Road accidents: worldwide a problem that can be tackled successfully!

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Abstract

Every year, worldwide about 500,000 people are killed in road accidents. This contribution gives an overview of the present state of affairs in the area of road safety.
The anticipated growth of (motorized) mobility on a global scale will, without effective road safety management, lead to an increase in the number of fatal accidents and injured persons. From experience we know that the problem of road accidents is not unassailable. An overview of prominent examples of effective measures is given. Also activities and measures which could lead to a further reduction in road casualties are described. These include realistic possibilities but it is not to be expected that one single all-embracing measure can be found to solve the problems. It is rather more the necessity to carry out existing measures and activities in a better way based on synergy and permanent implementation. Furthermore, preventive and explicit road safety considerations will have to include decisions concerning the planning and investment in road infrastructure (construction and maintenance), in order to prevent road safety problems rather than solving them with hindsight ("When the steed is stolen the stable-door is locked").
Of importance is the setting of political priorities, adequate organization and sufficient budgets. The international exchange of know-how on effective measures, for example via meta-analyses and 'best practice' overviews, could be of help and to this end the international road safety community is encouraged to take initiatives to develop cooperation.

Road safety is a worldwide problem and has not been solved to satisfaction anywhere. But there are many recognized possibilities which have, and in the future can have, a visible positive effect. If this insight can be brought to bear upon politicians and policy makers, the number of road accidents can be tackled even more successfully.

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1. Road accidents

Road safety tends to be regarded by most countries as a social problem, albeit a high level of social apathy can be noted. Generally speaking, the result in everyday practice is that the aim of reducing the number of road accident victims does not receive high priority.

Many different ways to shine a light on road hazard problems have been tried out, so that 'eyes are opened'. For example, rather than by presenting the annual (small) probability of dying in an accident, one has attempted to draw attention to the problem by calculating the probability of an individual becoming involved in an accident some time during his/her life, or by estimating the economic consequences of road accidents (1 to 2% of a country's Gross National Product), or by pointing out that young people often become the victim of a road accident (the principal cause of death amongst people aged between 15 and 45), and therefore that road hazard leads to a high number of 'lost years of life', or by showing how many people will have a fatal accident in the next twenty years 'if policy remains unaltered' (e.g. 400,000 in all countries of Central and Eastern Europe), or by reporting that there is no technological system in existence today (such as transport by rail, air, energy production, etc.) that has led to so many fatalities - and will continue to do so - as the current road transport system. But, to date, all these descriptions do not seem to have been successful in drawing the attention of the general public and the politicians to the problem of road hazard.

There are a number of explanations for this. The large majority of all traffic accidents hardly makes any impression on the general public or on the press, in contrast for example, to airplane disasters or shipping disasters. In addition, both the nature of the road hazard problem and the approach to be adopted towards it is complex. There are many possible causes while the relationship between the causes and the many actors or stakeholders involved in the approach adopted is extremely intricate.
The finger cannot be pointed at any one source.
Another explanation is that many people believe that road accidents are unavoidably associated with road transport systems.
Finally, the fact should be mentioned that road safety measures are rarely popular, neither amongst road users, nor politicians, because they cost money and frequently restrict individual freedom, while the - anticipated positive - result of these measures can rarely be determined.

A study conducted in Norway amongst top level decision makers in the road sector in that country throws a disconcerting light on this matter (Koltzow, 1993):

> "Three principal impediments to safety interventions were identified: (i) mobility is considered as primary importance; the freedom of the car is difficult to restrict, (ii) as a consequence there is much more lobbying for mobility than for safety, and (iii) road safety commitments and policies are weak, even among some of those responsible."

There may be an underlying factor to explain the apathy towards road hazard: hardly any individual, including politicians and policy makers, experiences road hazard as a personal problem. People think that they are only rarely personally affected by the consequences of road accidents. *But, it is easy to calculate that many persons will be affected in their lifetime, one way or another, in a serious way by road accidents. However, the difficulty has to overcome that road traffic is not perceived as a dangerous activity.*
Therefore, skill is required to solve this paradox of a social problem which is not experienced as such by the individual. What should in any case be realized is that the scope and nature of the problem must be documented as thoroughly as possible, and brought to the attention of decision makers and road users. *On this basis, the road user and people at large, including the decision-makers and politicians, will have to acknowledge the problem of road hazard in its true proportions: as a public health problem, as an economic problem, as a social problem and as a traffic problem.* Only then will the impression disappear that only others (can) have an accident.

Public awareness must be increased to ensure that road safety measures, which cost money and restrict freedom, are introduced and accepted. Again and again, the dilemma between road safety and other objectives will have to be investigated and solved, if 'optimal road safety result' is to be achieved. In this regard it is difficult to imagine the government (central and local) not playing a prominent role, even if it were only to set the right example.

Perhaps attention can be drawn to the problem in an entirely different way: by demonstrating that it can be tackled successfully. Improving road safety has proven not to be an impossible task. In highly-motorized countries, there has been no question of a considerable reduction in the number of road accident victims, even though mobility was constantly on the rise. However, growth in mobility has not led to a parallel growth in the number of road accident victims, however. More striking still; a growth in mobility in many countries has even gone along with a drop in the number of road accident victims.

Could both these approaches (profiling road hazard as a real social problem, and a problem that can be tackled successfully) lead to the support of politicians and policy makers of course supported by a more manifest (and professionally conducted) lobby from the public and social organizations?

After all, to date there is no country anywhere in the world where people are totally satisfied about the way in which the problem is tackled or satisfied about the results of this approach. There is no country in the world where the high level of road hazard is accepted as inevitable, even in those countries where a high level of mobility is linked to a relatively low number of road accident victims. What is the perspective for road safety, if road transport as we know it today does not undergo a fundamental change in the coming decades (roads in a historically and geographically determined situation, various modes of transport that use the same physical space, variations in speed limits between 5 to 150 km/h, the individual as an independent, decision making being and roads where few

restrictions are imposed)? Can the number of road accident victims be (further) reduced by 10%, 50% or even by 90%? And how can the various countries in the world learn from each other?

2. Recent developments in road safety trends

Two indicators are regularly used as a yardstick to compare road safety in one country with another: traffic safety and personal safety (Trinca et al., 1988). Traffic safety - sometimes indicated in terms of fatality rate or casualty rate - is a measure of how safely the road transport function is performed. It is commonly measured in terms of deaths per 10,000 registered motor vehicles or per 100 million vehicle kilometres travelled. The other - personal safety - indicates the degree to which traffic accidents affect the safety of the population. It could be considered a public health indicator: the number of traffic fatalities per 100,000 population (mortality).

In a paper for the PIARC Congress in Marrakesh, Harris & Wegman (1991) gave data on traffic safety and personal safety for a number of countries; the most recent from 1989. More recent data are given in the Annex to this report prepared by the UK Transport Research Laboratory and using data from the International Road and Traffic Accident Database (OECD/BASt).

The following conclusions can be drawn from the data on personal safety and traffic safety in *highly-motorized countries*:

- generally speaking, the personal safety rate is improving (in the last seven years between 10 and 40%). However, the reduction rate differs; the reduction rate was higher in the seventies than in the eighties;
- generally speaking, the traffic safety rate is improving, and the reduction rate is higher than that of the personal safety (in the last seven years between 15 and 60%);
- the reduction rate for traffic safety differs per country and is not a constant one per country over time; nowadays the decline in the fatality rate is lower than it used to be;
- a good road safety record (low traffic safety rate) corresponds with a short half lifetime of traffic safety rates; no evidence of a law of diminishing returns has been found. Examples are the United Kingdom, Norway and the Netherlands with relatively low safety rates and high reduction rates, also in recent years.

It is impossible to come to one consistent conclusion for *developing countries*. This is understandable, in view of the complete different situations regarding road transport and motorization in that part of the world. During the last ten years the number of vehicles per head of population multiplied by ten in some countries (e.g. South Korea, Thailand), while in others the growth was more modest (South America). In many countries in Africa the motorization remains very low, between 1 and 100 vehicles per 1,000 inhabitants). The traffic safety record for many developing countries (a quality indicator for the safety of road transport) remains very high, compared to high-motorized countries (decuple). Any conclusion about developments in time is obscured by the poor quality of available data.

There is no doubt about the worsening situation at the end of the eighties and the beginning of the nineties in countries in *Central and Eastern*

Europe. However, the worsening situation was not only a structural one, but also an incidental one. On the other hand, improvements in some countries cannot be considered as structural improvements but only as incidental changes during times of turmoil.

In various papers my colleagues Koornstra and Oppe (e.g. Oppe & Koornstra, 1990) have successfully modelled the developments of road fatalities based on long-term developments in traffic growth (motorized kilometres) and in fatality rates (road deaths per distance of travel). The so-called logistic function, which is an S-shaped curve, fits the long-term trend of traffic growth for many highly-motorized countries.
In the long term, the growth of motorization in many countries is accompanied by an exponentially decreasing curve for fatality rates, that is a reduction in annual road fatalities per kilometre driven with a constant percentage (log-linear trend), although this percentage differs from one year to the next. The percent decline per year differs per country. On the grounds of empirical data Koornstra and Oppe concluded that cyclic modifications should be added to the long-term macroscopic trend of mobility growth and of fatality rates, although some room for discussion remains. Simply by combining both developments as a product [fatalities = fatalities/kilometre * kilometre], the development of fatalities could be described (see *Figure 1*).

Figure 1. *Trend in fatalities as result of trends in mobility and fatality rates.*

This leads to the conclusion that a reduction in the number of fatalities ought to be the result of a higher *decrease* in the fatality rate rather than an *increase* in mobility growth. Should the growth in mobility accelerate, for example due to high economic growth extra attention should be devoted to (road safety) measures with the aimed at a further decrease of the road traffic risk, otherwise an immediate increase in fatalities will result. The model used by SWOV has been calibrated with statistics from many countries around the world.
To illustrate this approach, an example for Central and Eastern Europe can be used. This example was presented to a Policy Seminar on 'Road Safety for Central & Eastern Europe' in Budapest in 1994 (IBRD/World Bank, 1995). The SWOV model used available data from both past and present. Making a conservative estimation of growth in vehicle ownership and combining this development with a rather optimistic (reduction rate of 5.7%) and pessimistic development (reduction rate of 4.4%) in fatality rates, the resulting estimates of fatalities are as shown in *Figure 2*; the cumulative difference during the period 1995-2010 amounting to some 400,000 lives saved.

