Infrastructure design & road safety

OECD Workshop B3 for CEE's and NIS held on 15th-18th November 1994, Prague (Czech Republic); Part 1: Summaries, conclusions and recommendations, and statements from Central and Eastern European countries

D-94-14 I
Leidschendam, 1994
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Foreword

The workshop 'Infrastructure design and road safety' was one of the initiatives which the OECD Steering Committee for Road Transport Research developed with the aim of exchanging information in the road transport sector, in order to respond to the urgent needs expressed by Central and Eastern European countries. Road safety was indicated as one of the priority areas.

The workshop was held in Prague, Czech Republic on October 12-14, 1994. The workshop was attended by some 45 participants from 11 CEE countries and 4 from the West. Presentations were given on all major issues in the field of infrastructure design and road safety. Statements on road safety problems were given by 8 CEE countries. The workshop formulated general conclusions and recommendations at the end of the workshop and all participants expressed their opinion to intensify exchange of knowledge and experience on 'infrastructure design and road safety'. Based on the success of the workshop the participants expressed the wish to repeat a workshop like this and international organisations such as OECD, PIARC, the European Union (PHARE-programme) and banking institutions (World Bank, EBRD, etc) are encouraged to feel responsible to organize or at least facilitate this technology transfer and possibilities for co-operation.

The seminar was organised by the SWOV Institute for Road Safety Research in close co-operation with the Czech Ministry of Transport. Special thanks are addressed to Pragoprojekt (Mr. Zdenek Trcka) as local organiser of the workshop. We thank the Western experts who presented high quality contributions and shared their experiences. Last but not least, we thank all participants for their active contributions during the workshop.

The proceedings of the workshop are in 2 volumes:

Part I : Summary report, conclusions and recommendations (D-94-14 I)
Part II: Lectures of the workshop (D-94-14 II)

Fred Wegman
SWOV Institute for Road Safety Research
Chairman of the workshop

Contents

1. Introduction, programme and summaries

1. Introduction

OECD Workshop B3 on
INFRASTRUCTURE DESIGN AND ROAD SAFETY

WHERE: In the Czech Republic (Prague)

WHEN: 15-18 November 1994

WHY: There is no question about the intimate relationship between road design and management on the one hand and traffic safety on the other in terms of accident frequency and severity. Many technical studies in the past in OECD Member countries and several OECD/RTR publications highlight and identify these connections and point to priority areas where immediate benefits will accrue through low-cost engineering measures. The workshop will tap ons this knowledge and provide easily applicable expertise to CEEC technical experts.

HOW: The workshop has been organised around two axes:

1. Presentations by CEEC experts of overall and specific road safety problems. The present quality and conditions of infrastructure by type of road, network class and area (urban, rural). Priority issues are given.

2. Presentations by selected OECD/EU experts and consultants of the present state-of-the-art practice and technology: network planning, design principles and standards, speed and road accident, geometric characteristics and the relation between road design parameters and accidents, implementation of facilities, design of carriageways and road sides, black spot approaches, low-cost engineering countermeasures, working zones.

PARTICIPATION: CEEC technical experts from highway administrations, at national. regional and local levels. City engineers and planners. Traffic and Traffic Safety experts. Police officers. Economists from planning and finance Ministries. EU and OECD experts from the Netherlands, Denmark, Germany, United Kingdom.

ORGANISATION: 50 participants. Language: English. Duration: 4 days (starting Tuesday morning, ending Friday midday. Accommodation: training centre with meeting facilities in Prague.

2. Detailed programme of the workshop

Tuesday, 15 November 1994

9:30 - 11:00	Opening statements
	* Opening, Mr. Machart (Czech Ministry of Transport)
	* Workshop's objectives, Fred Wegman (SWOV)
	* Practical matters, Zdenek Trčka (Pragoprojekt)
11:00 - 11:30	Coffee Break
11:30 - 13:00	Short statements on road safety problems by representatives of some CEE Countries
13:00 - 14:00	Lunch
14:00 - 14:30	Introduction of Road Transport Research Programme of OECD, Burkhard Horn (OECD)
14:30 - 15:30	Short statements on road safety problems
15:30 - 16:00	Coffee break
16:00 - 17:15	Road Safety phenomenon, Fred Wegman (The Netherlands)
17:15 - 18:00	Road design and design standards and Road Classification, Pim Slop (The Netherlands)
18:00 - 18.30	Discussion

