TRANSPORT SAFETY VISIONS, TARGETS AND STRATEGIES: BEYOND 2000

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Introduction to the European Transport Safety Lecture

Professor Herman De Croo

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I have great pleasure in introducing the first in a new series of evening lectures which has been established by the European Transport Safety Council. I am delighted that Neil Kinnock, EU Transport Commissioner and Pam Cornelissen MEP have accepted the invitation to be our Principal Guests.

We are bringing together in this event key individuals who, in view of their role and responsibilities, will make a major contribution to shaping future levels of transport safety. We aim to increase awareness of innovation, research-based solutions to important problems, and results-based transport safety management amongst senior levels of government, Parliament and the private sector. We want to stimulate a high level debate across the European Union to exchange knowledge and experience and to help forge new commitment to efforts to reduce the risks and costs of transport crashes.

The ETSC Board thought there could be no better person than Professor Kåre Rumar to start us off on this course and to present the 1st European Transport Safety Lecture. Professor Rumar works at the Swedish Road and Transport Research Institute and has broad experience of both policymaking and research in traffic safety. With the theme of “Transport Safety Visions, Strategies and Targets: Beyond 2000” he provides thoroughgoing analysis of how far we have come in realising the potential for transport crash reduction and what future directions EU transport safety action should take.

Of all the aspirations which policymakers and professionals will hear this year as we approach the Millennium, there is no doubt in my mind that the challenge which he sets will be among the most important we will hear.

Executive summary

The safe movement of goods and people is at the heart of the aims of the European Union. Society and the individual are dependent upon road transport and will be so for the foreseeable future. There are, however, a number of problems currently associated with road transport. The most costly are crashes, injuries and fatalities.

The main message of this Lecture is that the human factor both in terms of behaviour and physical vulnerability is the main problem in transport safety. Therefore, we have to take a number of technical and organisational actions to neutralise the human factor to achieve safety in the traffic system.

Transport, in general, and road transport, in particular, are vital for the prosperity and functioning of society. The individual places a very high value on freedom of movement and car use. In order to identify opportunities for future action, we have to look to how transport grew and how problems became more pronounced. A brief analysis is, therefore, presented on the history of transport and why road transport became so dominant.

The volumes and risks for various transport modes in EU countries are described and discussed. Road transport is predominant in volume as well as the number of injured and killed and risks per kilometre and hour. Rail is the safest mode. The worst safety records in road transport are found for two-wheelers and pedestrians.

Road crashes are a major public health problem and should be treated as such. For example in the EU:

- 1 in 3 citizens will need hospital treatment during their lifetime due to road crashes
- 1 in 20 citizens will be killed or impaired by road crashes
- 1 in 80 citizens will end their life 40 years to early due to road crashes
- Road crashes cause 6 months shorter life expectancy
- Road crashes cause on average 2.5 years-expected health loss
- The injury risk per time unit is 40 times higher on the roads compared to industry
- Contrary to other death causes road accidents hit young people
- Road crashes are the largest single cause of death for persons below 45 years
- Road crashes cause the highest number of lost years of any cause of death

Road safety problems are split into first order (obvious), second order (semi-obvious) and third order (hidden). We focus too much on the first order and too little on second and third order problems.

There is one major problem with road transport safety and three different approaches to improve road transport safety. The major problem is the human operator: the human body cannot withstand collisions at speeds higher than about ten km/h. and additionally, the human operator always adapts to changing conditions in ways which do not always serve safety. The three principal ways to reduce these problems are to reduce exposure to motorised traffic, to reduce the probability of a collision, and to reduce the seriousness of injury and permanent disability. The means of reducing human error are also threefold: by selection, by improvement, by adaptation to human characteristics and limitations. These principles are applicable to all transport modes.

Previous and most present road safety work has to some extent followed these principles. However, it has suffered from a number of deficiencies. Analysis of these deficiencies forms the basis and rationale for the range of proposals and recommendations presented for future road safety work in the EU.

In an effort to focus attention the final conclusions are limited to ten key components in future EU road safety work (The Ten Golden Rules) which are:

1. Treat road injuries and fatalities as a public health problem (not as a complication of mobility)
2. Carry out road safety work along all three countermeasure axes (exposure, crash risk, injury consequence) and behavioural approaches (selection, improvement, technical adaptation)
3. Build the transport system around human characteristics (behavioural response, human tolerance)
4. Increase public awareness of road safety importance which is critical for future success in road safety work. Measuring traffic, driver education and traffic enforcement are important factors in this work
5. Motivate citizens and road safety workers through a road safety vision for the future and quantitative road safety targets, both nationally, and for the EU as a whole (e.g. < 25.000 killed 2010)
6. Encourage the private sector to take a more active part in future road safety work by making road safety a competitive transport variable.
7. Implement present knowledge and carry out research where answers are needed. In both cases an EU road safety information centre could play an important role.
8. Address the most important problems. Among the primary: Speed, alcohol and drugs (the EU should set ceiling limits (eg. Speed and blood alcohol limits); an EU Directive on safer car fronts for unprotected road users is urgently required; DRL could be implemented). Among the secondary: Driver licensing and traffic enforcement
9. Encourage and carry out effective road safety management by road safety indicators and result management
10. Support consumer information which can be fast and very powerful

1. The importance of transport

The economic and structural development of our present society is to a very large extent based on successive improvements in transport. Exchange of products, services, knowledge, expertise between regions that differ is the basis for technological and cultural progress and prosperity. Improved transport possibilities have largely made urbanisation possible.

In broad terms there have been three logistic network revolutions in Europe (Andersson & Strömquist 1988):

- The first revolution was based on development of better ships and lasted between about 1000 and 1500. Good examples were in the North the German Hansa and in the South Italian trade organisations round the cities of Genoa and Venice.
- The second revolution was commercial. It happened was when Europe was connected to other parts of the world such as America and Asia. Every region became more specialised thereby further increasing profits. It lasted between about 1500 and 1700. The Netherlands and Belgium led this technical and commercial development and became the centre of Europe.
- At the end of the second revolution the scientific bases were laid for the third logistic revolution -- the industrial revolution. Again the development of the transport network was the key factor. Canals solved some of the problems with rivers. Rail transport solved the friction and the carrying power problems of roads. The steam engine solved some of the problems with the limited power of horses. However, the heavy bulk transport on water and rail required a more intricate network for distribution of goods and people. Cars and improved roads solved that problem. As products became more refined, lighter and more expensive the speed of transport also grew in importance. Flight transport systems have increased by about twelve per cent each year since the Second World War – twice as much as the increase in trade. The various transport modes have successively replaced each other as technology has advanced and products and transport requirements have changed (Figure 1).
- Now we are about to enter the fourth revolution -- the fast communication revolution. Knowledge contacts, messages have become more and more important. Telephones, faxes, e-mail, Internet are the main quick communication channels. Knowledge and expertise are the main content.

Personal mobility and transport has probably changed even more than trade transport. An average Swede, for example, moved about 200 metres each day in 1800. In 1900 this average mobility had increased to about 500 metres per day. In the year 2000 it is estimated that the average mobility of a Swede will be about 50 kilometres!

The individual is also giving high priority to transport. Partly the reasons are the same as for society as a whole -- quick and comfortable transport facilitates the possibilities to carry out professional as well as private tasks. But there are also other reasons for the high value placed on it. Individual transport has become not only a symbol for but also a real sign of freedom. The proportion of the family budget that is spent on transport has increased from about ten per cent in 1950 to almost 20 per cent now. To some extent this is due to the pattern of living, working, shopping, leisure in different places (the dispersed infrastructure) that improved transport has made possible.