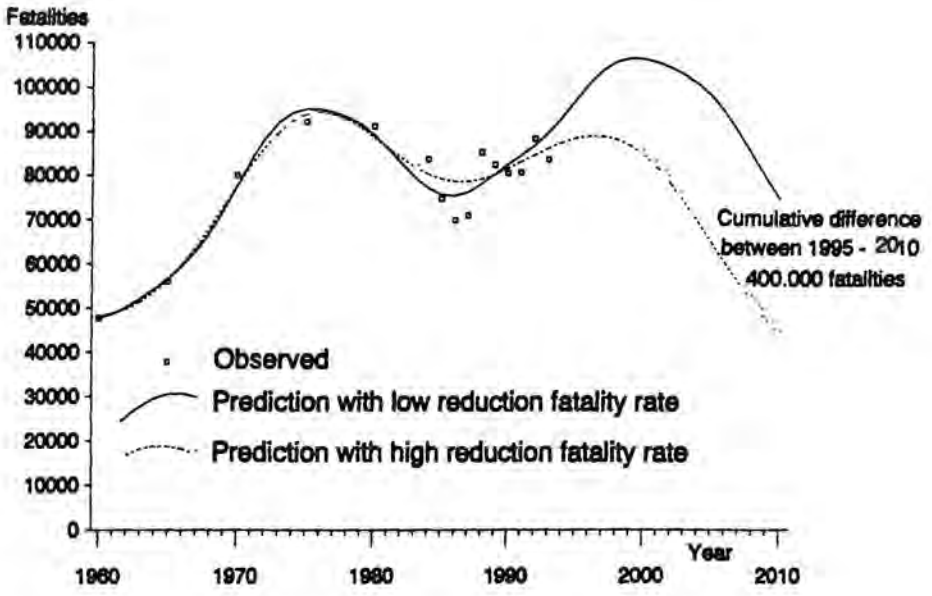


Figure 2. *Fit and prognosis of road fatalities for Central and Eastern European countries, Russian Federation and countries of the former Soviet Union.*

However, in no sense can a correlation between the growth of mobility and the reduction of fatality rates be the result of natural law or spontaneous development. We might consider this correlation as a collective influence to adapt society to growing traffic. Growing traffic requires an enlarged, renewed, improved and well-maintained road traffic system. This traffic growth and its corresponding adaptation results in better and newer roads, increasing average driver-experience, newer and safer vehicles and appropriate traffic regulations and enforcement. All highly-motorized countries went through this adaptation to mass-motorization, however, at different speeds.

Research indicates two interesting results of these modelling activities, which are of great importance for policy-making. Firstly, the more explosive the motorization growth, the larger the annual decrease in the fatality rate. And secondly, a lagged correlation between traffic growth and fatality rate reduction. Hence, after some years high traffic growth leads to higher fatality rate reductions. This could be understood as the time-lag needed to implement effective countermeasures for risk reduction. A long time-lag could be considered as a poor answer to traffic growth. A road safety policy anticipating traffic growth is the effective answer to this time-lag.

3. Road safety around the world

The next question that should be answered is, of course: how can a reduction in the fatality rate be achieved? What factors can explain an established reduction, and to what degree has road safety policy been a contributing factor? In considering these questions, it is of course impossible to treat all parts of the world in the same way when considering these questions.

3.1. European Union

Each year, accidents are the cause of about 50,000 deaths and more than a million and a half injuries on the roads of the European Union. Since the Treaty of Rome was signed, almost two million people have been killed in the twelve countries which were Community Members (until 1995) and almost forty million injured. But road accidents do not only have dramatic consequences in human terms: the economic cost is also substantial. For the Community, these losses can be valued at about 70 thousand million ECUS a year from estimates that, according to the method used, range between 45 and 90 thousand ECUS (1 ECU = 1.3 $).
At the Community level, the principal actions taken so far in the area of road safety have been concerned with the harmonisation of rules relating to motor vehicles, through the adoption of over 100 directives; for example, maximum driver's hours, minimum tyre tread depth for private cars, the periodic inspection of vehicles including harmonized standards for the testing of brakes, general standards for obtaining a Community model driving licence, the mandatory wearing of seat belts including restraints for children and speed limiters for heavy vehicles.
In addition, two important draft directives are on the Council table: harmonisation of speed limits for commercial vehicles and maximum permitted blood alcohol concentration.
Nevertheless, even with the advances that have been made in technical and behavioural standards, the road safety record of the Member States varies significantly, as can be seen in the *Annex*. The fatal accident rate (expressed per kilometre of travel) differs more than sevenfold between the most advanced Member States and those with the worst figures. Moreover, the trend also varies considerably; some states improving their position much more than others while in a few countries the situation is actually deteriorating. Using the same basis of measurement, the average risk on Community roads is nearly twice that in the United States. If it were possible to attain the US level, more than 20,000 deaths could be avoided every year. The scope for improvement is clearly considerable.

A European Policy for Road Safety report (Gerondeau et al., 1991) was drawn up by a committee of experts on road safety (the so-called Gerondeau Committee). After reviewing the situation, the Committee first set about compiling a list of over sixty technical measures that could contribute to reducing the number of people killed and seriously injured by 20-30% by the year 2000. Many of these measures are already well-known, yet their implementation throughout the different Member States of the Community is far from homogeneous and complete. That is why the Committee rapidly concluded that its work should not be limited to

identifying the technical means available to help reduce the number and severity of road accidents. It was equally important to determine the ways through which the EU could contribute to setting up efficient road safety policies in the whole of the Community territory. The Committee made the following suggestions.

Firstly to issue, directives through regulatory channels, binding on the Member States. Secondly to pool of experience and allow all Member States to benefit from the others' experience. And thirdly, to set up a permanent specialized Community body, on a strictly professional basis, to act by means of advice, assistance and persuasion. The following tasks were suggested: to survey and to analyse the experience of the different Member States, to promote research and to disseminate the knowledge acquired, to assist and advise the Member States, and finally, to monitor road accident trends and to give impetus to the implementation of active and effective road safety policies throughout the Community.

The European Commission decided to set up a Community programme on road safety with qualitative targets (not quantitative!) and the identification of priorities. The Commission decided that the process of harmonisation through legislation and the development and application of common research projects should be considered as the main types of Community action, applied in the fields of user-behaviour, vehicles and infrastructure. Nothing has been heard of a 'Specialized Community Body on Road Safety or Road Safety Agency' since.
Nowadays, two organizations are active in the field of European road safety policy: the European Transport Safety Council (ETSC) and the European Road Safety Federation (ERSF) in which different non-governmental associations are joining forces. Both, together with the Commission, a high level group of road safety directors of the Member States and other interested parties in road safety (e.g. the Federation of European Road Safety Research Institutes FERSI), are now looking for an effective organization, procedures, priorities etc., sailing between Scylla and Charybdis in the European Union: Member State autonomy and European Union subsidiarity.
Of course, the emphasis of activities in the European Union lies with the Member States themselves. It is not within the role of this paper to offer a description of the policy plan for each member state, but the bibliography attached to this report includes interesting publications from the various countries. For example, *Sicherheit im Strassenverkehr* (BfV, 1994) from Germany, *Traffic Safety, the Danish Way!* (Ministry of Transport, The Road Directorate) from Denmark, the UK *Road Safety Report* (DoT, 1995), the Netherlands (Long-term policy plan for road safety, to be revised in 1995/1996), France (road safety policies established by the Comité interministériel de la Sécurité Routière), Sweden (Rumar & Stenborg, 1994). Switzerland, a non EU-member, issued a road safety plan in 1993 (EJPD, 1993).

It is hardly possible to summarize all European road safety plans in a few lines. However, some trends can be recognized:

- creating more awareness of road safety problems amongst politicians, intermediate actors or stakeholders (regional and local authorities, private organizations, the private sector) and the general public/road users;

- targeted road safety programmes comprising the most cost-effective packages of measures and monitoring and, if necessary, revising programmes;
- paying more attention to the various options to implement certain measures;
- because central governments appear not to be the only actor in developing road safety strategies and in implementating those strategies, it is apparent that other stakeholders should be involved and committed;
- looking for funds to finance road safety measures other than the regular budgets spent by the central government.

3.2. Developing countries

According to estimations by the World Bank, 350,000 people are killed in automobile accidents in the developing world every year. Two thirds of the accidents involve pedestrians, most of whom are children. Two thirds occur in cities or in the surrounding areas. As a result of the surge in urban areas and vehicle ownership, the figures are mounting. In fact, the numbers have reached such levels that among the 5 to 44 year age group, road accidents are the second most important cause of death. As a result, accidents cost developing countries a whopping $1.4-2 billion, or an estimated 1-2 percent of their GNP. To make matters worse, much of this bill must be paid in foreign exchange, since many vehicles, spare parts and medicines are imported. In Asia for example, car ownership jumps by 12 to 18 percent each year, yet streets, highways, and safety measures have not kept pace. Thus, the rate and number of accidents have increased dramatically.

Much of the problem is related to a shortage of funds, both for owners of vehicles and for governments. Many private and commercial vehicles are old and in poor condition. Streets have deteriorated. Different kinds of traffic - pedestrians, non-motorized transport, buses, trucks, and cars - all share the same streets, unsegregated. Footpaths are often non-existent, particularly in outlying areas. Streets and vehicles are poorly lit, increasing the risk at night.

The improvement of road safety in developing countries requires the development of sustainable project components to match public awareness and governmental commitment. Countries exhibit different degrees of readiness to implement road safety measures, depending on the government's sensitivity to the problem and its importance on the political agenda. The lower the awareness level, the less likelihood there is of government interest and ability to absorb safety components in projects sponsored by the World Bank or other donors. World Bank consultants in the field of road safety have pinpointed three levels of awareness:

1. *Awareness level 1.* In these countries, there is little safety awareness. Accident data may or may not be collected and any data system will be primitive. Little is known about trends or road users at risk. There is no one working specifically on safety matters. General interest by the government is low.

2. *Awareness level 2.* The government is aware of the road safety problem, but has given it little priority. Accident data are sparse. Occasionally, there may be road safety pressure groups. The media

may be beginning to press for action. Some university research may be underway.

3. *Awareness level 3.* The government has recognized the need for assistance. An improved data system has been established and staff trained in safety operations. Analysis is undertaken of black spots and to identify the road user groups most at risk. A National Road Safety Council (NRSC) coordinates a national road safety programme. Efforts are made to improve driving tests and vehicle examinations, to develop children's traffic education and improve legislation. There is a core of people specialized in safety who are keen to tackle the problem but lack resources. Road safety research is being undertaken and the media is active in pushing for action.

The nature of the World Bank loans are related to the level of awareness. Of course, major differences between countries can be seen with respect to awareness, measures and policy. A general impression is that developing countries only devote attention to road hazard in a very modest fashion and have other priorities but the developments in highly-motorized countries that have gone before clearly show the negative consequences such an attitude can lead to. The attention paid by the World Bank to road safety is therefore (unfortunately) scant, but there are indications that there is a growing level of World Bank interest in road safety (see, for example, the major efforts of the Bank in Central and Eastern Europe).

In a contribution prepared by the World Bank as a building block for this paper, examples have been given of recent advances in a number of developing countries, where, with the support of the World Bank, activities are being developed in the field of road safety. The following examples can be cited:

China (Zhejiang Province): in preparation of the engineering design for the World Bank project '130 km/h expressway, Shanghai - Zhejiang', three key areas have been identified which will help to improve road safety:
- accident analysis and identification of causes;
- implementation of accident remedial measures;
- change in attitude towards design philosophy.

