paragraph my intention is to discuss more specifically how technical and non-technical measures may be used to reduce accident risk at hazardous roads or road sites.

3.1. Introduction

3.1.1. *Problem-analysis*

Having once identified high risk or hazardous sites, it is then necessary to carefully examine the nature of the safety problem at the site or sites with a view to selecting possible countermeasures. I will not go into an extensive examination of the process of diagnosis itself. I would like to point out however that it may be useful to complement traditional accident data with other more subjective sources, e.g. interviews with road users or sources of local knowledge. Local people who may give valuable information are local government staff, emergency service personnel, local safety groups, residents, local businesses and, of course, local police officers. Structured interviews with road users, including people who have been at a site of interest, may also be helpful. This evidence, though more subjective in nature, may give good pointers to problems (Ogden, 1996).

Basically, our problem analysis of a hazardous road scenes may lead us to typify the scene by one of the following descriptions:

- A. There are great differences in speed, mass and direction of different road users
- B. The hazard inherent in the road scene is not visible or easily recognisable
- C. The road hazard occurs seldom and is unpredictable
- D. The hazard does not correspond with road users expectations about potential hazards
- E. The road scene simply demands too many simultaneous decisions and behaviours and overtaxes the driving task capabilities of the road users
- F. The road scene tends to decrease or mislead human alertness and attentional monitoring processes.

Road scenes characterised by either A or E require without doubt physical measures, bringing about a drastic change in the actual scene. Hazardous road scenes characterised by B, C, D or F may also be in need of physical measures, but the physical change can often be less drastic and in these cases non-technical measures may sometimes be a substitute to a physical measure or may play an important supplementary role. With respect to C and F, engineering measures can be employed to reach an optimal level of stimulation for the attentional processes of the road users. Both over taxation as well as under use of mental capabilities during driving increases the chance of human error.

3.1.2. *Mix of instruments*

There are some stereotypical wrong notions about how the three E's are related to each other. A widespread misunderstanding is that the three E's refer to different domains, or are necessarily separated or independent from one another. The common factor in all three E's is behaviour modification. Whether we are changing the physical characteristics of a traffic situation, or are organising police road controls or are publicly informing road drivers about specific road safety dangers, all these activities have in common that they are aimed at changing behaviour of road users. The success of all these activities is measured by behaviour change and in the longer term by a change in road safety injuries.

A further misunderstanding is that engineering solutions are by definition more effective than solutions involving enforcement, education or other behaviour modification activities. It is important to realise that road users treat safety as one of a number of goals. They are not just trying to maximise safety, but trying to maximise a more general utility function in which safety, saving time, extra motives, driving pleasure et., are all competing motives. Thus, what the road users actually do involves trade-offs in multiple traffic goals. From the perspective of the road users, engineering safety measures may serve different purposes, that is, their safety effects may be traded for other benefits. Hence, engineering measures alone will not always guarantee safety improvement, and the human reactions to the measures may be of the utmost importance (Underwood, Jiang, and Howarth, 1993). In many cases non-technical measures can help engineering measures to perform an expected safety function more effectively by informing or motivating the road users to change their behaviour in the right direction.

A last misconception is exemplified by the English saying 'First things first'. Some experts may put forward the argument that improvement of roadway and roadside design is first priority above all else. If a high priority for engineering measures results in a large neglect of education and enforcement measures, we should not be surprised if the next generation of road users turns out to be some degrees more undisciplined and irresponsible than the present one.

3.1.3. *Implementation of measures*

After the diagnosis of the road safety problem, a mix of measures may be selected and implemented. As regards to implementation of measures, some general advice is:

- It is important to have some overall strategy or plan regarding the implementation of engineering measures. Some form of consultation of local authorities and road users can significantly improve the quality of planning and decision making.
- Expert groups of one-sided composition only guarantee one-sided decisions. Often a road safety problem can be more fruitfully approached from a multi-discipline perspective, in which both accident statistics and views from local public and local road users are taken into account.
- All plans should leave room for change. A plan is not holy.

- Public and organisation support for road safety work is often very important for the success. In some cases, road safety interests and commercial interests or policy interests may collide.

Let us consider in the next paragraphs the three possibilities for coping with hazardous situations in traffic: no physical change, change in rules or physical changes, and see how education or enforcement may be of importance.