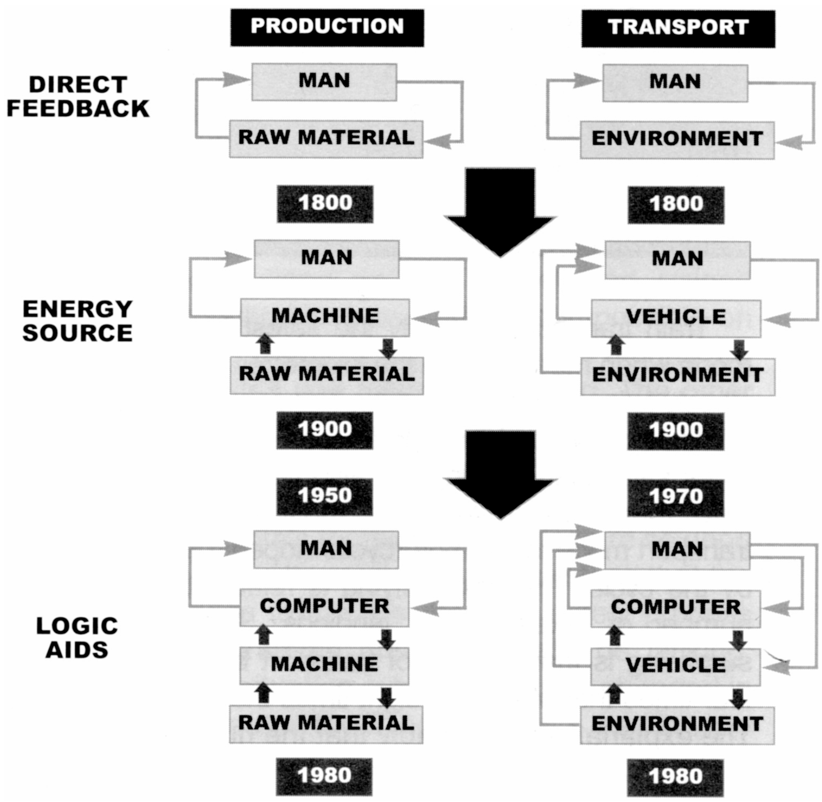
Another sign of the priority given to private car transport is illustrated by what happened in Eastern Europe when the Iron Curtain fell. The first thing that the families bought was a refrigerator. But the second main capital investment seems to have been the private car. Car ownership in East Germany increased dramatically the year after reunification.

Against this background it is not surprising that the car has become a dominant transport mode. This is illustrated by the fact that 88 per cent of all passenger transport of EU citizens within the EU is carried out on the roads.

2. An analysis of the development of transport

The development of transport may be compared to the development of production (Rumar 1985). Initially human transport was carried out by foot and things were produced by hand. Both these were comparatively inefficient but self-instructive, fairly safe and environmentally friendly means of transport and production (Figure 1).

Figure 1. Comparison of what has happened in development of production and transport. First the motor replaced the muscles as energy source. Then the logic aids and communication try to replace the human senses and brain. This development has changed the role of the human operator radically.



During the 19th century the steam engine replaced animal and human muscle power as the main energy source. This increased the efficiency of both production and transport by about a factor of ten. However, this leap had not only favourable effects. It was the point at which the negative effects on safety (injuries, fatalities) and the environment (pollution, noise) appeared for the first time. The combustion engine, the electric engine and other engine principles later succeeded the steam engine and further increased the efficiency of production and transport. But the main negative safety and environmental effects remained and even increased due to the increase of production and transport.

Initially the problems with road transport were mainly technical. The cars were not reliable and the roads could not stand the load and the wear from traffic. But as engineering gradually solved these problems the human operator proved to be the weak link in the system. Man was susceptible to injury and often behaved in a way that triggered incidents and crashes. When technology became reliable man proved to be unreliable.

One of the reasons for this unreliability was that the role of the human operator changed radically with this change. Three important changes were increased speed, lost feed back, and loss of social control.

Everything went much more quickly and thereby on the one hand the demand on operator attention increased considerably and on the other hand the energy released by crashes increased by the square of the speed increase. Another change was that the direct contact between the operator and the material or the path/road was to a large extent lost. This had the effect that the self-instructive characteristics of the system were lost. Reward for correct behaviour and punishment for the wrong behaviour was no longer reliable and could even be inverse. A third effect, especially for the driver, was that the close social interaction with other road users disappeared. The communication between operators was cut to a minimum (e.g. the horn). This led to anonymity and seriously reduced social control in road traffic.

The next phase in the development of production and transport is to replace not only the human muscles as the main energy source but also the human brain as the major decision maker. The idea is of course to counteract the human errors, to improve decisions and to reduce decision times. The human operator could then concentrate on the tasks on which he or she is so far superior -- e.g. decisions having to do with power of judgement.

This change has come a long way in industry but is only just starting in transport. Industry has partly been very successful in this transition but has partly made mistakes from which we should learn when we apply intelligent systems in transport. One repeated mistake is to make the operator passive, sitting in front of and controlling the intelligent system, which very seldom makes mistakes. A better principle is to let the system control the routine behaviour of the human operator. Another mistake has been to further remove feedback to the operator. Feedback is already impaired. Instead feedback to the human operator (the driver) should be enhanced.

Public transport could be made to be much more environmentally friendly as well as much safer than private cars. Therefore, there is a strong belief that public transport will be able to solve many of these problems. However, the living, working and shopping infrastructure created by the gradual improvement of transport makes this very difficult except for the big cities. The very spread out way of living makes the task for public transport extremely tough. New forms of public transport must replace the old rigid line systems. Furthermore, in order to be friendlier to the environment use of public transport must be much higher than is presently the case.

3. Risks in transport

The number of crashes, injuries and fatalities in transport give an idea about the absolute size of the problem. The annual number of transport fatalities within EU are distributed in the following way (ETSC 1999a):

- Road users 42.500
- Train passengers 108
- Air passengers 190
- Ferry passengers 100

These figures show a shocking dominance of road victims. However these frequency figures only tell part of the story. In order to understand the factors behind these figures - the rise or decline of the level - it is necessary to establish the exposure to the situations in question. By dividing the absolute numbers by the size of the exposure of the activity it is possible to calculate the risk associated with a certain transport mode.

There are several ways to indicate the size of the exposure. Number of persons or vehicles, time in the activity, distance travelled with that transport mode etc is some of the more frequently used measures. Using time as the exposure measure gives the result that the fatality risk per hour is about 40 times higher for road transport than for all other employment activities (ETSC 1999a). Compared to home activity. road transport still has a fatality risk which is about 12 times higher. Another result shows that for persons younger than 45 road transport has a higher mortality rate that for any disease including cancer and heart disease. The fact that road fatalities primarily hit young persons also leads to the result that the number of years lost and the size of the economic costs is higher for road fatalities than for any disease.

Many journeys consist of a combination of different modes such as walking, cycling, driving, and taking a bus, a train or a flight. In order to estimate the total risk of a trip it is then necessary to combine the risks of the various modes. In Table 1 the transport risks for the various modes are calculated per distance and per time (see table 1)

Table 1. Estimates of fatality risks per person kilometres and hours for each transport mode in the EU

Mode		*per 100 million person kilometres*	*Per 100 million person hours*
Road	Total	1.1	33
	Bus	0.08	2
	Car	0.8	30
	Foot	7.5	30
	Cycle	6.3	90
	Motorcycle/moped	16.0	500
Train		0.04	2
Ferry		0.33	10.5
Air		0.08	36.5

Train transport is clearly the safest transport mode per kilometre closely followed by bus and air. The risk picture is dominated by road transport. Car travel is ten times safer than walking but also ten times less safe than bus travel. The most dangerous transport mode is the motorcycle/moped followed by cycle. The risk of flying is related to the number of take-offs and landings. Somewhat surprising is that the risk of transport by ferry is four times that of air and eight times that of train. The explanation is probably that the number of fatalities on each ferry fatal accident is so high.

Based on these risk assessments safety should be improved for walking, bicycling and moped/motorcycling. High-speed trains should be used instead of air transport on most stretches within the EU because air is only safer than train on distances longer than about 1200-1600 kilometres. Ferry safety is an area, which obviously deserves further interest. The largest risk differences in transport between the EU-members are found in road transport and rail transport. Work should be initiated to reduce these national differences. During the last years the EU has taken some initiatives to improve safety on roads, on sea and in air (CEC 1997a,b,c,d). These initiatives are good but insufficient. Furthermore, as far as is known no initiative has been taken taken to improve rail safety.

Fatalities are used here and in most statistical calculations not because they are the only interest but because there are no reliable reporting of number of serious injuries in different transport modes. This is not an acceptable situation and should be changed. Another observation in the study (ETSC 1999a) is that the fatality registration and exposure data for various transport modes (especially water and air) are unreliable within the EU.

The estimated costs of the road traffic crashes within the EU are over 160 billion euros. This is appraoching twice the entire EU budget! Only a fraction of this sum is used to reduce the problem, which we know can be considerably reduced. One of the key ideas in the EU is to increase mobility and trade across the borders. Such efforts must be accompanied by strong efforts to increase transport safety, as envisaged in the Treaty.

The difficulties in managing safety are for several reasons much more difficult in road transport than in the other modes (except leisure boats). All operators in the other modes are professional and can be selected, trained and checked in a way, which is impossible on the road. The networks in the other modes are fairly limited and can be controlled. The other modes have implicitly a zero-vision but the safety work seems to be more systematic concerning road traffic than in the other modes. The safety in the other modes is so good that the motivation to run a systematic safety process and programme often seems to be lacking. This is a situation, which should be changed in the future and the EU could take a lead in view of the international nature of air, ferry and rail travel. We want to transfer some of the road traffic to other modes. If we can improve the safety of the other modes further (and that is clearly possible) the argument for mode change will be stronger.