China (Xinjiang Province): as part of the World Bank financed project in the Xiang the following proposals have been accepted by the Chinese project authorities:
- black spot improvement;
- road infrastructure;
- road signs and marking;
- law enforcement.

The *Fiji Road Safety Action Plan* prepared under the technical assistance component and financed by the Asian Development Bank, focused on four main areas, viz:
- accident data system;
- infrastructure improvement;
- National Road Safety Council;
- traffic police enforcement.

In *Mexico*, a Secretariat for Communication and Transport, which represents the sector on the National Safety Council, is working to increase road safety awareness. The proposed World Bank 'Highway Rehabilitation and Traffic Safety Project' would support implementation of the system for driver testing and licensing, for research on road safety, for information campaigns, for a programme to reduce about 350 hazardous highway locations and for vehicle safety standards. The road safety programme would co-finance both these activities as well as an international traffic safety seminar.

A World Bank Transport Sector Review in *Bangladesh* indicates that more than 50% of accidents occur in and around Dhaka; on the highway system nearly 80% of the accidents are associated with trucks and buses. Bus operations appear to be especially accident-prone. Under the institutional development programme of the World Bank project, a road safety study will be carried out and safety audits will be introduced in the terms of reference.

An accident diagnosis system and a black spots prioritizing system have been developed and tested for diagnosing accident problems in *Malaysia*. An accident treatment framework has been demonstrated which provides a working model for full implementation throughout Malaysia. A new traffic accident recording form has been introduced and is in use nationwide since 1992. The computer analysis system developed enables a thorough analysis not only on a macro scale but also of specific black spots.

In recent years, a large number of conferences and seminars have been organized, focusing on the promotion of road safety. Organizations such as the United Nations, the World Bank and other banking institutions, the WHO and the OECD have played an important role in this regard. The following could be mentioned: road safety conferences in Africa (Addis Abeba), Asia (Kuala Lumpur) and this year in Latin America (Sao Paulo). These conferences bring together a wealth of information and many contributors who know how to promote road safety. It seems to be more a question of how to get road hazard recognized as a political problem, and how to realize the financing and organization of road safety policy, than which measures to take.

Although positive World Bank interventions to improve road safety in developing countries could be pointed out, the conclusion seems to be inevitable that these efforts are too incidental to result in a reduction of the number of accidents and casualties. Road safety programmes have to be launched on a more massive scale and all partners involved (developing countries, international banking organizations, donor agencies) are urged to commit themselves to such programmes.

3.3. Central and Eastern Europe

Recent estimates indicate a road accident toll of about 75,000 road deaths every year in Central and Eastern European countries. Since 1986, a dramatic increase in accidents and deaths has occurred in these countries. Of course such an increase is closely related to the recent political, economical and social changes. It was reported in many CEECs it was

reported that almost all absolute and relative indices of accidents have been increasing.

Based on the models used by SWOV as described in Chapter 2, a consideration of present and expected vehicle ownership trends and current accident rates - as they might be modified by achieving accident rate-reductions similar to those observed in several highly-motorized countries - led to the conclusion that if, during the next fifteen years, appropriate road safety policies were put in place and implemented, at least 400,000 lives could be saved (see *Figure 2*). In both predictions, an increase of fatalities has to be anticipated in Central and Eastern European countries, although a major difference does exist between both developments.

Based on available data and analyses of these data from different Central and Eastern European countries, SWOV came to the conclusion that the actual development of road accidents (sharp increase) at the end of the eighties was quite extraordinary and no indication of any long-term development. If this conclusion is correct, the positive developments during the beginning of the nineties (e.g. Hungary, Poland) are no herald of any favourable development, and the 11% increase in fatalities in 1994 in Poland proves the correctness of a reservedness to jump too firmly to too positive conclusions.

A number of reports have been written recently which give some indication of the road safety problems in the CEECs. For example, the World Bank and the European Community commissioned an initial survey in Hungary, Poland, Bulgaria, Rumania, the Czech Republic and Slovakia (a committee presided over by Monsieur Gerondeau has reported on this). The Technical Research Centre VTT from Finland has published a study on road safety in Estonia, Latvia and Lithuania (Segercrantz, 1992). The Working Group on Road Safety in the Baltic Sea region, under the patronage of the Nordic Traffic Safety Council, issued its report in 1993 (WG3, 1993).
In Poland, the first stage of the GAMBIT project has been completed (Technical University of Gdansk, 1995). At the end of 1992, the OECD organized a seminar on 'Technology transfer and diffusion for Central and East European Countries' in the area of roads and road transport (OECD, 1993). One of the themes of the seminar was road safety. The conclusion was reached that "traffic safety is a major concern and targeted and integrated actions should be taken as soon as possible in order to reduce drastically the high economic costs incurred by road traffic accidents". As a follow-up of this seminar, several workshops were organized (accident data bases, road design, vehicle inspection etc.). In 1994 a Road Safety Policy seminar was organized by the World Bank and the European Union PHARE Programme (IBRD & World Bank, 1995), resulting in the conclusion that it is possible to significantly reduce the number of road accidents by implementing and effective policy with short-term and medium and long-term objectives.

The political and economic changes at the end of the 1980s seem to be expressed also in terms of growth in the annual number of road accident fatalities. Of course, indications can be given to explain this phenomenon (see also Wegman, 1994a and b): a rapid growth in the number of vehicles, many new and inexperienced drivers on the road, many new and

second-hand cars from the west driving at relatively high speeds on inadequate and insufficiently maintained roads, much driving under the influence of alcohol in situations where there is little police enforcement and a poorly equipped police force, etc. These are possible explanations, but scientifically supported evidence is not available.

In the meantime, several CEE countries are active in preparing and implementing road safety plans. *Hungary is used here to illustrate these developments.*

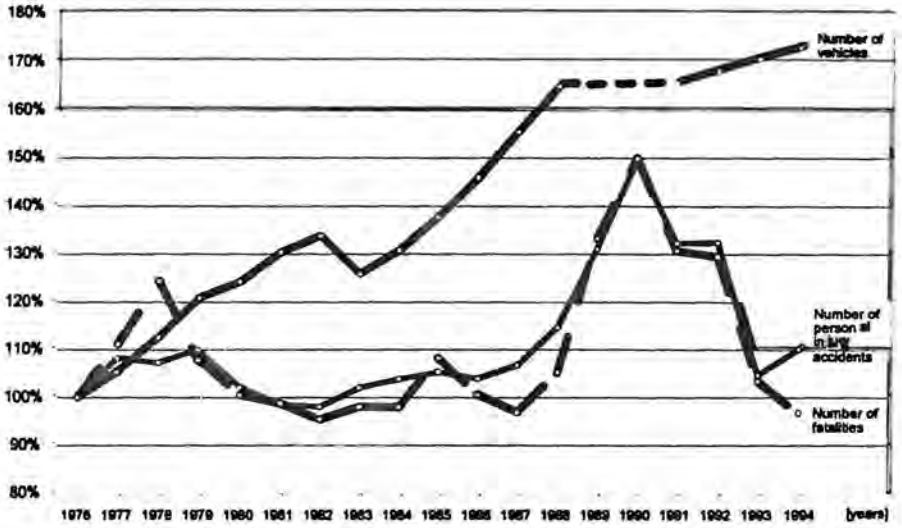


Figure 3. *Changes in the number of vehicles, personal injury accidents and fatalities in Hungary between 1976 and 1994 (source KTI).*

Figure 3 shows the changes in the number of road vehicles, personal injury accidents and fatalities between 1976 and 1994 in Hungary. Since the peak in the number of accidents in 1990, both the number of accidents and that of persons injured and killed in road accidents have shown a decreasing tendency. In 1994, the number of fatal victims diminished below the level experienced in 1976. This is a considerable change, because since then the number of road vehicles in Hungary has increased by over a million. The decreasing tendency also continued in the first part of 1995.

Such a reduction in the number of accidents is, of course the result of numerous factors: partly generated by social and economic changes and by carefully selected measures to improve traffic safety. Probably, the positive change has been due to the following factors:

- a gradual cessation of the negative 'side-effects' of the rapid and considerable social change;
- decrease in vehicle kilometres due to the increase of the cost of vehicle operation and maintenance; (7-8 percent between 1990 and 1991, increased by 2-3% between 1991 and 1992 and practically unchanged since then); however, the recent reductions in the number of casualties cannot be explained by decreased road traffic volumes;
- modification of the Highway Code (introduced March 1, 1993): introduction of speed limits of 50 km/h in built-up areas, the compulsory use of daytime running lights (DRL) on main roads outside urban areas and on motor-roads and the compulsory use of seat-belts on rear seats

outside built-up areas; The general obligatory use of DRL outside built-up areas was introduced on June 1st, 1994;
- increased and improved enforcement activities, combined with publicity campaigns and raised imposed penalties.

The effects of these measures are summarized in *Figure 4.*

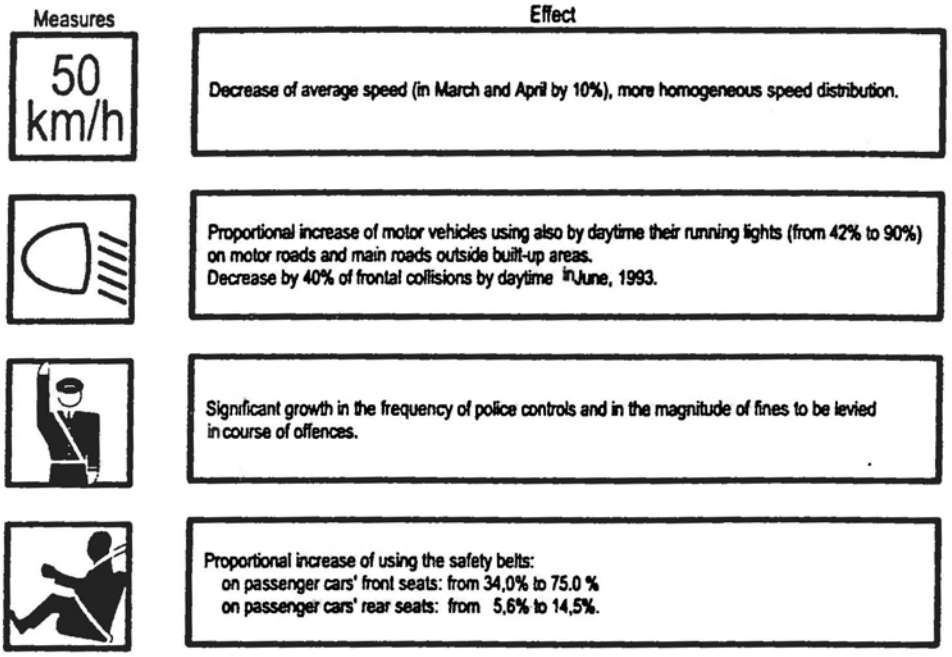


Figure 4. *Road safety measures and their effect in Hungary (source KTI).*

In spite of these efforts, a significant improvement in the severity of accidents has not been achieved. In order to achieve significant improvements in this respect, the strictness and consistency of enforcement, further increase of seat-belt usage, enhancement of the passive safety of vehicles and road furniture, improvement of the conditions connected with first aid and rescue services are needed in Hungary.