Wednesday, 16 November 1994

9:00 - 9:45	Methodology to assess road safety effects, Geoff Maycock (UK)
9:45 - 10.30	Vulnerable road users, Pim Slop, (the Netherlands)
10:30 - 11.00	Coffee break
11:00 - 11:45	Speed and road safety, Geoff Maycock (UK)
11:45 - 12.30	Discussion
12:30 - 13.30	Lunch
14:00 - 17 00	Excursion/Technical Visit in and around Prague

Thursday, 17 November 1994

9:00 - 10:30	Design of motorways and rural roads with special emphasis on traffic safety Rüdiger Lamm (Germany), read by Fred Wegman
10:30 - 11:30	Coffee break
11:00 - 11:45	Design of urban streets inc. residential streets, Kenneth Kjemtrup (Denmark)
11:45 - 12:30	Discussion
12:30 - 13:30	Lunch
13:30 - 14:15	Road side safety, Fred Wegman (The Netherlands)
14:15 - 15:00	Discussion
15:00 - 15:30	Coffee break
15:30 - 16:15	Black spot approach, Pim Slop (The Netherlands)
16:15 - 17.00	Low cost engineering measures, Pim Slop (The Netherlands)
17:00 - 17.30	Discussion

Friday, 18 November 1994

9:00 - 9:45	Vulnerable road users, Pim Slop (The Netherlands)
9:45 - 10.30	Road signing/marking/working zones, Kenneth Kjemtrup (Denmark)
10.30 - 11:00	Coffee break
11:00 - 12:30	Closing session: formulation of conclusions and recommendations
12:30 - 13:30	Lunch

3. Summary report of the various sessions

1. Road safety problems in Central and Eastern European Countries

Based on statements of the representatives from Central and Eastern European countries and the discussions during the workshop the main road safety problems could be formulated as follows.

In different reports from several CEECs (Bulgaria, Croatia, Estonia, Latvia, Hungary, Moldova, Poland, Rumania, Slovakia, Ukraine and Czech Republic) as main characteristics of the road safety problem were introduced:
- a sharp increase of the number of casualties since the political and economic changes at the end of the 1980s, although some countries seem to have stopped the unfavourable development (e.g. Hungary, Poland); Future developments have to clarify this.
- most of the accidents happened on urban roads, the most serious accidents on rural roads. Speeding (inappropriate and high speeds) is reported as a major cause of accidents, especially in curves. The same holds for accidents with overtaking and with fixed objects.
- poor design and maintenance of the road infrastructure is reported as a contributory factor to accidents
- inside built-up areas pedestrians and other vulnerable road users as cyclists form a large proportion of the total number of casualties;
- a general impression was expressed indicating a poor standard of road lay out, poor signing and marking and bad condition of the road side in CEECs;
- accident statistics show a large number of black spots.

Moreover, a proper organisational structure of road safety policies and their implementation is sometimes lacking in CEECs, especially when it comes to interministerial co-operation and co-operation between the national government and regional and local authorities. Furthermore, the role of private (traffic safety) organizations is not well-expressed.

Finally, most status-reports from CEECs raise the problem of lack of financial resources to improve the quality of the road infrastructure, and, consequently, to reduce road accidents.

2. Road safety phenomenon

The growth of motorisation is accompanied by exponentially decreasing curve for fatality rates. Just by combining both developments as a product [fatalities = fatalities/kilometrage * kilometrage] the development of fatalities could be described. This lead to the conclusion that a reduction in number of fatalities ought to be the result of a higher decrease in fatality rate than increase in mobility growth. *A reduction rate of 8-10% in fatality rates must be considered as realistic targets for Central and Eastern European countries.* If traffic growth is not accompanied by appropriate risk reducing countermeasures and activities, an increase of road fatalities might be the outcome. The lesson to be learnt from high-motorized countries is, when accelerated traffic growth is anticipated, no time has to be lost to invest in safety.

Road accidents usually occur as a result of a critical combination of circumstances and *seldom have just one cause*. There appear to be many opportunities for preventing human errors that brings about road accidents (cf. the so-called phase model of the accident process). This could be used as a starting point when formulating a road safety policy. This calls for integrated road safety programmes and requires the government to be organised in such a way as to reflect these. A politically sanctioned National Road Safety Policy, which is regarded by the entire road safety community as being its 'ownership', which can count on the support of (large sections of) the public, which is based on a clear analysis of road safety and contains concrete (quantitative) targets, can make a significant contribution to improving road safety.