4. The three levels of road safety problems

Due to the large dominance of road victims and road risks the following discussion is focused on road safety. Many of the problems and their countermeasures were mentioned already in the so called Gerondeau-report (1991) and more recently in ETSC's Strategic Road Safety Plan for the European Union (1997).

The problems of road safety seem to be possible to split into three levels:

- Problems obvious even at a superficial analysis (First order problems)
- Problems revealed by a somewhat deeper analysis (Second order problems)
- Problems almost totally hidden (Third order problems)

4.1 First order problems

By first order (obvious) road safety problems are meant the road safety problems that come out directly from the way we analyse our accident and injury statistics. The way the accident and injury statistics is collected, organised and analysed varies from country to country. Most countries within the EU have a number of common first order problems, problems to which we give a very high priority. The ranking of the problems is not identical but they seem to be common problems, which each country tries to reduce.

One reason for national differences is of course that the problems are different both in quality and quantity. Another reason is that the criterion for giving a high priority to a problem may differ from country to country. It may be the number of fatalities (e.g. young drivers), number of injured persons or number of accidents (e.g. built up areas). Or it may be high risks based on some calculation (e.g. motorcyclists). Or it may be a negative trend (e.g. drugs and driving or old drivers). Or it may be the fact that the road users in question cannot themselves reduce the problem (e.g. children or old persons)

Consequently it is difficult to give a general ranking list of the most important first order road safety problems in the EU. An attempt is made to list 17 problems that seem to constitute a group of common top priority direct road safety problems for the fifteen EU countries is presented below. For the reasons just given they are not ranked. Furthermore the first order problems listed below are to a large extent overlapping and interacting.

- Speeds, especially in built up areas, are too high.

- Alcohol and drugs are too frequent in road traffic.
- Road safety is too low in urban areas.
- The road safety of children is inadequate.
- The road safety of unprotected road users is too low.
- The crash risk for young drivers is too high.
- Driving of cars is too widespread especially in urban areas.
- The standard of the roads and streets is not correct in many places.
- The accident and injury risks for elderly road users are too high.
- Too many roads and vehicles are inadequate from an injury prevention point of view.
- The usage of protective devices (belts, helmets etc.) is too low
- The rescue service and medical treatment of traffic victims is not effective enough.
- The conspicuity of road users is insufficient in daylight. Their conspicuity at night is much worse.
- The crash risk in reduced visibility conditions such as darkness and fog is too high.
- The crash risk in winter traffic is too high.
- Heavy vehicles are over-represented in serious crashes.
- Some intersection types have crash risks which are too high.

Among these first order road safety problems speed is the most important one (ETSC 1995). There are many reasons for this, some are the following:
- Speed influences both crash risk and crash consequence
- Speed has an exponential effect on safety
- Speed is not realised as a danger factor comparable to height
- Speed is a key behavioural variable because driving is a self-paced task
- Reduced speed has an immediate effect on safety
- Reduced speed is an inexpensive (sometimes even beneficial) measure

4.2 Second order problems
The second order road safety problems are not equally obvious but they show up at a closer analysis of the first order problems. One way of defining them is to say that they reduce the effectiveness of countermeasures aiming at solving the first order problems. Such second order problems are e.g.:

- Road traffic rules (legislation) are not clear, not logical and not consistent
- Enforcement of license requirements and traffic rules is not efficient enough
- The control of road condition from safety point of view is insufficient
- The control of vehicle condition from safety point of view is insufficient
- Training and examination for drivers license is not good enough
- Traffic and traffic safety education of citizens is not adequate
- The way traffic offences and crimes are treated in court is irregular and not in harmony with the corresponding risks

4.3 Third order problems
By third order (hidden) road safety problems are meant problems that do not become immediately obvious from studying the accident or injury statistics. These problems are often of a more general character, not dealing directly with the traffic situation but with

underlying processes or conditions. These conditions may deal with the organisation of road safety work such as central or distributed responsibilities, decision processes, resources, co-ordination and roles. They may also concern the management of the road safety such as the steering process of road safety work. They may concern the awareness, the values and knowledge of road safety measures that are typical for citizens in a society -- decisions makers, road safety workers as well as roads users.

Third order road safety problems prevent or block the possible solutions of the first and second order problems. An improvement of third order problems would facilitate the implementation of much of the knowledge we have today about effective countermeasures which for one reason or another are not implemented.

On the one hand most people have placed the main responsibility for road safety on governmental or at least a public bodies. On the other hand when an accident occurs it is normally the road user who gets the blame. To a large extent this paradoxical situation will of course be true also tomorrow. However, the division of responsibilities between the individual and the public sector must be made much clearer. It seems that the main role of road users should be to follow the rules agreed upon, formally as well as in its spirit, and to demand new road safety actions to be taken. When unintentional mistakes are made the user should not be punished with death.

It is also expected that trade and industry will play a much more important role in the future. Today many progressive communities and companies have developed and introduced environmental policies and plans for their activities. In the future communities and companies should develop corresponding road safety plans for their activities. For instance when they buy transport one part of the specification should deal with the safety aspects of transport itself. This is fairly self-evident when buying transport of school children. But it should of course apply also for bus transport in general and for the transport of goods. Such policies would have a very strong and immediate impact on road safety.

In the same way consumers of transport products could be used in a very efficient way if we just give them the means to evaluate the safety of various products. The car itself is the most obvious and important product. By testing, rating and publishing at least passive safety of various car models it would be possible to influence the safety of the vehicles much faster, more effectively and less expensively than by traditional legislative means (EuroNCAP 1998) (which are still needed to set minimum safety requirements).

Some of the more important third order road safety problems are:

- Current awareness of the seriousness of road safety problems, the value of road safety measure is too low among decision-makers and road users. This has many negative effects. The main one is that that it prevents us from implementing the already existing knowledge about how to reduce road safety problems. One of the main reasons for this low awareness is the difference in perspective on road safety from above (authorities: striking large problem) and from below (road users: no striking problem)(Rumar 1988).
- The present management system for road safety work is inadequate. It is slow and inaccurate. In many cases it is almost non-existent. A quick and efficient road safety

management system requires result management based on performance indicators (Rumar and Stenborg 1994).
- When it is possible to create a vision of the future that most people in a company or a society stand behind, that is the most efficient way to lead people in the right direction and to create creativity, energy and participation. Road safety work in EU lacks good vision. In Sweden we have created the zero-fatality vision that seems to work even better than was expected (SNRA 1996).
- At least as important as visions are quantitative targets. Experience shows that quantitative targets on national, regional and local level are beneficial for the success of road safety work (OECD 1994. An EU target would also be very worthwhile.
- The present information and diagnosis system for road safety is very crude and partly inaccurate. In most countries it is exclusively based on police reported accidents. Road accident injuries and fatalities are a public health problem. Consequently the information system must be able to measure the health problem. To manage that hospital statistics must be used in a better way.
- Most countries carry out extensive road safety research. This is a complicated, demanding and expensive process. There is a fairly good co-operation between researchers. However there is very limited co-operation between financiers of research. This leads to differences in decision material and unnecessary differences in decisions. Road safety research within the EU should be more and better co-ordinated. The research on problems of the first and second order is quite extensive. However, research on implementation problems (third order) is very limited and should be expanded.
- We must ensure that consumers, communities and companies become more actively involved in the road safety effort. If that is handled properly it will be a strong, powerful and quick force to influence and improve road safety.

The third order road safety problems are not as eye-catching as the primary and secondary road safety problems. They are, however, probably more important problems in European road safety work than the first and second order problems for the following reasons:
- The first and second order problems immediately raise countermeasure questions and answers. The third order problems deal with the implementation difficulties that we all are facing
- Contrary to the first and second order problems people are not aware of the third order road safety problems
- The first order problems are comparatively narrow. The second order problems are comparatively broad. If we solve some third order problems we will influence the whole road safety process.