3.4. Australia

Australia deserves an international reputation for successfully reducing the number of road accidents. It was one of the first to introduce many well-known road safety measures: compulsory seat-belt use, helmets for motorcyclists and bicyclists and random breath testing. A National Road Safety Strategy was drawn up in 1992 (Australian Transport Advisory Council, 1992). It was the first national approach by federal, state and local governments, as well as industry and community groups, to reduce road accidents. Australia heads for road trauma below current levels despite an expected 18 per cent increase in the population and a 25 per cent increase in road travel by the year 2001.
Australian strategy defines three overall goals, four specific goals and eight key priorities. The eight 'key priorities' are: alcohol and drug abuse, speeding, protection of vehicle occupants, driver fatigue, road hazards, heavy vehicles, novice drivers and riders and improved trauma management. Policy objectives will be achieved through: *the coordination among and involvement* of all agencies in making the best use of their resources,

stakeholder commitment through partnership and agreeing on ways to measure the success of the strategy, *cost-effectiveness* considerations to set priorities and coordination in *research and development.*

A Road Safety Group of officials within the Australian Transport Advisory Council (ATAC) will assume responsibility for implementing strategy. While it is essential that the national strategy be seen to be owned by all stakeholders, there must also be *a driving force to provide a representative leadership*: the Implementation Task Force will fill that role. The task force will report annually to key stakeholders on progress made on adopting the national strategy and areas where improvement can be made. Based on the national strategy, a National Road Safety Action Plan has been set up comprising a blueprint of activities to achieve the national objectives over the next three to five years. A draft version of this Action Plan has been published and professionals and community groups have had the opportunity to comment.
The Implementation Task Force is assessing progress on the programmes. It has selected 39 nationally significant undertakings which 'stakeholders' have agreed will form the basis of road safety initiatives to be introduced nationally between now and the turn of the century. From these, 13 priority items have been selected for early implementation.

The State of Victoria (4 million inhabitants in a rather urbanized area including the capital Melbourne) has been acknowledged as one of the states making the best progress (FORS, 1993). An average annual change of fatal crashes between 1989 and 1993 of minus 13.5% has been registered; for the whole of Australia this percentage was minus 7.9. Together with New South Wales (minus 9.9%), Victoria is in the lead. The Road Safety Co-ordinating Council of Victoria, is made up of representatives of Vic Roads, the Transport Accident Commission (TAC) and the Victoria Police.
A number of studies have been carried out to evaluate which countermeasures and other factors have contributed to the substantial and unprecedented reductions in road accident fatalities and serious injuries in Victoria since 1989. The following have been identified (Cameron, et al, 1994): increased random breath testing, speed cameras, compulsory bicycle helmets, lowering the 110 km/h freeway speed limit, improvements to the road system especially through treatment of accident black spots, reduced economic activity and reduced alcohol sales. The estimated reductions in serious casualty crashes can be found in *Figure 5*: a reduction of 32% during 1990, 43% during 1991 and 47% during 1992, compared with expected levels. The road safety programmes are estimated to have contributed reductions in serious casualty crashes of 26-29% during 1990/1992.
The bulk of the reductions can reasonably be attributed to the two major road safety programmes, the random breath-testing programme and the speed camera programme. These two programmes in Victoria can be considered as extremely interesting for other jurisdictions because of the strategic use of road safety television advertising combined with police enforcement leading to general deterrent (drinking and driving) and specific deterrent (speeding). The research results indicate clear links between levels of publicity supporting the speed and alcohol enforcement programmes and reductions in casualty rates. Less positive results can be

reported from a publicity campaign ('Concentrate or kill') not directly linked to enforcement.

	1990	1991	1992
Modelled actual serious casualty crashes	6147	5350	5207
(actual serious casualty crashes)	(6156)	(5371)	(5156)
Expected* serious casualty crashes	9041	9380	9737
Reduction in serious casualty crashes	*32.0%*	*43.0%*	*46.5%*
Contribution of increased unemployment	*0.8%*	*10.8%*	*13.5%*
Contribution of reduced alcohol sales	*5.6%*	*8.5%*	*10.6%*
Contribution of speed camera TINs	*8.2%*	*9.2%*	*9.3%*
Contribution of speed and concentration publicity	*7.4%*	*10.2%*	*10.3%*
Contribution of RBT	*3.9%*	*4.1%*	*4.1%*
Contribution of drink-driving publicity	*9.9%*	*8.8%*	*9.5%*
Contribution of above four road safety programs	*26.4%*	*28.7%*	*29.3%*

**Expected if the road safety initiatives and other factors had remained at base levels*

Figure 5. *Estimated reductions in serious casualty crashes attributable to various factors in Victoria, 1990-1992 (source Cameron et al, 1994).*

3.5. Canada

During 1993, 3,601 road users were killed in reportable traffic accidents in Canada, an increase of 2.9% over traffic deaths in 1992, but still 3.2% fewer than the average number of road users killed during the three previous years. The 1993 figure represents the first increase in traffic deaths in Canada since 1989. For the third successive year, the number of road users killed in traffic accidents has remained at approximately the same level (3,500 - 3,700 persons). It would appear that this level has replaced that of the 1982-1990 period, when the number of annual traffic deaths ranged from 4,100 to 4,350 persons. This achievement has largely been the result of ongoing safety programmes and initiatives conducted at all levels of government, safety and enforcement organizations. The most successful continues to be the National Occupant Restraint Program (NORP), which targets a 95% seat belt usage by 1995.
Nationally, seat belt usage among passenger-car drivers is currently 90.1%. No doubt, this level of use has contributed largely towards keeping the number of fatally injured motor vehicle occupants at the same level during the past three years, despite increases of 4.7% and 6% in the number of motor vehicles registered and licensed drivers respectively.

Under the Canadian Constitution, Transport Canada is responsible for the federal mandate to reduce deaths, injuries, property damage and damage to the environment resulting from the use of motor vehicles. It exercises this mandate under the authority of the Motor Vehicle Safety Act by undertaking research and developing motor vehicle safety standards, regulations and testing procedures for all new vehicles, tyres and specified equipment manufactured in, or imported into Canada.
The provincial governments have responsibility for matters relating to the behaviour of drivers in their jurisdictions. They exercise this responsibility through driver and vehicle licensing controls, legislation, enforcement and public education programmes. In addition, the provinces have responsibility for all aspects of roadway design and operation.

Transport Canada works with the provincial governments through the Canadian Council of Motor Transport Administrators (CCMTA) to establish national road safety objectives and priorities. The Transportation Association of Canada (TAC) is also a major stakeholder in Canadian road safety activity. The 550-member non-profit association acts as a neutral forum for the discussion of transportation issues and concerns, and as a technical focus in the transportation area.

The Federal Constitution of Canada permits and requires provincial activities in many areas. In 1993, the Ministry of Transportation of Ontario issued a draft for a 'Road Safety Agenda' (Ministry of Transportation of Ontario, 1993). This policy document includes a vision, a strategy and an implementation programme. The following activities are presented as the most prominent ones: introduction of a graduated licensing system (TIRF, 1991), special attention to the problems of the older driver, high risk groups, introduction of high-tech tools for police enforcement and increasing seat-belt usage.

The Province of Quebec should be recognized as one of the most interesting jurisdictions in the field of road safety - self explanatory after reading *Une vision sécuritaire sur des kilometres* (Ministère des Transports du Quebec, 1995). Using the so-called Haddon-matrix an overview is presented of a variety of road safety programmes including the organizations in charge of their implementation. Most remarkable is a single governmental enterprise, 'La Societé de l'assurance automobile du Quebec (SAAQ)', that manages third party liability car insurance on a so-called 'no fault' basis. The SAAQ is responsible for accident prevention as well as, for example the organization of driver training and publicity campaigns, financed by a (small) percentage of collected premiums, nevertheless leading to considerable resources.

3.6. Japan

In recent years, about 11,000 road accident fatalities have been recorded in Japan annually (Japanese statistics: victim who die within 24 hours). In a population of 125 million, this represents a mortality rate of 8.8 (30 days: 11), indicating that Japan is one of the relatively safe countries in the world with regard to road traffic. The number of road accident victims per 10,000 vehicles is similarly 1.9.

It is significant, however, that while the annual number of road accident victims halved during the 1970s, it has since risen from 8,500 up to 11,000 (*Figure 6*).

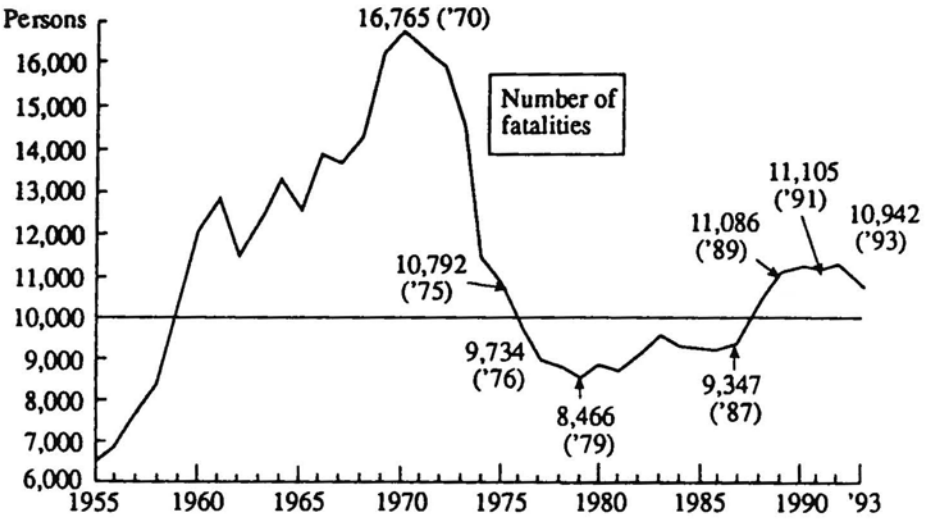


Figure 6. *Trend of road accident fatalities in Japan (IATSS, 1994)*

This means that Japan forms the exception with respect to other highly-motorized countries. Halving the number of road accident victims in the 1970s was mainly the result of technical and engineering traffic measures that led to a better structure of the road network and improved design of the roads and verges (Koshi, 1986). According tot Prof. Koshi:

> "In the 1980s however, those measures that were effective in the decade before approached their saturation levels in terms of both the number of installations and the extent to which they could prevent accidents; hence they became less and less effective. The Japanese failure to maintain the decreasing tendency of accidents in the 1980s was also due to the fact that Japan continued to implement conventional measures along the same lines as in the 1970s. Stress should now be placed on a new policy to improve driver quality (especially education of young drivers), traffic regulations and enforcement."