Proper road design is crucial to prevent human errors in traffic and less human errors will result in less accidents. To prevent human errors three safety principles have to be applied in a systematic and consistent manner as much as possible: preventing unintended use of the roads, preventing large discrepancies in speed, mass and direction, preventing uncertainty amongst road users. Where these principles have been applied (motorways and residential streets) low accident risks occur. In general terms: high driving speed, many inconsistencies, many differences in direction, speed, different type of road users occupying the same space explain the greater risks for arterial roads in urban areas and for rural roads.

3. Infrastructure design

3.1. Road design and design standards

Road design standards are generally supported on three main grounds:
- to ensure uniformity among different designs, thus making traffic situations and road user behaviour more predictable;
- to enable the existing expertise in geometric design, to be more broadly applied; and
- to ensure that road funds are not misspent through inappropriate design.

To serve these aims standards must have a certain coercion. In this respect, standards can be a great help, but compelling standards could have also disadvantages (unnecessary limitation of designers freedom). Making a standard compulsory is only justified if there is the certainty that the solution offered is the optimal one. Classifying standards with regard to their firmness could be regarded as an interesting approach by distinguish: regulations, guidelines, recommendations, suggestions and possibilities.

The safety aspect is not clearly represented in existing design standards. To improve the impact of the safety aspect among other criteria the following recommendations could be given: a more explicit treatment of safety, a better connection between research results and standards, a differentiation in the status of the standards and a system of margins, together with a set of instructions how to make use of it.

International harmonization of standards has the same advantages and disadvantages as setting national standards. But a process of international harmonization could be seen as a possibility to treat safety more explicitly in the various design procedures. This process should pay attention to the problem under what condition to depart from the standards.

3.2. Road classification

The main purpose of road classification from a safety point of view is that the functions of a road are made clear, so that the road users have a better expectation of the traffic processes on that road , and behave accordingly. The this end, the design of a road must be consistently related to its functions, either by distinct features or by the appearance of the road as a whole. The relationship between 'purpose' (= intended functions), 'shape' (= design) and 'use' (actual functions) of a road have to be in accordance with each other.

Using a hierarchical classification of the road network, drawn up in a traffic plan, can steer many aspects of traffic behaviour in a desirable direction. This means that road users should have an understanding of the functional relationship between parts of the road network.

Three functions can be distinguished: through or flow function (rapidly processing with through traffic), the distributor function (to enter or leave areas) and access function (to enter or leave the road). Besides these traffic function a residential function could be distinguished (making homes etc. accessible and at the same time making the street a safe meeting place). Many times, more than one aspect of the traffic function is supposed to occur on the same road: the roads are multifunctional. Comparison of casualty rates for various types of road reveals that the traditional roads, which are multifunctional (main roads within built-up areas and single and dual carriageways outside built-up areas, to which all traffic is admitted) are among the most hazardous. It is to be advised to remove as consistent as possible all function combinations. Three functional road categories (through roads, pure distributor roads and pure access roads, could be the result of this approach. All three road types have to be designed with three design principles in mind: preventing unintended use of the road (functional use), preventing large discrepancies in vehicle speed, mass and direction (homogeneous use) and preventing uncertainty among road users (predictable use).

3.3. Speed and road safety

The relationship between the traffic speeds on a road and accident rates depends on many interacting factors. *However, the evidence available from international studies suggests that for every one km/hour in the mean speed, injury accidents change in the same direction by about 3%.* This conclusion is independent from the type of intervention and the character of the before situation.

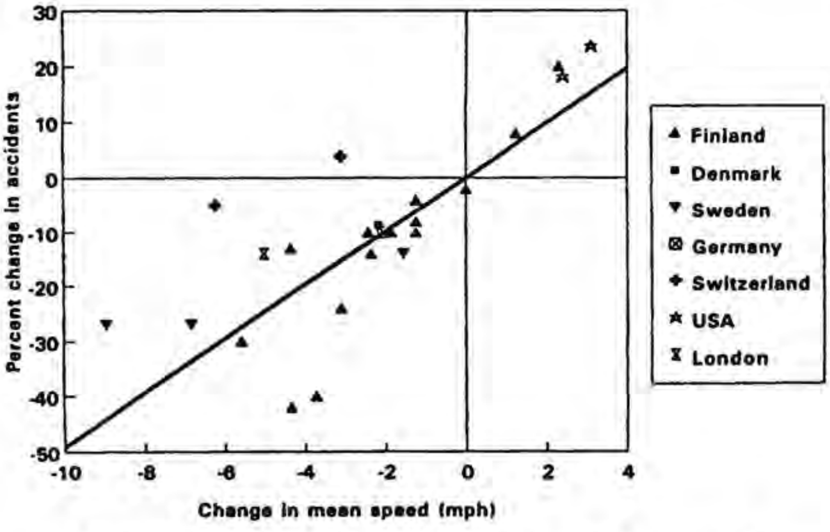

Fig. 1 International studies showing changes in accidents resulting from changes in mean speed