3.2. **Hazardous road scenes, no physical change**

A hazardous situation cannot always be changed. There may be no budget to make the required physical change, or there may be doubt about whether the change would actually result in an improvement of safety. In those cases, warning signs can play a valuable role.

Warning signs give advance notice of potential hazard such as crests, pedestrian crossings etc, and are of particular use when the design of the road is sub-standard. For particularly hazardous situations, special signs may be used to indicate the very high degree of danger.

Warning signs do not provide road users with information on how to adjust their behaviour to the future hazard. Especially when reaction time to adjust behaviour is limited, it may be wise to provide road users with extra information on the adequate behavioral response. Here publicity may play an important role. First, mass-media publicity may be used to inform the general public of road users about specific road hazards and adequate drivers reactions. Second, for particularly hazardous road scenes, publicity messages alongside the road may be a very adequate countermeasure.

3.2.1. *Road safety publicity and road hazards*

If black spots or dangerous road conditions have been identified, road safety education may be used in several ways to prevent further accidents. A first option is of course to inform the general public about the dangerous locations, dangerous conditions or dangerous behaviours. The following guidelines for publicity may be especially helpful:

1. A publicity campaign should motivate as well as inform. The target group first has to become responsive (motivational component) to the message (i.e. informative aspect).
2. The use of a wide range of channels to disseminate information is more effective than using one channel at a time.
3. The actual message should be based on those cognitions, opinions and evaluations which are immediately relevant to the behaviour in question. These cognitions should be determined beforehand.
4. Publicity can be supplemented by other strategies that influence (rewards, punishments, modelling desirable and/or undesirable behaviour) and reinforce its effects.
5. A nationwide publicity campaign is more effective when, at the same time, specific activities at a regional and/or local level are organised as the target group can then be directly and personally approached.
6. The use of several messengers to repeatedly present the same message is more effective than the use of a single messenger. This is especially true of prolonged campaigns. The use of more than one messenger means

that the target group does not become so quickly saturated and bored; it can even attract increasing attention.

7. Information about that proportion of the relevant reference group which demonstrates the desired behaviour, can contribute to the affectivity of publicity campaigns. When this information involves the majority of the reference group, the result may be conformist behaviour. In addition, information can serve as feedback, as a confirmation of attitude and/or behaviour change, particularly when the proportion of the group increases.

A publicity campaign can warn of dangers in general, but it cannot warn the road user of danger at a specific location which he or she is approaching.

3.2.2. *Information alongside the road*

After identification of dangerous locations, often some engineering measure may be employed to decrease the accident risk on that location. However, for some locations engineering measures may be too costly or unfit. For these cases, a simple and practical solution may be to give road users information alongside the road. Information alongside the road is certainly less costly and may even be more effective than engineering measures. For specific dangerous locations warning signs may be used or short behavioural messages. Of course, it is important to evaluate the effectiveness of these signs or messages.

3.2.3. *Driver training and road hazards*

Driver education may pay more attention to dangerous situations. It can do so in the following ways. Basing their conclusions on the opinion of experts, Vos & Vissers (1989) listed the following aspects which should be highlighted in basic driver training:

- the correct way of looking;
- observing and estimating risk situations;
- understanding the limitations of one's own skills in general and in specific situations in particular;
- being able to follow a route previously given without help;
- the uncontrollability of dangerous situations;
- the correct mentality and attitude in traffic;
- separating drinking and driving;
- an environment-conscious driving style.

Of course the specific target group for driver education is young drivers. Young people between the ages of 16 and 25 experience great changes in their lives. It is a period which is characterised by the shift from dependence to independence; living independently, choosing a partner, choosing a job and achieving economic and psychological independence. In this period of their lives, young people loosen the ties with their parents and choose their own path. In particular, values and norms are tested against the opinions of the peer group to which they wish to belong. In arriving at the self-chosen form of independence, much experimentation occurs and the limits of social acceptance are tested, often by exceeding those limits.

Where traffic is concerned, young people (Twisk & Van der Vorst, 1994):

- participate in traffic to a large extent in order to meet other young people, particularly at the weekends;
- also want to explore the limits of their driving style;
- overestimate their skills;
- want to comply with the values and norms of their peer group, also in the way they drive;
- (boys) want to impress girls with their tough behaviour.