Recent findings have shown, for example, that the number of persons wearing seat belts is falling also usage percentage can still be considered high in comparison with many other countries (*Figure 7*).

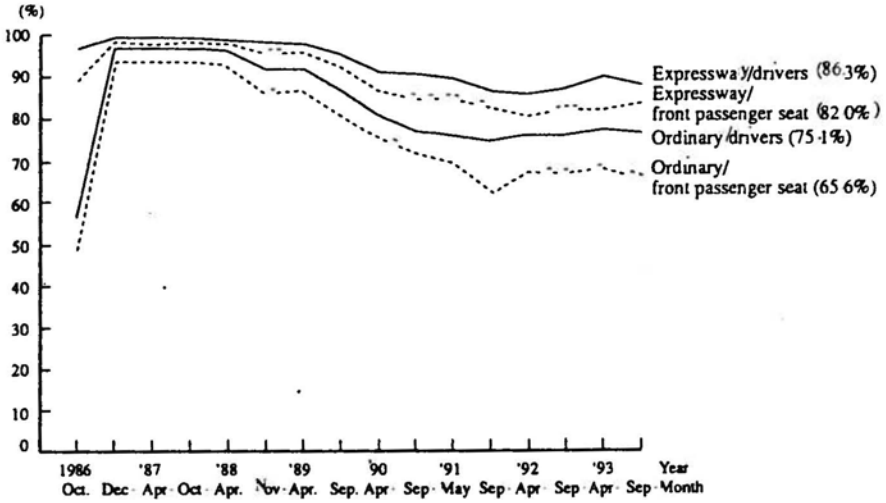


Figure 7. *Changes in the rate of seat belt use in Japan (IATSS, 1994a)*

The experience gained in Japan demonstrates that a sound implementation of known traffic measures is effective (1970s), but also that an increase in the number of road accident victims in association with a growth in mobility is not unrealistic. Furthermore, road safety measures should be maintained; an effect, once achieved, does not offer any guarantee for the future!

In more recent Japanese publications the following items are mentioned to improve the situation: countermeasures for the elderly, for women, for nighttime accidents, for accidents during holidays and vacations, accidents on expressways and in residential areas, accidents involving pedestrians, motorcyclists and mopeds and accidents related to on-street parking (see Matsumura, et al, 1993).

4. Effective recent initiatives

To date, it has proven impossible to explain the development in the number of accidents and road accident victims on the basis of our understanding of the causal relationship between these road hazard indicators and explanatory variables, such as the volume of traffic, composition of traffic, behaviour in traffic, quality of the infrastructure and of the vehicles, weather conditions, etc. Only in highly exceptional cases has it proved possible to trace the actual influence of road safety measures in the accident statistics (e.g. Harvey & Durbin, 1986; Koornstra, 1993).
This situation is unsatisfactory, certainly if scarce financial resources are available and only the best (most effective and efficient) measures should be selected. The situation is also unsatisfactory if the approach to road hazard has to compete with other social problems, where the relationship between problem, measure and consequences of that measure, is more obvious (e.g. in combatting noise pollution).

The state-of-the-art described above again emphasises the necessity to make optimal use of the study results available, also in an international context. It is beyond the scope of this paper to discuss all possible problems and effects of the measures, but a selection of the most important ones is appropriate. Before doing so, however, a warning should be sounded. Although a number of isolated problems and measures are summarized here, it is highly recommended to arrive at an integrated package of measures, approaches and strategies on the basis of a sound and unbiased problem analysis. Such a problem-oriented approach and the integration of measures gives synergy a chance and avoids wasting funds.

Based on contributions from the various authors and on a literature review, the following subjects have been included in this paper. Without doubt, this overview cannot be exhaustive; so, no special attention has been paid to young and inexperienced drivers, to road safety problems related with trucks and buses, to vulnerable road users, etc. But the chosen subjects can offer a significant contribution to the scope of road hazard and for which it has also proven possible to realize improvements:
- drinking and driving (under the influence of alcohol) (Zaal, 1994)
- excessive and inappropriate driving speeds (ETSC, 1995; Zaal, 1994)
- assistance given to road accident victims (Trinca, et al, 1988; NRTAC, 1993)
- restrained systems: seat belts, child restraints etc. (SWOV, 1992)
- vehicle safety (ETSC, 1994)

Many examples can be given of programmes which have proved successful in promoting road safety. This overview will describe a number of programmes of 'world renown'. Chapter 5 of this contribution deals with improvements to the road infrastructure, which are of major importance to improve road safety.

4.1. **Drinking and driving**

In 1988, Canada convened a National Road Safety Symposium for the purpose of identifying priorities and targets for the five year period 1990

to 1995. In all, twelve major concerns were identified which were then forwarded onto appropriate agencies for review and action. After extensive review, governments chose to concentrate on two major issues: to increase the use of occupant restraint systems and to decrease impaired driving.

In 1991, 48% of all drivers killed in road crashes had consumed some alcohol prior to the crash. The largest group of fatally injured drinking drivers - 62% comprised those with BACs over 150 mg%.

STRID: Strategy to Reduce Impaired Driving
STRID's objective was to reduce roadway collision deaths attributed to alcohol by 20% by the end of 1995. Each province has introduced their own programmes designed to reduce deaths related to impaired driving. Programmes vary from good host/hostess programmes aimed at the person who organizes a social event, to programmes aimed at potential passengers in vehicles operated by an impaired driver, to television advertisements aimed directly at vehicle operators. On a national level, a 6.4% decrease in the problem (as measured by the ratio of fatally injured impaired drivers to fatally injured non-drivers) has been achieved.

4.2. Speed

Speed is a core issue in road safety although the relationship between speed and accidents is a very complex one. Two 'laws of physics' are considered relevant (Maycock, 1995). The first law is that the stopping distance (in an emergency) is proportional to the square of the speed. It is reasonable to state that higher speeds result in a higher probability of becoming involved in an accident. The second relevant law is that the kinetic energy is proportional to the square of the vehicle's speed, which mean that a high speed accident will involve more damage and more serious injuries. Based on empirical data, TRL concludes that if mean speeds can be reduced by 1 km/h then, on average, injury and accidents will be reduced by about 3% (Finch et al, 1994). An increase of 1 km/h leads to an increase of 3%. More severe accidents (fatal) will be reduced by a greater amount according to the 'power laws of Nilsson (Nilsson, 1981). This means that only minor changes in speed will lead to high effects.

The problem nowadays is that in many countries, on many roads and under many circumstances, many drivers in almost all types of vehicles drive at excessive speed with no regard to the prevailing conditions (however, some drivers are driving too slow and provoke dangerous driving of other road users!). This makes speed management one of the most complex problems. A wide range of possible interventions are available or will become available in the future. But the complex nature of the problem, the pleasant and rewarding consequences for a driver driving at high-speed, the social acceptability nowadays of speeding and the actual possibilities of modern cars (top speeds of 160 km/h are no exception any more) demand from policy-makers, who "have the responsibility to move ahead of public opinion - that they move just far enough ahead to maximize the acceleration of change without alienating the public" (Allsop, 1995). We have to be amazed that we accept the present levels of road traffic speed!

Most of the time speed management means the limitation of personal freedom. This has to be made acceptable to the majority of drivers by proper road design, by proper speed limits and by education and information while the minority of irresponsible drivers have to be confronted with legal sanctions.

4.3. Assistence given to road accident victims

Road deaths either occur within a few minutes of the crash at the scene of the accident scene or within a few hours during transport to hospital or within 30 days. In the Netherlands, 57% die at the scene of the accident, 22% the same day and 21% within 30 days. Very little can be done for the first group. The lives of the second group depend on adequate management; i.e first aid, emergency calls as soon as possible, a correct initial diagnosis by the telephone operator, the fast transport of qualified medical personnel to the accident spot, correct diagnosis at the scene and optimal stabilization of the patient by properly trained and equipped personnel, fast (and safe) transport to a hospital and proper care during that transport, and treatment in a trauma specialized hospital.
This is a chain and a chain is only as strong as its weakest link. It requires an integrated approach: the education and training of the public, of the emergency services such as the police and fire-fighters and of the emergency medical services such as ambulance attendants.
A second important element are communications: public telephone inclusive car telephones with only one, alarm-number well-known to the public. Additional communications might be useful: for example emergency telephones on motorways, radios in heavy goods vehicles etc. The organization behind the telephone has to be a fast and professional one. Victims can be transported by ambulance or by helicopter if they are multi-trauma patients. Well-managed (general) hospitals and specialized trauma hospitals are needed. Time lags have to be as short as possible to allow proper treatment in 'the Golden Hour'.

The positive effects of this chain approach have been well-documented, leading to conclusions about preventable deaths and decreasing financial costs of medical consumption and (social) insurance costs (e.g. Draaisma, 1987, Trinca, et.al., 1988 and NRTAC, 1993). Most of the time experiences from other countries are not directly applicable to others, although common principles of integrated trauma care can be of considerable assistance. It is advisable to audit now and then on a case level, to find out how strong the different links are ('black book') and if appropriate, to carry out surveys. Decisions can then be taken about possible improvements on cost-effective considerations. These decisions could be taken as regards ambulance transport and/or helicopter transport, the transport of patients to general hospitals and/or specialized trauma hospitals, the use of public telephones and/or a road network-related communication system etc. Powerful medical professional organizations together with the insurance industry and consumer organizations could find the right balance between cost and effect, although the chain approach of trauma care will be the backbone of all trauma care systems.

4.4. Seat belts

(Proper) seat belt usage has been recognized as a major road safety measure and is part of road safety policy in almost all countries of the world. According to careful analysis, the effects of seat belt usage on front seats appears to be about 40%, which means that if seat belt usage increases from 0% to 100%, the number of people killed in a car crash will decrease by 40%. The effects of rear seats have not yet been studied extensively, but are expected to be somewhat smaller than for front seats. Air bags (without the use of seat belts) reduce driver fatalities by 20% (IIHS, 1992). Combining an airbag with seat belts results in another 5% effect: so about 45% (Evans, 1991).
One of the most effective means to improve wearing rates is to make it compulsory by law (Hagenzieker, 1991): compulsory for front seat usage seems to be very common, and also child restraints. For rear seats a lot of progress is being made. Wearing rates of over 90% are measured in a few countries: Germany, United Kingdom, Finland. The high compliance in the UK was not achieved by legislation, but in fact was the end of a long process to raise wearing rates by publicity. In general, it is the view of British road safety policy makers that *legislation follows compliance rather than vice versa* - it is necessary to catch the minority who will not be taught but is not effective at altering the behaviour of an unwilling majority.