3.4. Design of motorways and rural roads

A large proportion of serious accidents can be attributed to two-lane rural roads and a major problem on these roads seems to be the curve roadway sections. The actual driving behaviour in curves is many times not attuned to the geometric design parameters of that curve. Speed errors may be related to inconsistencies in horizontal alignment that cause the driver to be surprised by sudden changes in the road characteristics, to exceed the critical speed and to lose control of the vehicle.

To evaluate quantitavely curve design in the future, three safety criteria were developed:
- achieve operating speed consistency
- design consistency, and
- driving dynamic consistency.

Limiting the changes in operating speeds between road sections to certain ranges, it can be determined whether the break in the speed profile is acceptable, or may cause a speed change that could lead to critical driving manoeuvres. Research results also indicate that harmonizing the design speed and the 85-th percentile operating speed (V85) is an important goal to be considered in new designs, redesigns and rehabilitation strategies of rural roads. Design consistency in a curve meets driver expectancy and improve road safety. It is still to be studied within which limits of these two safety criterion one can speak of good design, fair design and poor design.

The third safety criterion compares side friction for a curve design in existing guidelines with the actual side friction demand at curved sites. For safety reasons side friction as assumed in the guidelines have to exceed the friction demand.

3.5. Design of urban streets

The condition for attaining the greatest possible level of road safety on urban road networks is that road users behave in a manner that reduces the risk of accidents. The road designer should take care that the traffic picture is comprehensible and simple, in order to minimise the cognitive loading. Due to differences in traffic culture it is not appropriate to offer unambiguous instructions on the correct design. However, recommendations could be given on certain fundamental physical conditions for the development of good design of urban roads and streets.

In designing road networks in urban areas consideration should be given to road safety, a sense of security, accessibility, passibility, capacity, clearness, the environment and urban architecture. Fast moving motorized traffic should be separated from slow moving, vulnerable road users. Many investigations have shown that speed has a significant effect on road safety, security and the environment. *The speed differential must be between certain limits when different categories of road users use the same space.* A road classification base on functional requirements (through, distributor and access) and speed classification (high, medium, low) per category of road has proved useful as a basis for setting priorities in road safety.

From this perspective arrangements have to be made for access control, parking needs,