5. The human limitations

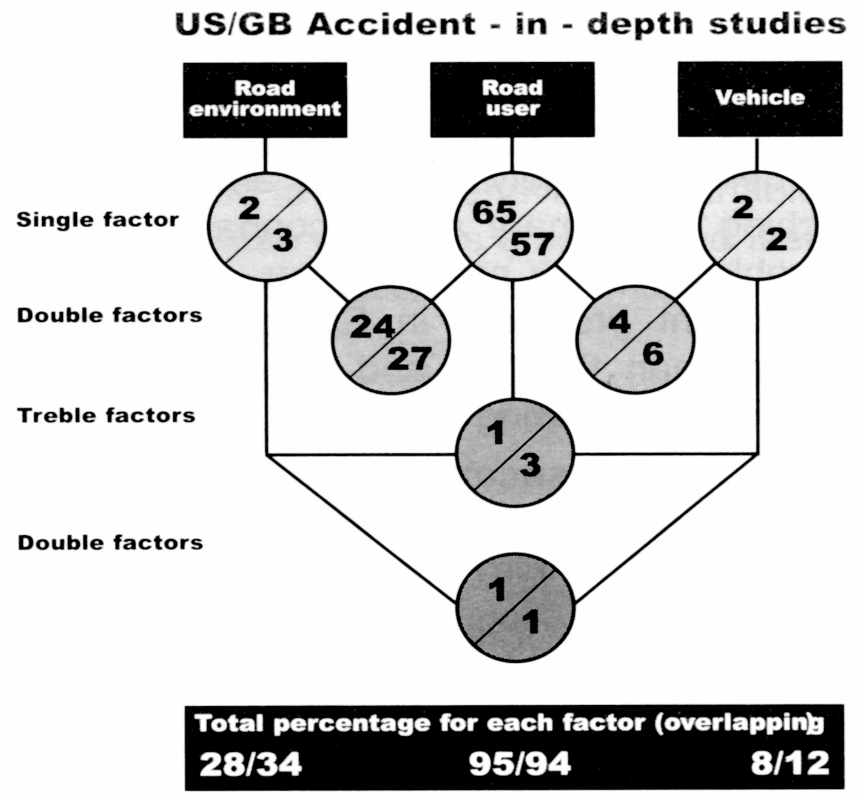
There are two major human limitations that influence the way we must attack the road safety problems:
- Human behaviour is unreliable and errors very often trigger crashes
- The tolerance of the human body to physical violence released in crashes is limited

<u>5.1 Human errors</u>

Many accident-in-depth studies indicate that in a majority of crashes one of the main factors is human error (Rumar 1982). This is often taken as a strong argument for concentrating road safety work on changing human behaviour by information, education, training, legislation and enforcement (see Figure 2).

When we argue like that we make at least two errors. First, we must realise that road user errors may trigger the incident or the crash, but are not necessarily the underlying cause to the crash. Secondly, we tend to forget that human behaviour is governed not only by the knowledge and the skill possessed by the individual but also to an equally large extent by the environment in which the behaviour takes place. Indirect influences such as the design of the road, the vehicle or rules or their enforcement are at least as important to influence road user behaviour as by direct influences such as training.

Figure 2. Illustration of the proportion (percentage) of the main factors contributing to road crashes according to the two largest accident-in-depth studies carried out (US and UK)



Behind road user errors are either capacity limitation such as vision in night traffic, detection of targets in the periphery of the eye, estimation of speed and distance. The fact that we do not realise the danger of speed in the same way as we realise the danger of height is a key problem in road safety work. Other causes of road user errors are motivational limitations such as no feedback, no social control and compensatory behaviour (e.g. increasing speed when friction or visibility is improved). Authority errors (e.g. design of an intersection, legislation) influence the probability and consequences of road user errors.

5.2 Vulnerability of the human body

Because human behaviour is unreliable we will never be able to prevent all crashes as long as the driver is the operator in the system. However, we may be able to prevent all fatalities and all impairments in road transport if we use the tolerance of the human body as the limiting parameter in the design of the transport system.
The human body has developed over a very long time and due to the natural selection first stated by Darwin it can stand the forces that can be inferred upon it at collision speeds corresponding to the speed of our ancestors -- that is 10-20 kilometres per hour. At higher collision or deceleration speeds the tolerance is low and the result is more or less serious injuries or even fatal.

The injury tolerance of the human body should be a determining design variable in what we often call ”passive road safety” work (aiming at reduction of permanent injury) as opposed to ”active road safety” work (aiming at preventing crashes). The basic ideas to reduce injury are (ETSC 1993):

- To reduce collision speed (speed limits)
- To decelerate the body over as long time as possible
- To decelerate the body over as long distance as possible
- To spread the forces over the strong parts of the body
- To treat the injury adequately as quickly as possible (rescue and trauma care))

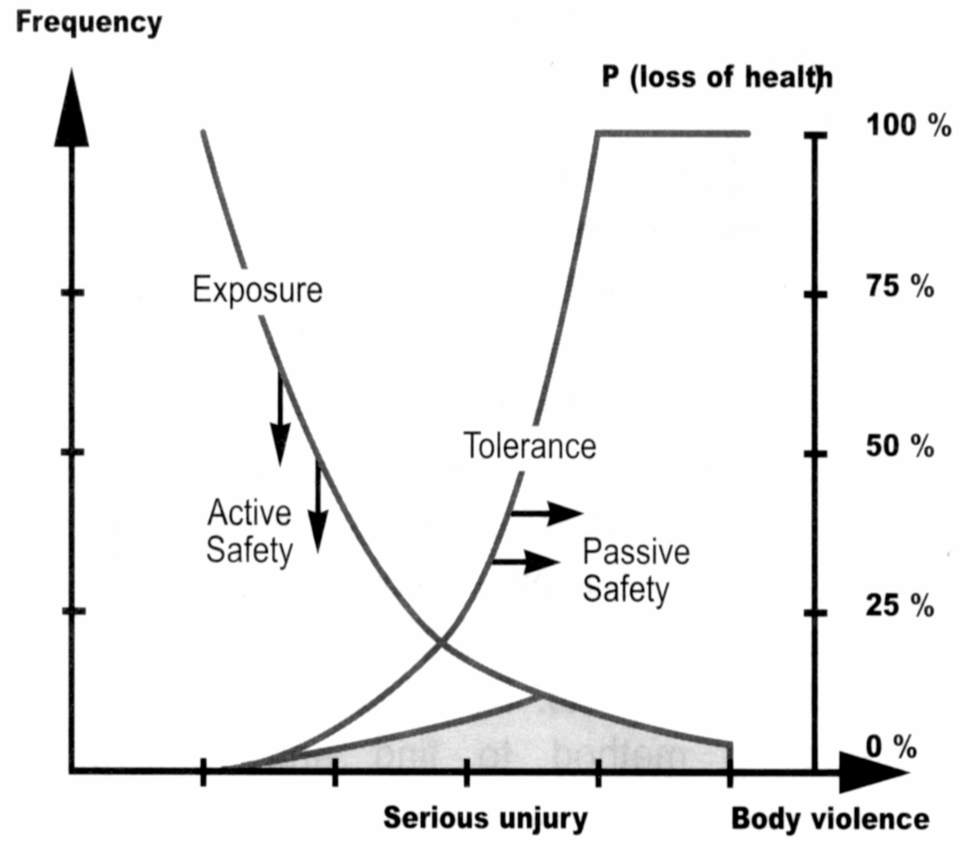
Seat belts, air bags, energy absorbing car fronts and rears are good vehicle examples. However, it is often the case that the collision takes place between a vehicle and the road environment. Therefore also the collision characteristics of the environment must be taken into account. Energy absorbing lighting poles and crash barriers are good examples of such designs. Dangerous elements along the roads should be removed. Road safety audits is a promising method to identify and remove such elements. So far the interaction between vehicle performance and environmental characteristics in collisions have not been studied to the extent it requires.

Another large and serious injury situation, which has not been systematically studied until fairly recently, is the collision between a car and an unprotected road user (pedestrian, cyclist, and motorcyclist). The results of the pedestrian tests used in Euro NCAP (1998) demonstrate the need for an EU action in this area.

Fast rescue service and adequate trauma care are two other elements, which reduce permanent injury, and which must not be forgotten.

Figure 3 illustrates the general task of road safety work split up into active and passive road safety improvements. Active road safety tries to reduce the frequencies of collisions, to lower the left curve. A majority of the active safety measures are aimed at reducing the probability of human errors. Passive safety on the other hand strives at increasing the human tolerance to the violence released at collisions (e.g. by means mentioned above), to move the right curve to the right.

Figure 3. Illustration of the different functions of active (preventive) safety and passive (injury reducing) safety measures.



The surface under the two curves indicates the size of the problem, the number of seriously injured and killed road users. The indicated movements of the two curves work to reduce this problem area.

6. A public health problem

Transport injuries and fatalities are often treated as a price we have to pay to keep our high level of mobility. However, as indicated in section 2 (Table 1) of this report the transport accidents in general and road crashes in particular create injury and fatality consequences which constitute a public health problem of a size that not too many decision makers and very few road users realise. Traditional accident statistics do not make this clear. The figures are there but the interpretation made by most readers fails to reveal the real situation. Most people believe that road crashes are events that happen to others -- not to themselves.