Where high wearing rates have already been achieved, cost-benefit analysis has to answer the question as to whether air bags should be mandatory. In this respect the smaller Eurobag - to address the problem of head and facial injury - could be considered.
Air bags are present all the time but fastening a seat belt is a deliberate decision. Sometimes legislation has been enough to create high wearing rates (e.g. Germany and the United Kingdom). But in many countries additional activities have been necessary. It is still an unsolved question why, under relatively similar laws, such big differences in wearing rates are measured. In Canada, police enforcement combined with publicity campaigns have been tried intensively and with great success.

In 1989, the Canadian federal and provincial ministers responsible for road safety agreed to a National Occupant Restraint Program (NORP), aimed at achieving a 95% restraint use by vehicle occupants by the end of 1995. Based on the national use rate of 74% in 1989, it was estimated that the programme could save 13,000 lives over the period 1990-2010. Building on their experiences with seat belt legislation, education and enforcement programmes in the 1980s, a strategy was developed permitting individual jurisdictions to implement a series of activities designed to achieve the objective: the Selective Traffic Enforcement Programs STEP. In order to achieve significant changes in behaviour, it was estimated that police would be required to issue at least 4,000 citations per year per million population. In 1990, the citation rates per million population were as high as 14,000, with a minimum supporting education campaign. The plan also called for amendments to provincial legislation designed to remove all exemptions for non-use, increases in the fine for non-use, and the introduction of demerit points for non-use.

As of June 1994, five provinces had achieved a level of 90% or greater, with one achieving a top level of 97 per cent. The national rate stood at 90% - a 16% increase attributable to NORP.

4.5. Vehicle safety

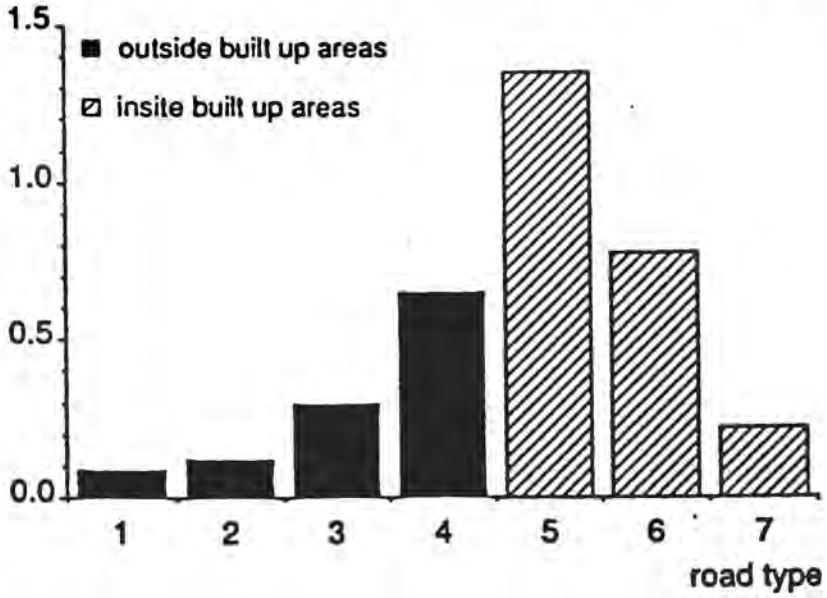
Any agenda dealing with accident avoidance (pre-crash measures, primary safety) and injury minimisation (crash measures, secondary safety) should include the following items:

- speed control: maximum speed and performance limits using intelligent speed control technology in which a car communicates with the surroundings and where speed limits are set per type of road or per risk influencing circumstances (bad weather). Special attention to be paid to public acceptance, fail-safe technology, legal problems and the introduction of such facilities;
- improvement of vision and conspicuity: daytime running lights;
- improvement of protection from frontal impacts (offset impacts), side impacts, compatibility between cars and HGVs (underrun protection), protection of pedestrians, cyclists and motorcyclists;
- seat belts, air bags, head restraints.

5. Better roads improve road safety

Investments to expand and improve road infrastructure are of major importance to improving road safety. Many countries can illustrate this statement by their own experiences (the Japan example is illustrative). *The principles of safe network design and road design are rather well-known* (TRB, 1987, Ruyters, et.al, 1994, ITE, 1993, CETUR, 1992, TRL, 1991, Opiela, 1995), *however, practical conditions, other criteria than safety and limited funds lead rather often to sub-optimal road design.*

A comparison of the fatality rates for various types of roads reveals that the traditional roads (main roads inside and outside built-up areas, to which all traffic is admitted) are among the most hazardous (*Figure 8*).



1. Motorway: 100-120 km/h
2. Motorroad: 100 km/h
3. Arterial rural road: 80 km/h
4. Local rural road: 80 km/h

The most elementary classification for the built up area is subdivided into:

5. Arterial roads with a speed limit of 50 km/h (sometimes 70 km/h)
6. Residential streets with a speed limit of 50 km/h
7. "Woonerf" and residential street (approx. 8 km/h to 30 km/h)

Figure 8. *Injury rates in the Netherlands (1986) per million motor vehicle kilometres.*

The fact that the proportion of safe types of road (traffic calming and motorways) in the total length of infrastructure has increased, and that the proportion of mobility on these roads and streets has increased even more sharply, has certainly contributed to the drop in the fatality rate. However, some eroding safety effects can be observed as a result of the deterioration of our infrastructure as a result of poor maintenance!

Roads are built with one major function in mind: to enable people and goods to travel from one place to another. However, it is necessary to make differentiations in traffic functions because the character of the travel process differs (long distance, allowing for access etc.) while these differences require different road design. An explanation of the high accident rates on 'all purpose roads' might be that these roads are multi-functional (flow function, distributor function and access function) and allow different types of road users in the same space and, at the same time, at relatively high speeds and big speed differences.
Design guidelines and road design standards, are available in many countries (e.g. Ruyters, 1994). But to date, these existing national standards only rarely contain information on the safety effects of the road designs that are recommended or even prescribed. To enable the design of safer roads, more clarity is needed about the relationship between the layout and the safety aspects of the infrastructure elements.
Several approaches could be used to improve the safety quality of a road network. The rather traditional approach is to analyse accidents on accident prone locations (black spots, black routes and black areas) by finding similarities between features of accidents. Improvements in road design then have to be found in order to eliminate these accidents (Delmarcelle, 1995).

This so-called black spot approach is effective in reducing fatalities, injuries and accidents; effects of up to 50% are reported. This approach could be considered as *the first generation* of road safety measures and the start of road safety policy dealing with 'the road'. It can be strongly recommended, especially when low-cost engineering measures are proposed (Slop, 1993).
Starting from road-user behaviour and their expectations, a *second generation* of road safety measures can be defined. The design philosophy of this approach could be characterized by consistency and uniformity in road design, homogeneity in traffic streams (speed!) and predictability for the road user. With proper road design the road-user's expectations can be induced and have to be met, always and everywhere. These principles find concrete shape in road classification or categorization and well-founded design standards. Experiences from different countries indicate the positive safety effect of applying modern design standards compared with those from some decades ago (tens of percents). The harmonisation of standards, at least regarding assumptions underlying these standards, must play an important role and future research results have to decide which assumptions and which scientific evidence forms the real core of our knowledge. More attention has to be paid to the human operator of the road system and how the road user respond to changes in the road system (e.g. OECD, 1990, Evans, 1991).
The third generation of road safety measures is described under 6.3. 'sustainable safe traffic'. The inspiration behind this concept is that we should no longer have to accept that we hand over a road traffic system to the next generation which in the Netherlands leads to thousands of fatalities and ten thousands of injured every year. We should try to reduce drastically the probability of accidents in advance, primarily by means of the infrastructure design, and by being less compromising than is common practice today.

6. Promising new developments

Of course, different countries with different cultures, different levels of motorization and different history concerning road safety policy have different means of improving road safety. Some promising new developments are presented here.

6.1. Road safety targets

An outline of good practice for targeted road safety programmes has been presented in a recent OECD report (OECD, 1994). See also Read (1995). *A targeted road safety programme is based on a clear target and consists of a set of countermeasures designed to reach the target.*

The following steps are distinguished:

- *Analysing accident trends and road safety problems.* It is useful to provide a description of road safety trends and the forces underlying them, both in order to understand past changes and to gain an idea of how road safety may develop in the future. A systematic description of road safety problems can help in identifying vulnerable road users or high risk groups that need special attention in a road safety programme.
- *Assessing the potential of countermeasures.* Assessing the potential of the various countermeasures requires knowledge both of their effectiveness and the target group. Although this knowledge will either be lacking or highly uncertain, it is considered good practice to estimate their potential. The theoretical safety potential can rarely be fully realized. Practical, political and economic obstacles are always present and realistic road safety programmes should address the implications of these obstacles.
- *Assessing the effects of confounding factors.* Exogenous factors affecting safety are always present and their implication for road safety policy-making should be addressed as well.
- *Setting the targets.* Clearly formulated road safety targets can guide policy-making in a better way than less clearly formulated road safety targets. Highly ambitious quantified road safety targets can help policy-making, but there is no guarantee of that the desired results are obtained.
- *Formulating alternative plans of action.* In order to find the least costly alternative, alternative plans of action should be examined systematically. The phases involved should generate different alternatives, estimate cost-effectiveness or a cost-benefit ratio per countermeasure and construct a cost-effective programme.
- *Monitoring and feedback.* The careful monitoring of targeted road safety programmes is needed in order to explain policy performance and, if necessary, to revise the targets and/or the plans and programmes. Monitoring is crucial in a targeted programme, leading to a need to improve the quantity and quality of road safety data - the lack of relevant, accurate, accessible, timely, standardized and integrated data hampers the development, delivery and evaluation of road safety countermeasures.

6.2. Safety auditing

Road safety is a quality aspect of road traffic and has to be balanced with other aspects such as: level of service, access for destinations, environmental impact, costs etc., when it comes to deciding in what infrastructural projects to invest. In making decisions on infrastructural projects, road safety arguments have to be already considered as explicitly as possible in the planning phase. An instrument has been developed with this aim: *Road Safety Impact Assessment RIA.*
On a *strategic level* safety consequences have to be assessed of changes (redistributions) of traffic over a road network due to infrastructural projects (new roads, new layout of roads) by using a scenario technique. This technique uses the fact that different categories of roads (with different road and traffic characteristics) turn out to have different road safety records dependent on traffic volumes. By modelling road type, values of relevant safety indicators and traffic volumes, road safety impacts of different alternatives can be calculated.
Secondly, on a *project level*, an audit technique can be used to make as explicit as possible the safety consequences of certain choices in the detailed planning and the design process and to optimize a road design. The primary objective of using an audit technique is to ensure that road safety is optimally incorporated during the design and realisation phase of infrastructure projects in order to "arrive at a road design which is simple and recognizable for future road users, thereby minimizing potential error".