Based on his study of the risk behaviour of young English drivers, Sinden (1992) identifies the following problems:

1. Dangerous driving is often caused by the social influence of parents or contemporaries, by the mood and music in the vehicle.
2. Dangerous driving, particularly where young men are concerned, is often caused by bad motivation based on inappropriate attitudes and opinions.
3. Dangerous driving is often caused by young people overestimating their own skills and by the illusion that nothing will happen to them.
4. Dangerous driving is often caused by not being able to identify dangers quickly enough.

Driver training should better reflect the social environment of young people learning to drive. Given his background as a professional therapist, Sinden advises to use psychologically-oriented group discussions to deal with the problems listed under 1-3. The aim of such group discussions is to bring about a cognitive restructuring in the participants, making them more aware of the nature of accidents, of the fact that accidents can be avoided, of their role in traffic and of the choice and responsibility of driving safely. With regard to item 4, Sinden recommends that the visual recognition of dangers should be included as a component of driver training. This could be done by showing a video in the classroom or by performing drills in thinking aloud while driving.

3.3. **Changing or sharpening the rule pertaining to the situation**

For some hazardous roads a change in traffic rules, e.g. overtaking restrictions, speed limits, may be required to produce better road safety. Essentially, traffic rules are prescriptions given by the government to direct the behaviour of road users, with the additional power to force penalties on road users who violate these rules.

Of course, rules can be made more effective if their function is in some way physically supported or clarified by engineering measures.

The introduction of a new rule should be based on an adequate problem analysis and be explicitly guided by a plan. Without a planned approach the quality of the decision-making process will be less and the operations designed to support a law or rule may take on a haphazard character. A planned approach to increase the acceptance of a law or rule can take the following consecutive steps (Noordzij, 1995):

1. Introduction of recommendation or rule

Even if there were no rule, there will always be a group of road users who already comply with the proposed rule, either because they feel this is the right thing to do, or because they do not feel the need for other behaviour. A first step to increased compliance is to introduce a formal rule. Based on the

authority of the government, this may be reason enough for some road users to comply, as long as the rule does not interfere with personal interests. For others, public information is needed to explain why compliance with this rule is in the interests of road safety. These road users are convinced by argument; for them, the threat of a sanction is irrelevant.

2. Punishment for violation

More road users will be convinced of the need to comply if a sanction is associated with violation of the rule. Simply put, they want to stay out of trouble. For this group, actual enforcement is not yet necessary as long as they realise that the police is able and willing to enforce the rule if they have to.

3. Evidence of enforcement and punishment

The next group of road users will need proof of actual enforcement before they are willing to change their behaviour and comply.

4. Enforcement with random probability of detection for all road users, and certain punishment following detection

For some road users, mere evidence of enforcement activities is not enough to deter them from violating the rules. For this group, law enforcement has to pose a greater threat, for example by making it more unpredictable.

5. Stronger enforcement (more punishment)

Finally, we are left with a group of road users with a great interest in violating the rules, who can only be made to comply if stronger enforcement is present. Apparently, this group of road users will repeatedly test if the level of enforcement is really as high as they are made to believe or if they can predict when and where to expect actual enforcement activities.

6. Changing the rule

After widespread compliance with the law or rule has been realised, it may be considered whether the rule should be further specified or intensified so that additional safety effects can be realised. This last step only makes sense if the previous steps (threat of enforcement, actual enforcement, optimisation of enforcement) have been successful. If there is still widespread non-compliance with the general rule, it does not seem worthwhile to further specify the rule.

Thus, a stepwise approach can be used and the effect of each measure can be evaluated before considering a new measure. Before a new rule or measure is introduced, the size of each of these groups should be known and the extent to which the expected safety benefits of a rule or measure might be reduced due to the non-compliance of a small minority. The size of the different groups of road users can be estimated on the basis of a population survey.

After each measure, it should be seriously considered whether the next step is still necessary. For instance, it can be asked whether establishing and enforcing a rule is necessary when a large group of road users is already showing the desirable behaviour. Two reasons for taking the next step are:

- a relatively small group can still cause a disproportionately large road safety problem by not complying with/adhering to a rule or measure -

- there may be indications that without further intervention, the number of offenders will increase.