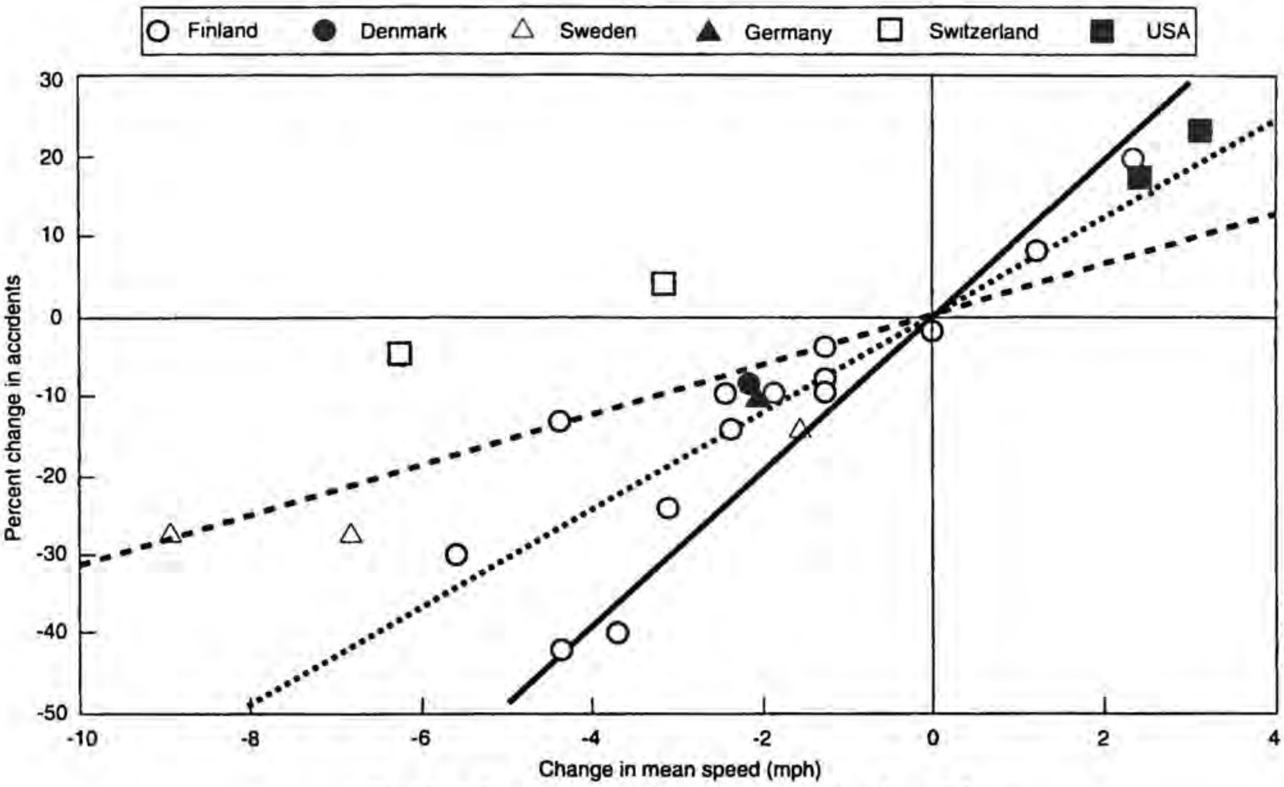

Fig. 2 a *Relationship between speed and accidents* (TRL, 1994)