Therefore the figures in Table 3 are presented in a way that is more difficult to misinterpret and push aside. It does not use society as a basis, but the individual. Therefore to most readers the figures show in a shocking way the size of the road safety problem to society and to citizens. Injuries from road accidents are a considerable public health problem in Europe!

Table 3. Illustration of the size of the public health problem of road traffic accidents in many European countries

- 1 in 3 citizens will need hospital treatment during their lifetime due to road accidents
- 1 in 20 citizens will be killed or impaired by road traffic accidents
- 1 in 80 citizens will end their life 40 years to early due to road traffic accidents
- Road accidents cause 6 months shorter life expectancy
- Road accidents cause on average 2.5 years-expected health loss
- The injury risk per time unit is 40 times higher on the roads compared to industry
- Contrary to other death causes road accidents hit young people
- Road accidents are the largest single cause of death for persons below 45 years
- Road accidents cause the highest number of lost years of any cause of death

The conclusion is that road injuries and fatalities is a problem not only for society but also for the individual.

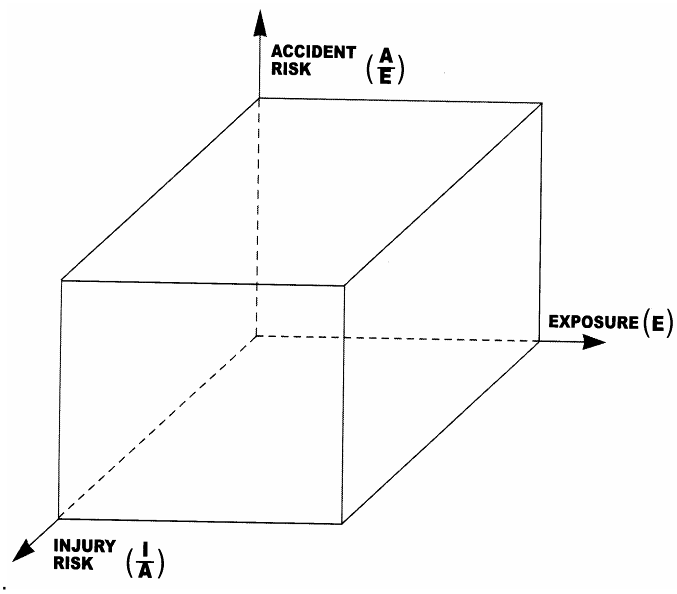
7. The countermeasure principles

The principles of countermeasures are treated here on two levels. First a general overview is given. Then countermeasures specifically aiming at the critical human factors are described.

7.1 General principles

There are three basic variables or dimensions that decide the size of the road safety problem from public health point of view. This is illustrated in the three-dimensional Figure 4 where the volume represents the total number of e.g. persons killed or injured in road traffic (I).

Figure 4. The size of safety problem (number of human injuries and fatalities) illustrated as a function of the product of the three variables exposure, crash risk and injury consequence



One important countermeasure dimension is the exposure (E) to road traffic. Many studies show that there is a very strong correlation between traffic volume and number of accidents. The general problem is to find out how the traffic volume can be reduced without losing too much mobility. Comparatively few nations have, however, really been working with this type of countermeasure. It is worth noticing though that this is the variable where the road safety proponents and the road environment proponents have a common interest and should support each other.

This dimension is probably the dimension with the highest potential to influence safety both from a volume point of view and from a time point of view. The fact that economic recession is generally associated with increased safety on the roads has a lot to do with the reduction of traffic volumes primarily for young drivers and heavy traffic. If a volume influencing measure is introduced it will have immediate effect.

We have not yet made real use of this safety-influencing dimension. However, it is my belief that in the future we will most certainly have to use this measure more frequently, if not for safety reasons, then for environmental reasons. The new transport telematics technologies will make it possible to do so in a more intelligent way than earlier, in a way that will reduce exposure without impairing the most important mobility too much.

Another countermeasure dimension is the risk of an accident occurring given a certain traffic volume (A/E). The general problem here is to find measures that will reduce the accident risk in high risk situations such as darkness, fog, ice etc. and for high risk groups such as for young drivers, for unprotected road users, for heavy trucks, etc. In the history of road safety work this is the dimension that has attracted the largest interest and most efforts and resources.

Accident risk reduction countermeasures may work along several lines. It is possible to reduce the risk through improved road user knowledge, road user attitude, driver experience, driver skill, improved vehicle performance, improved road characteristics, modified traffic legislation, stronger enforcement strategies as single or integrated measures. Today we have a considerable knowledge about how to influence the various risk factors. But this strategy, which is often called active (preventative) safety, is on the whole not so successful in spite of all the knowledge we have accumulated.

The main reason is that this type of measure aimed at reduced crash risk is often heavily influenced by the adaptive (compensatory) behaviour of users. Several studies have shown that the technical effect of countermeasures are normally reduced because users, e.g. drivers, use the improved visibility, friction, braking performance, road geometry, driving skill etc primarily to improve their mobility or their comfort -- not their safety. The most common way to react is to increase speed.

The third countermeasure dimension is what we can call the consequence variable. By that is meant the risk for an injury given an accident (I/A). The general problem is to find out how the injury level can be reduced in accidents of various types - e.g. head on collisions with cars, side collisions, collisions between car and truck, collisions between car and unprotected road user, single vehicle accidents, bicycle accidents etc. Road safety audits is a promising method to find and remove injury-causing elements along the roads. This countermeasure area has attracted considerable interest and substantial success during the last decades. The EU might encourage such activity by introducing safety audits of the Trans-European Road Network.

Contrary to the measures aiming at reduced accident risk the consequence measures often give close to full effects. The main reason is that the human adaptive counteraction is normally avoided. Drivers do not feel, do not get feedback from passive safety features. Consequently counterreactive behaviour, such as increased speed, is to a large extent avoided.

By multiplying the three dimensions we get the total number of killed, impaired or injured persons in road traffic

E X A/E X I/A = I

7. 2 Countermeasures focusing on the human factors

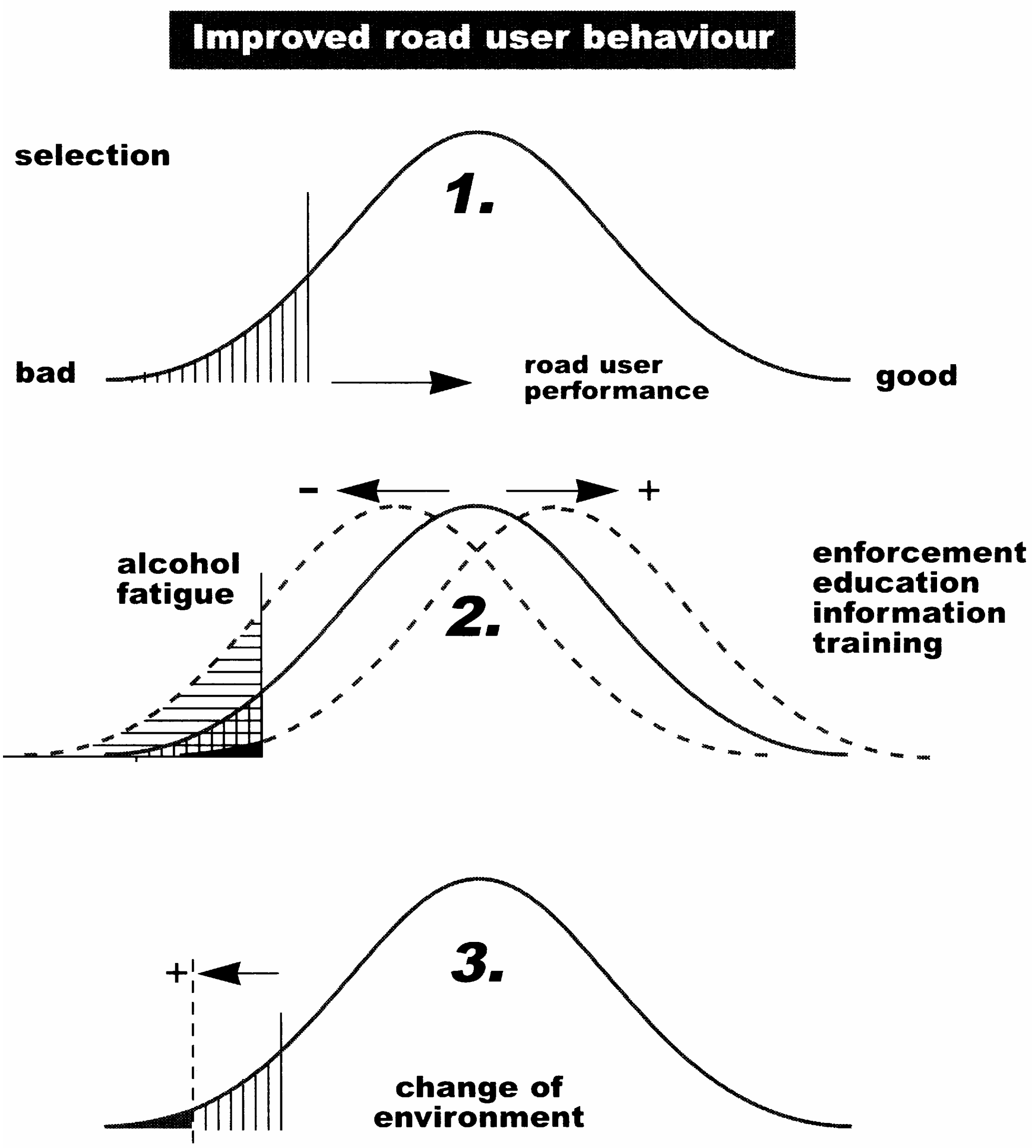
There are three possibilities to reduce human errors in road transport. Figure 5 illustrates the three possibilities.