The level of enforcement needed may be difficult to calculate in advance. But it is clear that the level of enforcement depends on the steps that have already been taken to realise compliance with a traffic rule. Stepping up the level of enforcement is not likely to be effective as long as earlier steps have not been taken carefully. Increased enforcement will not be very effective if it has not been made unpredictable or if this fact is not well known to the public.

3.4. Physical adaptation of the road scene

If a drastic physical change to a road scene is required, the regular road users need to be informed about the purpose of the change and the behaviour which is expected of them. Public information programs, possibly in combination with enforcement, may be helpful in preventing undesired behaviours. The public should be adequately informed about what they can expect and given clear behavioural safety advice in order to prevent undesired behavioural adaptations to the new situation.

Local information or education projects

Small scale information or education projects may be very effective in helping local road users to adjust to a new traffic situation. As part of a local project, schoolteachers, together with parents and local authorities, may develop a safe walking route to school for children of different neighbourhoods. The safe routes may be marked with paint or with special symbols, devised by the children themselves. Road users who see these paint or symbolic markings should be made aware that they drive through a special area where safety of children and other pedestrians ranks high. The schools, assisted by local authorities and education or road safety advisers, may also invest some time in exercising with pupils to cope with dangerous road crossings, or organise a system where young children always can be accompanied by older children on their way to school. The success of these local safety projects often depends upon cooperation between several individuals and organisations. Often one individual or one organisation has not the material resources or the knowledge to organise such a project.

3.5. Road safety as collective enterprise

A recurring motif through my presentation has been that road safety work often requires participation of different individuals, and organisations, e.g. police, local authorities, parents of young children, companies, local authorities, driving schools, police, school teachers etc.

Very often cooperation between different actors or organisations is needed to produce the road safety results. Engineers or technical scientists working in isolation from behavioural scientists, might overlook important human factors and devise a one-sided solution. Professional experts, engineers or social scientists, may do well to consult road users before they decide to implement measures. School teachers need to work together with parents to provide good safety education for young children. Effective enforcement of traffic rules often depends upon good communication between different

sections of the police force and good cooperation between police and local authorities.

Let me illustrate the need for cooperation by a reconsideration of why accidents happen. Accidents are rarely the results of a single unique cause. Often there is a chain of events leading up to an accident. Let's take the case of an accident on a city road with high intensity of motorised traffic. Suppose an 8-year old child on the way to school is run over by a car driver who saw the child walking over the pavement but was taken by surprise by the child suddenly crossing the street. The immediate factors explaining the accident may be the relatively high speed of the car, and the unsafe behaviour of the child. But it is clear that less immediate factors are also involved when we consider questions like:

- Why did the child have to cross this street in order to reach school? Was it not possible to organise some safer walking route to the school?
- Why was the child walking alone and not guided by elderly children or by parents? Could not some guidance program for young children have been organised by school authorities in cooperation with parents?
- Why didn't the driver decrease his speed upon first seeing the child on the pavement, so that he would be able to anticipate on unexpected movements of the child?

Etc., etc.

If an accident can be seen as the outcome of a chain of causes, this also means that our prevention efforts can be directed towards multiple causes. To accomplish this it is necessary that different parties, each with different knowledge of the various causes, cooperate with each other to achieve safety results.

An obstacle for cooperation may be that not all parties have the same motivation, perception or knowledge in regard to the road safety problem. Then the question becomes: How can we, despite these differences, involve individuals and organisations in road safety work or in a road safety project?

I would like to conclude my presentation with the following advice on how to involve different people or organisations in road safety work:

1. Inform people and organisations about the road safety situation.
2. Take time to communicate with people both within as outside your organisation: use a personal approach that inspires others.
3. Take suggestions and comments as to the nature of the problem and possible countermeasures seriously: joint problem-analysis.
4. On the basis of an adequate problem-analysis set up a concrete plan that describes which measures should be implemented. Set realistic aims in your plan. Work in small steps in your plan.
5. Show or explain how contributions from individuals or organisations may contribute towards a collective goal.
6. Ask for a modest contribution from individuals and organisations.
7. Show people that there is a collective effort of which they are a valuable part.
8. Keep people and organisations informed about any progress you make.
9. Not everything can be foreseen: be prepared to change your plan.

10. Success of a road safety project should be widely publicised in order to inspire interested parties and to reward symbolically those who have cooperated.

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