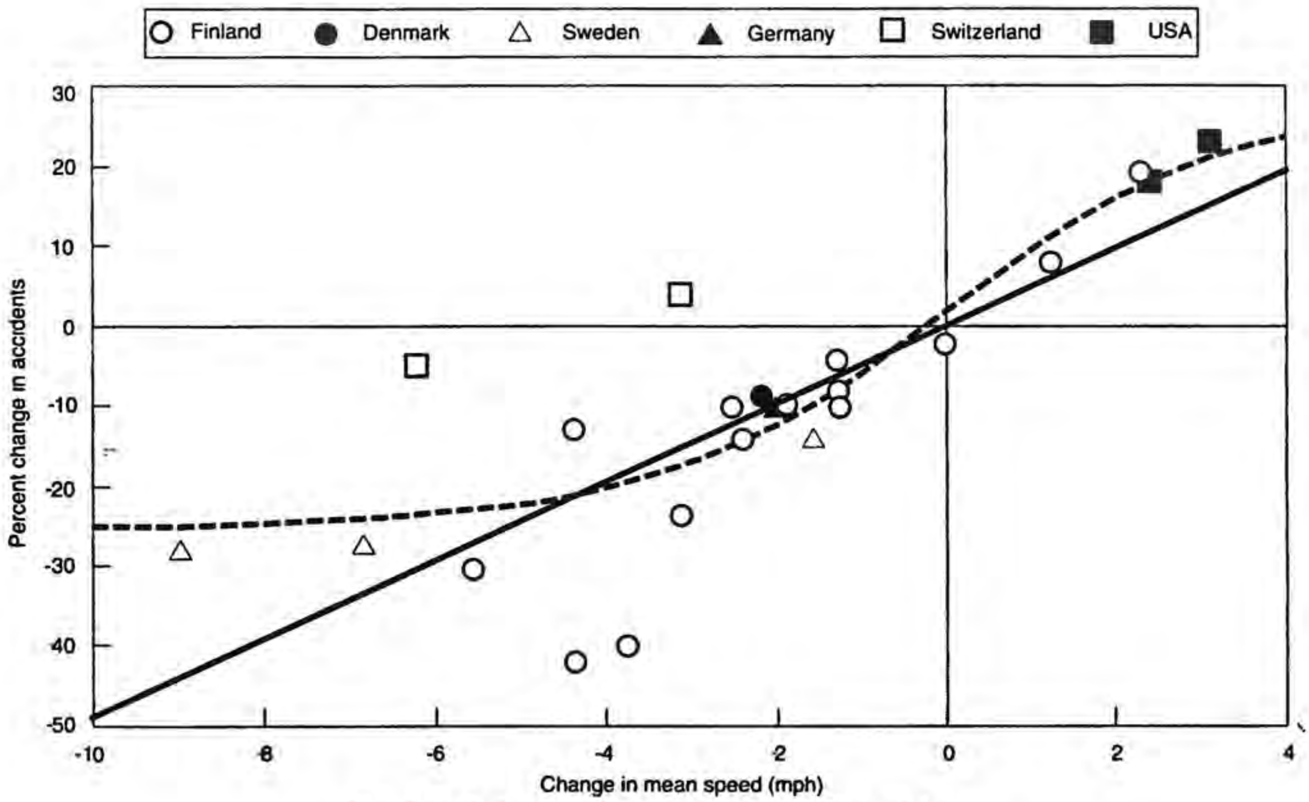

Fig. 2 b *Relationship between speed & accidents* (TRL, 1994) road equipment conditions etc. Alignment design, cross-section design, junction design and selection of types of speed reduction are crucial to design safe roads and streets. Inside established built-up areas freedom for safe design is generally rather limited, but 'best practice' guidelines are available in different countries (UK, Germany, Denmark, The Netherlands, etc.). These guidelines deals with arterial roads (through function) as well as with traffic calming in distributor and access roads.

3.6. Vulnerable road users

As vulnerable road users are considered
- those 'weaker' in accidents, influenced by differences in mass and degree of protection;
- those having a lower degree of physical resistance resulting in a higher risk of (serious) injury or fatality, eg. elderly road users;
- those having poor abilities to 'hold their own' in traffic, because of lacking knowledge of traffic regulations, experience in traffic, speed of response, eg. children;
- those who cannot strictly ge regarded as traffic participants, but who can be involved in road accidents, eg. playing children or shoppers.

This leads to the identification of pedestrians, bicyclists and motorized two-wheelers as vulnerable road users, and within these groups the young and elderly particularly. To improve their safety measures to prevent the occurence of accidents have preference over measures with a curative character. Segregation in advance by creating separate networks for pedestrians, cylists and motorized vehecles is one main principle. The other one is integration of traffic modes, but then very low vehicle speeds are required.

Segregation of pedestrians/cylists on one hand and motorized vehicles on the other could be designed on a small-scale (footways, cycle tracks, pedestrianised streets etc.), on a medium scale (car free city centres, complete cycle routes seperated from the carriageway, etc.) and on a large scale (overlapping networks with grade seperated crossings).

Of course these types of solutions are necessary where a lot of vulnerable road users are present: inside built-up areas, in residential areas, near schools and in areas where many aged people live, in shopping areas etc.

4. Road safety features

4.1. Road side safety

A large proportion of accidents occur where vehicles leave the road. Safe verges could be designed according the following procedure:
- design obstacle free zones;
- if necessary, deal with single obstacles by removing rigid obstacles, by placing 'harmless' obstacles and by protecting rigid obstacles through crash barriers or impact attenuators;
- if necessary, design full protected zones.

Test acceptance criteria have to be established for impacts. First of all accelerations and decelarations have to be below certain maximum values (so-called ASI-values), impacting vehicles should not underride or override a safety barrier, have to remain upright and the exit angle have to be limited. A barrier should contain and redirect the vehicle without breakage, no part of the barrier should be detached and no part shall penetrate the passenger compartment. The dynamic deflection of the safety barrier should be below certain values.

The European Committee for Standardization (Technical Committee 226, Working Group 1) defines vehicle impact test criteria and acceptance tests for different containment levels.

Concrete barriers and steel guard rails could perform equally under light and medium severe impact conditions. Steel barriers perform better under high impact conditions (large impact angles, high speeds). For working zones special safty devices have been developed.

4.2. Low cost engineering measures

Different strategies could be used to rate and weigh accident countermeasures. Simply choose the countermeasures that are expected to reduce at most the number of accidents or injuries. However, these are usuallu also the most expensive! A second approach is to express the accident reduction in financial terms and calculate the difference between benefits and the costs of the countermeausres (per year). Choose the countermeasures that show the largest positive difference. In the third approach the rate of benefits and costs are calculated: this indicates what you get back for your money. *The last and most commonly used, approach calculates the number of casualties to be saved by a countermeasure per unit of money spend on the countermeasures: cost-effectiveness.* This last approach leads to the implementation of low-cost effective measures.