The concept emerged in the United Kingdom in the 1980s (IHT, 1990 & DoT, 1990a and b). This new tool for accident prevention is in operation in the UK, the USA (ITE, 1995), Australia (Austroads, 1994) and New Zealand. In France, two audit experiments will be undertaken on French toll motorways in 1995. Following the different procedures audit activities would involve five phases:
- feasibility/initial phase (or the strategic level of a RIA);
- preliminary design;
- detailed design;
- inspection of the road in the pre-opening phase;
- inspection of the road in-service.

The Road Safety Impact Assessment (including the audit technique) is a useful instrument for assessing those aspects relevant to road safety at an early stage and during all the subsequent phases of road design (for new and also for existing roads). To obtain optimum benefit from this concept, the following recommendations could be formulated (Wegman, et al, 1994):
- independent auditors;
- publication of auditors' report;
- commence a safety audit with the strategic scenario results;
- publish audit reports after completion of the preliminary design, after completion of the detailed design and just before the road is opened;
- audit reports give advise to the initiators of a road project; the initiator remains fully responsible;
- 'best practice' checklists should be developed and used.

Of course, to carry out road safety audits teams of well-trained experts are needed.

Although the concept of auditing looks very promising because of its preventive and explicit nature and the fact that audits are used successfully in other fields, so far no research is available in which these positive expectations are confirmed in terms of 'accident reduction'.

6.3. Sustainable safe traffic

The general concept of sustainable development introduced by the UN Brundtland Commission also inspired the vision evolved by the SWOV Institute for Road Safety Research, in close cooperation with other Dutch research institutes, in the field of road safety (Koornstra et al, 1992 & SWOV, 1992).

A scientifically supported, long-term concept for the implementation of an essentially safer road traffic system can best be achieved by tackling the causes underlying accidents, by removing areas of conflict or by making these controllable by road users. Where accidents still occur, the risk of serious injury should be virtually excluded.

A sustainable safe traffic system has:
- an infrastructure whose proper road design is adapted to the limitations of human capacity;
- vehicles fitted with ways to simplify the task of the road user and constructed to protect human beings as effectively as possible; and
- a road user who is adequately educated, informed and, where necessary, controlled.

As to the infrastructure, the key to arrive at sustainable safety lies in the systematic and consistent application of three safety principles that reduce in advance the liability of encounters with implicit risk. The three safety principles are:
- the functional use of the road network, by preventing unintended use of each road;
- the homogeneous use, by preventing large differences in vehicle speed, mass and direction of movement; and
- the predictable use, thus preventing uncertainty amongst road users, by enhancing the predictability of the road's course and the behaviour of fellow road users.

This approach could be characterized as a preventive one, a systematic one and a consistent one which is in contrast to the curative one, the incidental one, and the 'compromise approach' of many road safety policies of today.

6.4. Improved police enforcement

For many years, the police have played a prominent role in improving road safety. It is generally accepted that the success of police enforcement in changing human behaviour depends on the ability to create a *general and a specific deterrence*. General deterrence relies on the perception of the road user that traffic laws are enforced and violations are prosecuted

and punished. Specific deterrence deals with actual experiences of violators who are detected, prosecuted and punished. Both deterrences have to fit in to a far more broader road safety strategy to prevent an impossible enforcement task.

The general principles of effective police enforcement are rather well-documented (Wegman, 1992, Zaal, 1994 and Goldenbeld, 1995). These principles have been applied to major offenses *(drinking and driving, speeding, red light violation and seat belt enforcement)* in many countries and much practical information is available. The most important principles are as follows:

- combine police enforcement with publicity preceding and during enforcement activities; it is essential that road users actually observe increased levels of enforcement;
- social acceptance of enforcement can be influenced positively by publicity and could lead to better safety effects;
- combine continuity with the short-term intensive enforcement ('blitzes') of high risk behaviour and locations;
- combine a selective mix of visible and less visible controls;
- apply other legal sanctions than just fining, such as license suspension and revocation, curfew, point demerit schemes etc., and ensure that the chance of violations being detected are high.

To help the police to be as effective and efficient as possible a 'Manual on Enforcement' has been issued recently in the Netherlands (Ministerie van Verkeer en Waterstaat, 1995) in which 'a good practice' is presented. It is to be hoped that this manual will help to demolish the following barriers to successful police enforcement: lack of up to date knowledge in this field, lack of priorities in the police force in dealing with traffic enforcement, a historic police attitude towards pursuing and apprehending offenders instead of improving road safety, lack of motivation of police management and individual officers, poor communication with other links in the enforcement chain (public prosecutors, publicity organizations etc.), lack of proper equipment.
This leads to the conclusion that enough knowledge is available and that improved and successful police enforcement is based on better management, better education and information, better motivation, a better build-up of a chain with strong links and better use of available knowledge and expertise. It now comes down to implementation with the better use of existing forces rather than more manpower and more equipment. However, our knowledge about the cost-effectiveness of different strategies is still poor and it is recommended that a meta-analysis is made in this field and that research projects comparing different strategies are carried out. It is evident that in Central and Eastern Europe and in developing countries the nature of the police enforcement problem and possible solutions will differ, but the general principles remain the same.

6.5. Telematics

Telematics (Applied Transport Telematics ATT) is increasingly considered as a means to improve traffic and transport management as well as road safety. Road safety arguments turn out to be a good sales argument. High-pitched expectations are created around telematic applications and their expected positive effect on road safety, expectations which are not

completely fulfilled. In addition, the developments in this area are barely steered by relevant social and policy-making developments but rather by a 'technology push'. From the point of view of road safety, the following questions are of importance in an assessment of telematic applications:

- controlled traffic growth;
  (i.e. route planners, fleet management with GPS)
- optimal distribution of traffic over time and space;
  (actual radio traffic information)
- management of traffic streams;
  (i.e.homogenizing driving speed)
- reducing risks;
  (i.e. warnings of extreme road and weather conditions, improvement of visibility, intelligent speed limiters)
- restriction of the negative effects of accidents
  (accident alarm system, co-ordination of assistance)

There are also developments afoot which could have a negative influence on the driving behaviour and driving performance (i.e. 'the car used as office, including telephone and fax'). It is necessary that safety assessments on such developments be made, which could perhaps lead to regulations. Over and above, this there should at least be a 'code of practice', a checklist such as exists in England whereby possible negative consequences can be established. Furthermore, from the point of view of the user, the acceptance of all these developments is of importance and equally the comprehensibility (man/machine interaction) especially in an ageing society.

Governments and representatives of road users should closely and more carefully follow telematic developments and applications (individual and collective systems as well), make assessments at management level and - if necessary - try to make corrections. Of course this should be done on an international basis.

7. Road safety policies

7.1. Raise public awareness

It seems to be that our societies are beyond the stage of astonishment: why do we accept the far higher probability of being killed in road traffic than in other transport modes, in the working environment, in technological-energy installations or in natural disasters? Are we so used to road hazard, combined with the assumed inability to do anything about it, that we seem to have adopted a somewhat apathetic attitude, which permits too much laxity in the approach towards road safety, even today?
However, responsible people complain to the Government about hazardous situations: people drive too fast or a crossing is dangerous. There are parents who are worried that something could happen to their children in traffic. This can be the start of a local community taking road safety seriously. A form of social mobilization is necessary, the first phases of which are problem identification and problem recognition. Public support based on public awareness is no static concept, but rather a dynamic one. Public support can be created but if it exists one day, it can subside the next; 'maintenance' is needed.

Public awareness could be a flywheel but also a dead-weight for road safety. When the general public is sufficiently aware and acknowledges that there is a road safety problem, it is to be hoped that politicians will act, that private road safety organizations will be founded and function successfully, that a special Road Safety Agency will be established by the Government and that enough funding will become available etc.

Influencing social norms is a key issue in this respect (Evans, 1991). Community groups, private road safety organizations, road safety practitioners and scientists and the press all have to play their role in influencing not only local/regional and national politicians to create 'safer road conditions', but also road user behaviour. No panacea can be given for this complex game comprising public affairs activities, influencing the political agenda, marketing of measures etc. However, it is essential that the road safety sector enters this field if it is to leave its marginal existence. When developing a road safety strategy, more and explicit attention has to be paid to 'raising awareness' than has been done in the past.

7.2. Marketing of road safety measures

A new approach to improving road safety seems to be the application of marketing principles in order to find out how road safety measures can be introduced effectively and efficiently and as a specific method for improving communication (OECD, 1993). We speak of social marketing when the producer is not concerned about his profit margin in return for exchange, but motivated by a social goal such as health or safety. Until now, in the field of road safety we have been very much dependent on regulation and control to influence behaviour. And this approach has been successful, as is illustrated in this report, but has not been able to solve all

the problems: traffic violations are common practice everywhere. Social marketing could expand existing possibilities to change human behaviour. Traditional road safety policy tries to prescribe what people should do, social marketing helps to identify the best ways to promote the right kind of behaviour. A special problem in the field of road safety is that unpopular measures could result in more safety but that a better acceptability of these measures will result in a better compliance.

The OECD report concludes that to pursue a successful marketing strategy the following requirements must be recognized and taken into account:
- place more emphasis on the requirements of the target group than on the demands of safety experts;
- the target group must be analysed and the safety offer modified to suit the motives, values and requirements of the consumer;
- an appropriate exchange and compromise must take place between the safety experts and the consumer's needs and the consumer should be able to perceive the benefits of safety-oriented behaviour;
- the following elements should be included in a marketing strategy: situation analysis, selection of target groups, setting objectives, choice of marketing instruments (product, price, promotion and place), pre-testing, implementation of remedial measures and evaluation and feed-back.

No hard evidence can justify social marketing as an additional means to improve road safety. But the philosophy (communication between producer and consumer) and its success in the commercial sector give social marketing a real potentiality.

7.3. Organization of policy

The nature of the problem of road hazard and the fact that road hazard is only one facet in a multitude of other areas of policy makes it unrealistic to improve road safety through an individual sectoral approach (OECD, 1984). In those countries where the approach to road safety forms an explicit part of government policy, the aim is to find a suitable form of organization which can work effectively and efficiently. Of course, the actual interpretation of this aim should fit within the political and administrative context of the country. But a number of principles do seem to have proven their worth:
- an independent, coordinating body, which can operate sufficiently close to political decision making, that has its own, albeit modest budget to carry out policy, but also has the means to invite others, or oblige others and call upon that obligation, to promote road safety. This coordinating body is responsible for the acquisition and dissemination of knowledge.
- a recognizable interaction with areas of policy which are important to road safety, preferably by accentuating win-win relationships (urban planning, public health, safety considerations etc.)
- a strong vertical coordination between central government and other government branches in which the implementation of policy takes place (provinces, municipalities).
- an explicit role for private organizations who accept responsibility for carrying out areas of policy (PRI members, consumer organizations, interest groups for certain road users such as motorists, pedestrians,

cyclists etc.), who are also able to generate and maintain road safety awareness, together with the government.
- a good road safety plan in which both the strategy for policy and an adequate organization for implementation are described; a quantitative task for policy (-25% road accident victims within fifteen years) can offer an attractive and binding element.
- adequate basic information about accidents, variables of influence and the policy performance and a monitoring system creating feedback for a road safety policy;
- the professionally organized transfer of knowledge and the training of professionals.