By selection we can remove those persons who commit many errors from the traffic system. This is possible for professional drivers, less possible for private drivers and not possible for other road users. In the figure this is illustrated by moving the cut off to the left.

By information, education, training, legislation and enforcement we can try to influence road users to behave in a safe way. At the same time we have to be avoid such influence that works to reduce human performance (e.g. alcohol, drugs, fatigue). In the figure this is illustrated by moving the distribution to the right.

By adapting the traffic conditions to the human characteristics and limitations we can make it easier to walk, to bicycle, to drive and thereby avoid errors. Good examples of such measures are e.g. daytime running lights (DRL), intelligent speed adaptation (ISA), reflectorised road signs, road lighting, high mounted stop lights. In the figure this is illustrated by moving the cut off to the left.

Figure 5. Illustration of the three ways to reduce human errors: To take away those road users who make many errors (selection). To improve the performance of road users by information, education, training, legislation and enforcement (improvement) and at the same time make sure that their performance is not impaired by negative factors such as alcohol, drugs, fatigue. And finally to adapt the situation to the human characteristics so that it becomes easier to walk, to cycle and to drive.



We have to use all these three principles in the future. However, we should try to focus more on the third approach than we have done in the past. That principle is for many reasons superior. Its effect lasts, it does not exclude road users from taking part in the transport, the road users welcome it.

8. Previous road safety work

In order to understand how road safety work should be carried out successfully in the future it is necessary to analyse how it has been carried out in the past and which results were reached then.

8.1 Unclear roles of road safety actors

In too many countries the distribution of tasks and responsibilities between administrations and other organisations active on the road safety scene is unclear.

There are four main actors on the traffic safety scene:
- Road users (we are all road users by foot, bicycle, public transport or car)
- Authorities (local, regional, national and international)
- Voluntary organisations
- Industry

If we look into the rear view mirror we will probably realise how badly organised the roles and responsibilities among these four groups and within these four groups have been. We will probably realise that some areas of interest for several actors cover traffic safety while other areas are not covered by anyone. It seems that this is a specific problem to the EU on the one hand in relation to national authorities and on the other hand within the EU (several directorates deal with road safety). It is very important that responsibility and power follow each other.

8. 2. Activity management

Present road safety work in most countries is mainly managed by activities. It is decided that due to the accident development we should for example launch a campaign, we should strengthen the police enforcement or we should change the legislation. This type of management is comparatively weak and inefficient. Commercial companies have to a large extent left this type of management system for their activities. They have moved to something, which is called result management. Instead of using activities as the management basis the results are used.

8. 3. No exposure control

As stated above we have managed to control crash and injury rates. But the public health problem created by injured and killed road crash victims is still increasing. One of the main reasons for this failure is that traffic exposure is increasing faster than the reduction of crash and injury risk. The fact is that presently the number of cars is increasing faster than the number of persons on this planet.

We will not be able to improve road safety radically until we use exposure control as one of our instruments. Another reason for doing so is that road traffic presently is one of the major sources to environmental problems in the world (e.g. the green house effect). Road safety proponents should join the environmentalists in their effort to control exposure without losing too much of the mobility and flexibility offered by motorised traffic.

A specific part of the exposure problem is the fact that we would like to move transport to the safest roads and to the safest transport modes. Intelligent debiting systems may be a way to achieve this.

8.4. Too many central decisions

In most countries decisions influencing road safety work are carried out mainly on the central level. The consequence is that ordinary people do not feel it is any of their business. Road safety is the task of the authorities. A gap is opening between authorities and the public, the road users. We know from other areas of society that when people feel that they have influence over their own situation, they become much more interested and engaged in solving various problems.

To the EU this is a balancing act. On the one hand the road safety problem is so large that the motivation to act is very strong. On the other hand the EU should not intervene unnecessarily in national problems. However, EU could give the national authorities *and professionals* much more help and support in their efforts to improve safety. The sevenfold difference in national road safety within the EU is not acceptable and most of the problems are common.

This gap is widened by the fact that the road safety problem looks very different from the authorities and from the individual road user. Any driver has a microscopic risk in every trip taken. What he forgets is he is travelling every day, every week, every month, every year of his life. Together all these microscopic risks add up to quite a sizeable risk. Every road user may violate any rule and find that instead of being punished he benefits from it.

One of the main problems with present road safety work is that authorities and road users do not speak the same language, do not understand each other.

8.5. Trying to plan future road safety actions

There are in principle two ways to make a process work, to reach the goal that has been set up. One way is to plan everything in detail and tell everybody what to do. The other way is to describe the goal in a simple but clear way and to make the goal very visible -- to create a vision.

The top down *planning strategy* is the old way to approach a problem. This has traditionally been the way that administrations have worked -- also when it comes to road safety. The most extreme planning society was the old communist regimes. The *vision strategy* is a much more modern approach. It has lately been used quite extensively by various commercial companies, to make the staff work together against a common goal, without too much detailed instruction.

The more complicated a process is, the more difficult it is to use a pure planning strategy, and the more appealing is the vision strategy. The road safety problem and road safety organisation are both very complicated, with many independent variables, and many actors which are not very well co-ordinated.

8.6. No quantitative road safety targets

OECD (1994) has in its report ”Targeted Road Safety Programmes” given a very good review of practices, purposes and effects of setting quantitative targets in road safety work. The report shows convincingly how specified quantitative goals lead to more realistic traffic safety programmes, better use of public funds and other resources, and improved credibility for those involved in the traffic safety work. ETSC (1997) argues strongly for quantitative road safety targets at local, national and at EU level. All the best EU members from safety point of view have had targeted road safety programmes for several years.

8.7. Unclear strategy to reach the targets.

A number of clear road safety targets is not enough. What is also needed is a strategy explaining how the targets are going to be reached. The strategy has to explain which actions that have to be taken along the three axes described above (exposure, risk reduction, injury reduction). It must be based on identification of the primary, secondary and third level road safety problems. At the same time it must be clear, transparent and easy to understand.

A vision, clear targets and a strategy together with a road safety management system constitute the main points in a road safety programme.

8.8. Separate budgets for costs and benefits of road safety measures.

One major problem with road safety work is that whatever action is suggested is perceived as pure cost amongst those who have to take the decisions. The reason is that the benefits in terms of reduced number of killed and injured persons and lower administrative and material costs are entering into another budget. Consequently there is no economic incentive associated with road safety measures.

8.9. Low awareness of the need for increased road safety.

One of the major problems for efficient road safety work is the fact that the public normally does not realise the size and seriousness of the road safety problem. The risk of an accident is very low in every trip. What we tend to forget is that we travel many times each day, every week month, every month every year. The sum of all these small risks is considerable.

This cannot be felt or realised without systematic information and education. When the public do not realise the problem the decision-makers do not dare to be of another opinion because if the gap between the decision-makers and the public is too large, decision-makers will soon be out of office. .

However, studies (SARTRE 1997) show that the public opinion is often more positive to safety actions than most decision makers believe. Decision-makers could be much more aggressive on safety matters.

Therefore we have to raise the general awareness of the seriousness of road accidents and the need for road safety measures among the public and decision-makers in parallel. We have to do it from early age to retiring age. It is not enough to try to do it in connection with the driver education, training and licensing.

8.10. Low participation of the private sector in the road safety work.

As stated above road safety work is generally considered to be the task of the authorities. However, in order to be effective and successful also the public and the private sector (industry, transport companies, trade) has to be actively involved in the road safety work.

So far the private sector has been involved in development and trade of road safety products and as sponsors of road safety campaigns. It is important however; to get them involved also in the efforts to influence road user behaviour, the weak point in all road safety work.