The following examples could be given of problems to be solved with low-cost measures: *narrow lanes/shoulders:* pavement edge lines, raised pavement markers, post delineators. *Sharp horizontal curves:* post delineators, obstacle removal, pavement antiskid treatment, obstacle shielding, speed reducers, shoulder widening, appropriate superelevation, gradual sideslopes. Various hazards at *intersections*: priority control, siganl control, pavement antiskid treatment, public ligthing and speed reducers. It is to be advised to develop a catalogue of all possible measures, their expected effects and their possible disadvantages.

4.3. Road signing/marking/working zones

Fundamental principles are available of planning, establishing and maintaining road signs, so that thay can be seen and understood at all times by road users. These principles could be applied in such a way that these are valid across the entire spectrum of traffic culture and national borders. As far as the reading and understanding of information is concerned road usersneeds can be divided in four phases: observation of information, selection of information, reading and processing of information and braking distance.

The purpose of road markings is to guide, advise and regulate traffic with a viwe to increasing road safety and the effective flow of traffic. Road marking should therefore be visible under all road conditions of illumination and, to the extent possible, under all weather conditions. Some types of marking are more visible than others in wet weather. A decision have to be made by a road authority what where to apply: flat markings, profiled markings and studs; their needed visibility under varying conditions of illumination and weather determines their optimal application. The necessary visibility distance is additional - fifth step - detailed investigation have to be made. The sixth step is establishing accident causes, the seventh is selecting countermeasures and the next step is evaluating whether the implemented countermeausres work as expected (no side-effects) and reduce accidents by evaluating the measures.

Research results indicate average reductions in casualties of 50 - 60% of treated black spots. A black spot approach is hopefully the victim of its own success. The next generation of approaches is to investigate 'black routes or areas'. This opens the possibility to introduce the consistency of road design.

4. General conclusions and recommendations

1. Although big differences exist between Central and Eastern European countries resp. the New Independent States (former Soviet Union) and OECD Member countries all people attending the workshop expressed the opinion that exchange of knowledge and experience on "Infrastructure design and road safety" is considered very useful. Appreciation was expressed to the organisers of the workshop. Based on the success of the workshop, the participants expressed their wish to repeat a workshop like this. Furthermore, technology transfer and co-operation and research in the field of the theme of the workshop is recommended. International organisations, like the OECD and PIARC, the European Union (PHARE-programme) and banking organisations (Worldbank, EBRD, etc.) are encouraged to feel themselves responsible to organise or at least facilitate this technology transfer and possibilities for co-operation. Suggestions were made of research items to be studied with researchers 'from the east and from the west'.

2. Participants hold the opinion that organisation of road safety policy and financing of road safety measures deserve more attention from policy-makers and politicians in Central and Eastern European countries. These countries could learn from experiences from Western Europe and decision-makers and politicians could be invited to seminars or to make study-visits.

3. Accident rates (number of casualties per kilometer travelled) in Central and Eastern European countries are two to three times higher than the ones in highly motorized countries as OECD countries. The WorldBank estimates that at present between 1 and 2% of the Gross National Product is lost through costs incurred by road accidents in CEECs. The number of casualties has increased during the last few years, although in a number of countries the growth in road hazard seems to come to a halt. However, the long term developments of casualties in the developed countries could be described well by a S-shaped growth of motorisation accompanied by exponentially decreasing curve for fatality rates. It is assumed that this relationship will be realistic in CEECs as well. This means that the expected traffic growth has to be accompanied by appropriate risk reducing measures and activities, otherwise an increase of road casualties might be the outcome.

4. It is realistic to expect that an effective road safety policy in CEECs will result in a smaller increase in casualties, as was the case in highly motorised countries until the beginning of the seventies. Without an effective road safety policy the number of casualties will increase much more. The earlier this safety policy will be implemented, the less accidents and economical losses due to road accidents can be expected.

internationally defined as the time that enables the road user to drive a vehicle in an efficient and foresighted manner.

Road work zones disturb the free passage of traffic and will therefore always be considered as inconvenience by road users. *It is vital that road work zones be planned thoroughly and with the greatest possible consideration for the safety of the road users and the road workers.* A plan that describes the potential for disturbances of traffic through a reduction of speed and the probability of queue fromation should be drafted for every work zone. The decisive factor is reduction of speed to the level that is deemed suitable for the road users and for people working on the road. If road users must change direction/lanes, they shall given timely warning and so they may understand what is expected from them.