7.4. Funding

The paradoxical situation, in which the high social costs of road hazard do not lead to the allocation of proper budgets for the prevention of road accidents, should be solved in situations where, from a social perspective, the costs outweigh the benefits. The financing of measures to promote road safety, in particular adaptation of the infrastructure, proves to be a significant obstacle. Developing countries and countries in Central and Eastern Europe have so many problems to solve, that, when it comes to the allocation of priorities, road safety is dropped. There is even the question of a growing problem if governments allocate less funding, as is currently the case in developed countries. This means that it is necessary to find a means of 'creative funding', i.e. other means of financing than the 'standard item on a government budget' (see also Lowe, 1995).

It is mainly the individual as a tax payer, who invests in prevention, while the individual as a payer of insurance premiums, should also benefit from public investment. The use of vehicle insurance premiums as a source of road safety financing raises some interesting issues and possibilities. Of particular interest is the use of motor vehicle insurance levies as a potential source of road safety financing, as is the case in Finland, Canada and Australia. A number of questions have to be resolved:
- does road safety need an independent source of funds?
- is insurance an attractive source of revenue for road safety?
- are insurance levies an effective form of pricing of road safety expenditures?
- do insurance bodies as clients for road safety programmes create greater accountability for effective spending?

Another interesting possibility seems to be to combine investments outside the road safety sector with road safety countermeasures. One may think about combining investments in the road sector (new roads, rehabilitation programmes etc.): such a link could be formalized, by regulation or law, for example by introducing the concept of a Road Safety Impact Assessment (RIA). Other possibilities are investments in the public health sector and investments to improve the environment.

8. Conclusions and recommendations

1. The annual number of road accident victims is estimated at 500,000 fatalities and 2,500,000 injured. It can reasonably be expected that this number is more likely to increase than to fall, particular in developing countries and probably also in countries in Central and Eastern Europe. But also in highly-motorized countries, where a considerable drop was registered in the 1970s, there has been a less significant drop in recent years, and sometimes even a 'rebound' effect. A further drop in road accident statistics may be achieved through an effective road safety policy.

2. Although an increase in mobility can be linked to a drop in the number of road accident victims, as has been shown in many highly-motorized countries, it must be feared that a high growth in mobility will not be associated with a parallel reduction in the road accident statistics.

3. There is no question about the effectiveness of some remedial measures to prevent accidents and their severity: prevention of drinking and driving, use of seat-belts and crash helmets, improvements to road infrastructure and of car design, the maintenance of vehicles and proper assistance to road accident victims. Enough research results are available regarding the principles of these measures and of 'best practices' as well. Although remedial measures could not simply be copied, translation to prevailing conditions are possible. The emphasis should be put on systematic and long sustained implementation.

4. There seem to be no options available for simple, large-scale, new and effective measures which can further promote road safety. On the contrary, we should focus on the problems and measures that have already been recognized and adopted. The better implementation of well-known measures, leading to larger and longer-lasting effects at less expenses, is more appropriate than searching for a new 'universal remedy'. A large number of countries are currently focusing on three areas of priority: driving under the influence, speeding behaviour and the insufficient use of seat belts and helmets. Furthermore, attempts are being made to improve road safety for high-risk groups (young drivers) and vulnerable road users (pedestrians, children, the elderly).

5. The international community has been unable - even in a world where a multitude of technological means is available to simplify communication over long distances (fax, internet) to organize the transfer of knowledge effectively. It is an important mission of international organizations to organize this transfer of knowledge. As yet, no single international organization has been defined as the only potential organization to be considered for this leading role. Cooperation is urgently needed and members of international organizations are called upon to act. The basis of such an exchange of knowledge lies in the willingness of members of these organizations and of individual countries together with the professional community to make an effort to realize such a transfer of knowledge.

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Annex Road Accident Fatality Rates by Country

Country	Year	Source	Fatalities	Fatalities per 100.000 population	Fatalities per 10.000 vehicles
1. EUROPE					
Austria	1993	IRTAD	1283	16.2	3.1
Belgium	1993	IRTAD	1660	16.5	3.4
Bulgaria	1992	IRF	1299	15.3	6.5
Cyprus	1993	IRF	115	18.4	3.3
Denmark	1993	IRTAD	559	10.8	2.7
Finland	1993	IRTAD	484	9.6	2.1
France	1993	IRTAD	9568	16.6	3.4
Germany	1993	IRTAD	9949	12.3	2.2
Great Britain	1993	IRTAD	3814	6.7	1.5
Greece	1993	IRTAD	2104	20.3	6.6
Hungary	1993	IRTAD	1678	16.3	N/A
Iceland	1993	IRTAD	17	6.4	1.2
Ireland	1993	IRTAD	431	12.1	3.7
Italy	1993	IRTAD	7177	12.6	2.0
Lithuania	1993	IRF	892	24.0	10.2
Luxembourg	1993	IRTAD	76	19.2	3.1
Netherlands	1993	IRTAD	1252	8.2	1.9
Norway	1993	IRTAD	281	6.5	1.3
Poland	1993	IRF	6341	16.5	6.9
Portugal	1993	IRF	2171	22.0	6 0
Rumania	1993	IRF	2826	12.4	11 5
Spain	1993	IRTAD	6378	16.3	3.6
Sweden	1993	IRTAD	632	7 3	1 5
Switzerland	1993	IRTAD	723	10.5	1.8
Turkey	1992	IRTAD	8078	14.1	N/A

				Vehicles						
Country	Year	Source	Fatalities	4 Wheelers `000	2 Wheelers `000	Total Vehicles `000	Population `000	Fat/10k Vehicles	Veh/10k Persons	Fat/100k Persons
2. AFRICA										
Botswana	1993	TRL	379			94	1425	40.3	660	26.6
Cameroon	1987	IRF	1034			180	10700	57.4	168	9.7
Central Afr Rep	1993	IRF	30	1	1	2	3041	150.0	7	1.0
Ethiopia	1991	IRF	1169	59	2	61	52000	191.6	12	2.2
Ivory Coast+	1989	Swed	606			340	13000	17.8	262	4.7
Liberia	1987	IRF	80			11	2221	72.7	50	3.6
Mauritius	1991	IRF	163	67	69	136	1078	12.0	1262	15.1
Morocco	1990	IRF	1921			749	25091	25.6	299	7.7
Niger	1987	IRF	148	41	0	41	7439	36.1	55	2.0
Rwanda	1990	IRF	331	10	8	18	7200	183.9	25	4.6
Seychelles	1992	TRL	8			7	72	11.4	972	11.1
South Africa	1992	IRF	10142	5108	285	5393	31917	18.8	1690	31.8
Swaziland	1990	IRF	193	51	3	54	726	35.7	744	26.6
Tanzania+	1989	Swed	1116			250	25000	44.6	100	4.5
Tunisia	1989	IRF	1172	494	12	506	7910	23.2	640	14.8
Uganda+	1989	Swed	1271			200	17400	63.6	115	7.3
3. AMERICA										
Barbados+	1991	TRL	23			65	250	3.5	2600	9.2
Brazil	1993	IRF/EYB	5500	13469	N/A	13469	156578	4.1	860	3.5
Canada	1992	IRF	3485	17010	339	17349	27297	2.0	6356	12.8
Chile+	1992	TRL	1700			1361	13813	12.5	985	12.3
Colombia	1989/90	IRF	2564	1329	245	1574	32317	16.3	487	7.9
Costa Rica	1993	IRF	235	335	46	381	3167	6.2	1203	7.4
Ecuador	1991	IRF	1057	384	N/A	384	10502	27.5	366	10.1
Honduras	1990	IRF	400	107	8	115	4800	34.8	240	8.3
Jamaica+	1989	Swed	400			150	2500	26.7	600	16.0
Mexico+	1989	Swed	7401			8000	86000	9.3	930	8.6
Suriname	1993	IRF/WHO	55	58	N/A	58	446	9.5	1300	12.3
USA	1992	IRF	39235	190362	4065	194427	255078	2.0	7622	15.4

				Vehicles						
Country	Year	Source	Fatalities	4 Wheelers `000	2 Wheelers `000	Total Vehicles `000	Population `000	Fat/10k Vehicles	Veh/10k Persons	Fat/100k Persons
4. ASIA & MIDDLE EAST										
Bahrein	1993	IRF	56	141	1	142	538	3.9	2640	10.4
Brunei	1991	IRF	47	128	4	132	261	3.6	5057	18.0
China+	1990	CARS	49271			10095	1100000	48.8	92	4.5
Hong Kong	1993	IRF	351	462	28	490	6020	7.2	814	5.8
India	1991	IRF	56525	4025	4	4029	844000	140.3	48	6.7
Indonesia	1990/92	IRF/EYB	10887	3256	6987	10243	179379	10.6	571	6.1
Iraq	1989	IRF	4625	1041	N/A	1041	17785	44.4	585	26.0
Japan	1993	IRF	10942	63266	16395	79661	123788	1.4	6435	8.8
Korea South	1993	IRF	10402	6274	1936	8210	44056	12.7	1864	23.6
Kuwait	1989	IRF	301	610	5	615	2095	4.9	2936	14.4
Malaysia	1993	PDM	4666	3229	3483	6712	19050	7.0	3523	24.5
Nepal	1992	TRL/RSP	530			68	18916	77.9	36	2.8
Pakistan	1993	IRF	6299	774	1166	1940	122801	32.5	158	5.1
Philippines	1990	IRF/CARS/EYB	1099	1219	383	1602	61480	6.9	261	1.8
Saudi Arabia	1991	IRF	3719	5103	13	5116	11861	7.3	4313	31.4
Singapore	1993	IRF	258	441	118	559	2873	4.6	1946	9.0
Sri Lanka	1992	IRF	1795	381	516	897	17894	20.0	501	10.0
Taiwan	1993	IRF	2349	4208	10948	15156	20944	1.5	7236	11.2
Thailand	1993	IRF	9496	4136	7106	11242	58336	8.4	1927	16.3
Yemen Arab Rep	1993	IRF	1334	484	N/A	484	14020	27.6	345	9.5
5. OCEANIA										
Australia	1992	FORS/IRF	1977	9954	292	10246	17483	1.9	5861	11.3
Fiji	1994	TRL	88	53	1	54	761	16.3	710	11.6
New Zealand	1993	IRF	600	1900	61	1961	3500	3.1	5603	17.1
PNG	1992	TRL	290	50		50	3920	58.0	128	7.4

Notes

+ Source other than International Road Federation (IRF) eg World Year Book 1993 (WYB), World Health Organisation Stats 1993 (WHO), Road Accidents Great Britain (1994), Road Traffic Accidents in Europe & North America 1995, United Nations (UN). N/A = Not Available