8.11. Road safety measures judged necessary must be marketed.
If public response is negative to a chosen road safety measure we have to convince them otherwise. We must market our product using all the knowledge that commercial companies have collected over the years and which we too seldom have made use of.

Every road safety measure is perceived to have a certain benefit but is also perceived to require a certain sacrifice. If the size of the benefit is perceived as larger than the sacrifice, then it is really no problem. However, if the sacrifice required is perceived as larger than the potential benefit then the public is naturally negative to our proposal.

Our task is to change public perception in such a way that the traffic safety proposals we make are all are all perceived to have larger benefits than sacrifice. This is not such an impossible task as many say. Neither the public nor the decision-makers did previously accept many of the traffic safety measures that are presently accepted.

8.12. Too old technology
A larger and larger part of a modern car consists of electronics and semi-intelligent systems (e.g. in the motor, in brakes and suspension, in instrumentation, in communication). Also traffic control systems (e.g. traffic signals, variable message signs, radio) use more and more information technology. All this advanced technology could and should be used also for a number of road safety purposes (ETSC 1999b).

8.13. Lack of follow-up and evaluation of road safety measures.
Evaluation, feedback and monitoring of the effects of various road safety measures are very important because without this kind of feed back, learning is more accidental, not systematic. The same mistake can be repeated. The ineffective measure will be used again.

There are two types of evaluations. One is at national and regional level with the task to compare the real situation with the targets specified. Some independent body -- for instance a university group, is best placed to carry out this type of general evaluation of road safety work.

The other type of evaluation has to do with the effectiveness of road safety work itself at any given moment. For this type of evaluation we have to find other more frequent variables than crashes and injuries. Normally behavioural measures are used. For example usage of seat belts, bicycle helmets, proportion of drivers being drunk, proportion of drivers exceeding the speed limit, time for accident victims to be rescued, proportion of drivers running red signals etc.

9. Key components in future road safety work

The EU has according to its rules a certain responsibility to provide protection for citizens and obligations to improve transport safety. On the basis of the above made analyses and discussions the following components are considered crucial for a successful future road safety work:

- Treat transport injuries and fatalities as a public health problem deserving much more societal interest rather than as a transport complication, or a necessary price for a high level of mobility. In consequence with the public health approach health statistics should be used much more frequently than is presently the case. Thereby the diagnosis of the injury and fatality consequences of transport accidents will be much more realistic and true and the use of statistics for effect analysis and follow up studies will be more valid and reliable. The CARE project should be developed along these lines and also include important secondary information such as the wearing of seat belts.

- Today each EU member country works more or less on its own with their specific transport safety problems. This is certainly right to a large extent because conditions are so different between countries. However, on the one hand countries can very well learn from each other even if the final solutions are different and on the other hand there are also a number of common problems that should be solved in a close co-operation. For these reasons an EU safety information centre for transport safety should be created. This is also suggested in the EU Road safety programme (1997a)
- Transport has in general terms one primary goal and three restrictions
  - To move people and goods (primary goal)
  - Not to cause too many crashes, injuries and fatalities (restriction)
  - Not to cause too many environmental problems (restriction)
  - Not to cost too much (restriction)

  Road safety work could benefit from joining forces with the environmentalists because to quite some extent safety and environment argue for the same measures. Together we could be stronger and more influential than separately. Such a co-ordination between safety and environment in transport should be carried out also within the EU.
- As was elaborated on in the previous subsection (8.10) we need to develop a public/private partnership in road safety work One way to achieve this could be to make safe transport a competition variable or prerequisite in the same way as environmentally friendly transport today is a competition variable. This process could start with community transports such as public transport. Only companies that are able to guarantee that their vehicles are safe and their drivers follow the rules can compete for contracts. When that step is taken the same could apply for other more commercial transport. Another area in which a public/private partnership could be established is consumer information on car and other traffic products.
- For reasons presented in subsection 8.8 above the cost and benefit budgets for road safety measures should be linked more closely together. Some pilot trials in that direction have started. But much more should be done to develop this idea.
- In the draft EU road safety programme a 1.1 million ECU principle was suggested. The intention was to suggest that any road safety measure that could be expected to save a life and which would cost less than the costs estimated for a lost life on the EU roads is worth being implemented. Admittedly it has a number of drawbacks. But it could introduce cost benefit analysis as one of the criteria in the European road safety work. In the future such estimations on a much higher level would need to be required (Despontin et al 1998).
- The most serious first order problems in the EU today are overly high speeds for cars and overly common use of alcohol and drugs among road users. As a first step EU should take action to suggest speed limits. In urban areas at or below 50 km/h, encouraging 30 km/h in residential areas and speed limits in general at or below 120 km/h. EU should also as a first step suggest BAC limits generally at or below

0.5 promille and for young novice drivers at or below 0.2 promille. An EU Directive on safer car fronts for unprotected road users is needed. Another primary problem that could be handled quickly is bad conspicuity. There is a good case for mandatory daytime running lights fitted to motor vehicles. Important second order problems are effective enforcement and driver training and licensing. A common EU electronic and intelligent driver licence is a suggestion worth developing.

- The most serious third order road safety problem in EU today is the low awareness; the low value placed on road safety measures because it prevents us from implementing the countermeasure knowledge we have. It leads to very low demand for increased road safety from the public, which in turn makes politicians, public authorities and producers of cars hesitant to spend money on road safety improvements. Furthermore it prevents the private sector from using road safety as a means of competition. Finally it leads to low observance of safety legislation, low usage of safety equipment, weak social control in road traffic, and compensatory behaviour from the road users. We must raise the awareness about and the perceived value of road safety measures among road safety workers, decision-makers, and road users!

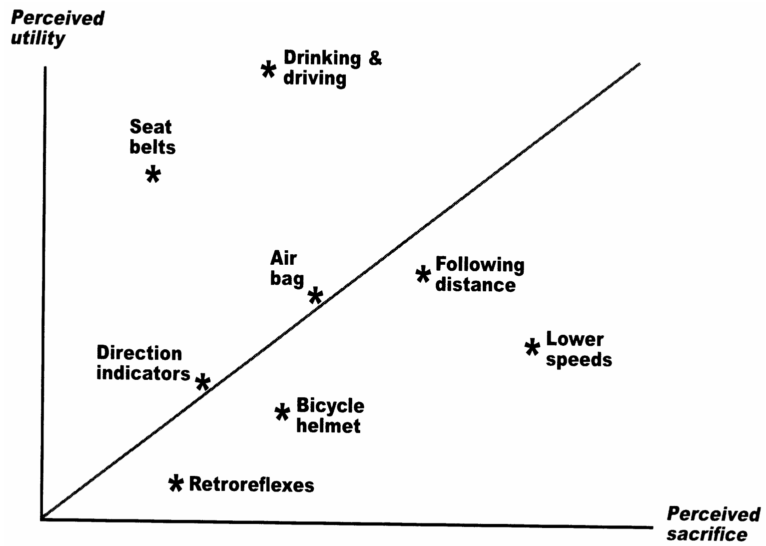
- In subsection 8.1 above it is argued that we must organise clear actor roles in road safety sector. One should have the main and the co-ordinating responsibility. The other actors should have well defined responsibilities within their sector and when given responsibility they should also be given resources to accept that responsibility. The distribution of responsibility for transport safety within the EU does not seem to be all that clear.
- Traditionally road safety work has been based on accident statistics. This principle has two major drawbacks. First it does not give the true public health problem picture (see above). But more important in this respect is that unfortunately from this point of view crashes are rare events. Therefore the accident statistics system is not fast and reliable enough to be used in management of road safety work. We have to establish and specify specific road safety performance indicators. Normally behavioural measures such as usage of seat belts and bicycle helmets, proportion of drivers being drunk, exceeding the speed limits or running red, time for crash victims to reach qualified treatment are used. Such measures make it possible to get a fair idea of the road safety situation very quickly, in very limited areas and within very specified problem areas.
- Road safety performance indicators of the type just mentioned is a prerequisite for an efficient result management system. By means of a management system based on performance indicators it is possible continuously to check the road safety situation nationally, regionally and locally. If something goes wrong it is immediately detected and actions to turn things right can be taken without any loss of time.
- As indicated above many of the national road safety problems should be handled on the national or even regional or local level. The EU should not fall into the same trap as many nations have -- to try to solve all road safety problems centrally. The subsidiary principle should always be applied when there is no added EU value. However, in transport safety work the added value of an EU action is normally there.
- Traditionally legislation has been the primary measure of administrations. And legislation will be necessary also in the future to specify the minimum level accepted for behaviour, on roads, for vehicles from safety point of view. However, legislation

has a number of drawbacks. The major draw back is probably that legislation will always be more or less obsolete at the time of ratification. The reason is that the legislative process takes a very long time and includes a number of steps of compromises. Another reason is that legislation requires long transition periods before it becomes compulsory. Therefore we must complement legislation with something that is quicker, something that represents the front of present knowledge. Testing for consumer information is such a quick method. If we can agree on testing situations and testing methods consumer information is a very quick and powerful measure. The enlightened consumer is probably the most powerful factor in a market society.

- If we find that the public opinion is negative to a measure we have suggested and for which we think we have solid arguments, then we must try to convince the public. We must market our product using all the knowledge that commercial companies have collected over the years and which we too seldom make use of. This point is closely related to the previous point.

Figure 6 illustrates the task facing us. Every road safety measure is perceived to have a certain benefit but is also perceived to require a certain sacrifice. If the size of the benefit is perceived as larger than the sacrifice, then it is really no problem. However, if the sacrifice required is perceived as larger than the potential benefit then the public is naturally negative to our proposal.

Figure 6. Illustration of how any safety measure is perceived to have a certain benefit and cause a certain sacrifice. Our task is to increase the perceived benefit and to decrease the perceived sacrifice in such a way that the measure is accepted and followed.



Our task is to change public perception in such a way that the traffic safety proposals we make are all above the diagonal, are all perceived to have larger benefits than sacrifice. This is not such an impossible task as many say. Look at the figure. Many of the traffic safety measures that are now above the diagonal were below the line not too long ago.

- Present cars and present traffic control contain a lot of semi-intelligence. Also communication systems such as mobile telephones and short wave local communication systems have been substantially improved during the last years. This

and other examples of modern technology should be much more used to improve road safety than is presently the case. ETSC (1999b) make a number of suggestions for EU initiatives. Some promising applications are:
- Intelligent speed adaptation (ISA)
- Intelligent surveillance and enforcement systems (Policing)
- Emergency notification systems (Mayday)
- Intelligent incident detection systems
- Systems checking driver authority to drive (intelligent driving license) and monitoring driver condition (e.g. alco-lock)
- Intelligent driver self-learning (tutoring) systems
- Intelligent exposure control and road debiting systems

In the future only our imagination puts limits to all the possible road safety applications of Intelligent Transport Systems (ITS)

10. Conclusions (The Ten Commandments)

Considering the dominant role of road transport in transport safety all these recommendations deal with road safety. An effort is made to limit the proposals for future road safety actions on the part of the EU to ten. These are the ten Recommendations:

1. Treat road transport injuries and fatalities as a public health problem and use health statistics more extensively to diagnose the road safety situation and to evaluate the effect of various road safety measures. Develop CARE in that direction.
2. Carry out the road safety work along all three of the countermeasure axes (reduce traffic exposure, reduce the probability of a crash, reduce the injury consequences of a crash) and behavioural principles (selection, influence, technical adaptation)
3. Be aware that the human reactions to your actions are critical for the success of the crash prevention measures. Try to create conditions, which the users can handle and are motivated to carry out in a safe way. Make sure that when a mistake is anyway occurring the violence towards the human body is within its tolerance limits.
4. Focus much of your efforts on creating a high awareness about the importance of road safety work because a low awareness will limit the effect of all your other measures and actions. An efficient enforcement system will always be needed for road safety measures that has not reached acceptance.
5. Formulate a road safety vision which is at the same time simple and easy to communicate and not too unrealistic. Specify quantitative injury and fatality targets on EU (e.g. <25000 killed 2010) and national levels to be reached at set times not too far away (3-5 years).
6. Increase public/private partnership. One promising possibility to do that is to make safety (of vehicles and drivers) a competitive variable in the bid for transport contracts first on the public and then on the private market.
7. In some problem areas (e.g. speed, alcohol) our knowledge is good. Here we should concentrate on how to implement focused measures. In other problem areas (e.g. road safety awareness, intelligent transport systems) our knowledge is still limited. Here we should focus on co-operative research. In both cases an EU road safety information centre could play an important role.

8. The single most important first order road safety problem that we have to deal with is speed. It will take some time before we have rebuilt all roads and all vehicles in such a way that they can forgive human mistakes at high speeds. Until that is made we will have to reduce speeds in many areas. The second most important first order problem is alcohol and drugs. EU should set ceilings for both (speed < 50 km/h, <120 km/h; alcohol <0.5,<0.2 BAC). A Directive on safer car fronts for pedestrians and cyclists is needed. Daytime running lights could be implemented. Among the second order problems traffic enforcement and driver training and licensing are most important.
9. In order to be able to carry out a result management system we have to construct a number of road safety performance indicators. These measures, which are normally of behavioural character, will serve as quick and simple indicators of how well our road safety work runs and how we could improve it.
10. Legislation has been the primary tool used in international road safety work (e.g. vehicles, signs, and signals). We will always need legislation to specify minimum requirements from safety point of view. However, in the future we will have to use more often a quicker and more updated method to influence consumers on the individual and aggregated level. Agreed tests and consumer information (e.g. EuroNCAP programme) is a very promising and powerful method.

References

1. Andersson, Å. and Strömquist, U (1988) The future of the C-society (in Swedish) Prisma, Stockholm, Sweden
2. Despontin, M., De Brucker, K., Coeck, C. and Verbeke, A. (1998) The economic evaluation of road safety in the European Union
3. ETSC (1993) Reducing traffic injuries through vehicle safety improvements
4. ETSC (1995) Reducing traffic injuries resulting from excess and inappropriate speed
5. ETSC (1997) A strategic road safety plan for the European Union
6. ETSC (1999a) Exposure data for the assessment of risks: Use and needs within and across the transport modes in the EU
7. ETSC (1999b) Telematics and intelligent transport applications for road safety
8. CEC (1997a) Promoting road safety: the action programme 1998-2001
9. CEC (1997b) Safety assessment of third country aircraft using community airports
10. CEC (1997c) Safety requirements of professional competence for cabin crews in civil aviation
11. CEC (1997d) Conditions for the operation of regular ro-ro ferry and high speed craft services
12. EURO NCAP (1998) Crash Tests
13. Gerondeau, M. et al (1991) Report of the high level expert group for an European policy for road safety
14. OECD (1994) Targeted road safety programmes
15. Rumar, K. (1982) The human factor in road safety. Invited paper at 11th Australian Road Research Board Conference, Melbourne, Australia
16. Rumar, K. (1985) The role of perceptual and cognitive filters in observed behaviour. In Evans, L. and Schwing, R.C. (eds.) Human Behavior and Traffic Safety. Plenum Press, N.Y., USA
17. Rumar, K. (1988) Collective risk but individual safety. Ergonomics 31,4, 507-518

18. Rumar, K. and Stenborg, L. (1994) The Swedish National Road Safety Programme; a new approach to road safety work
19. SARTRE-2 (1998a) The attitude and behaviours of European car drivers to road safety. Part 1. Report on principle results. SWOV Institute for Road Safety Research, The Netherlands.
20. Swedish National Road Administration (1996) The zero fatality vision

Figure captions (Rumar 1999)

Figure 1. Comparison of what has happened in development of production and transport. First the motor replaced the muscles as energy source. Then the logic aids and communication try to replace the human senses and brain. This development has changed the role of the human operator radically

Figure 2. Illustration of the proportion (percentage) of the main factors contributing to road crashes according to the two largest accident-in-depth studies carried out (US and UK)

Figure 3. Illustration of the different functions of active (preventive) safety and passive (injury reducing) safety measures. Explained in the text.

Figure 4. The size of safety problem (number of human injuries and fatalities) illustrated as a function of the product of the three variables exposure, crash risk and injury consequence.

Figure 5. Illustration of the three ways to reduce human errors: To take away those road users who make many errors (selection). To improve the performance of road users by information, education, training, legislation and enforcement (improvement) and at the same time make sure that their performance is not impaired by negative factors such as alcohol, drugs, fatigue. And finally to adapt the situation to the human characteristics so that it becomes easier to walk, to cycle and to drive.

Figure 6. Illustration of how any safety measure is perceived to have a certain benefit and cause a certain sacrifice. Our task is to increase the perceived benefit and to decrease the perceived sacrifice in such a way that the measure is accepted and followed.

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His pioneering work in the safety field is known and appreciated worldwide, This has ranged from research into improving vehicle conspicuity to the development and application of a range of road safety strategies, including the sustained application of results-based road safety management in Sweden.

He has represented Sweden in a number of international committees dealing with road safety. He is also chairman of the PIARC Road Safety Committee and the Nordic Road Safety Committee. He has written about 250 papers on road safety and the human factor and is associate editor of the scientific journal Accident Analysis and Prevention. He has recently joined the Board of Directors of the European Transport Safety Council.