5. Research and methodology

5.1. Methodology to assess road safety effects

Two types of studies could be used to establish the relationship between design characteristics and accidents: the before and after method and the cross-sectional approach. The before and after approach relies on identifying trial sites at which design changes are proposed, and obtaining accident data before and after the changes are made. In principle, the effect of the change on accidents is then simply the ration of the accident frequency after the change to that before the change. However, in statistical terms a number of complicating factors have to be taken into account. These are random fluctuations in the basic accident data, the need to control for systematic changes in accident rates over time and bias by selection.

The cross sectional approach relies on obtaining extensive accident, flow and geometric data from a wide range of sites of a particular type and analysing this data to obtain estimates of the relations between accidents and the geometric design variables of interest. Different well-known modelling techniques could be used (eg. GLIM).

Careful design of methodology, high quality of data-collection and craftsmanship determines the quality and the validity of research results.

5.2. Black spot approach

The aim of black spot analysys is to find indications for improving the layout of an accident prone location, by studying similarities between features of the accidents occurring on that location. The analysis is primarily based on accident data, together with data on traffic, infrastructure layout and road environment. The best approach seems to be to combat combinations of circumstances and/or events that apparently often lead to accidents or often occur at accidents.

Black spots on a road network are locations with high accident records. Black spots may be identified by retrieval from systematic accident registration in the national database. Once the black spot have been selected, analyses of these black spots can be made. *The entire method consist of seven steps: data collection, data analysis, formulating hypotheses about accident patterns related to road layaout, testing of hypothesis.* When necessary and

Maycock, G. The relationship between speed and accidents.

Maycock, G. & Summersgill, I. Methods for investigating the relationship between accidents and road design standards.

Mikulik, J. Presentation of road safety problems in the Czech Republic.

Monics, P. Measures to improve transport safety on the National Public Road network.

Pukitis, A. Road safety situation in the Republic of Latvia.

Slop, M. Road design and design standards.

Slop, M. Road classification.

Slop, M. Low-cost engineering measures

Slop, M. Vulnerable road users.

Strat, A. Romanian experience and programs concerning design and road safety.

Wegman, F.C.M. The road safety phenomenon.

Wegman, F.C.M. Road side safety

Zabyshny, A.S. Traffic safety control on the highways of the Ukraine.

6. List of participants

Bulgaria	Dimitar Petrakiev Dimitri Vassileff
Croatia	Karlo Anic Ivan Legac
Denmark	Kenneth Kjemtrup
Czech Republic	Gizela Capkova Michala Davidkova Jaroslav Horin Josef Mikulik Evzen Prediger Pavel Busta Pavel Karlicky Jiri Misek Zora Sachlova Petr Jirava Zdenek Trcka

5. Research reports from high-motorized countries have concluded that a majority of accidents (90-95%) are due to human error only or in combination with other causes and about 30% result from faults in road design (10% are the result of mechanical defects). Research results from CEECs are not available and might differ (slightly). It is an erroneous conclusion that education or enforcement are the most important, effective or efficient manners of preventing accidents. *It is also possible to prevent human errors by proper road design.* During the workshop concepts and many examples were given to illustrate this.

6. The nature of the road safety problem requires an integrated approach to solve it (physical planning, infrastructure planning, public health policy, police policy, etc.). Integration with environmental policy might be considered. Infrastructure design is only one of the possibilities in this respect. Proper (safe) road design should be based on the following principles: a functional road classification in which function, design and road user behaviour are attuned, a management of speeds (reduction of speed and more homogeneous speed), creating - and meeting everywhere - expectations of road users and segregation of different traffic modes in case of high/moderate vehicle speeds.

7. The following items were mentioned as priority areas in the field of infrastructure design and road safety and could be recommended for future co-operation:
- black spot approach based on a high quality accident registration by the police (especially the accident location), data processing by computer, leading to low cost engineering measures. National guidelines should be developed;
- independent road safety audits to improve the quality of road design in which the aspect road safety is treated explicitly;
- design of rural roads (two times two lanes, 2+1 lanes, etc.) in which capacity, safety and costs are weighed;
- traffic calming measures;
- specific road safety problems on rail road crossings, in tunnels, on intersections, with pedestrians, in working zones, in winter period.

5. Papers presented during the workshop

Celnar, J. Road safety in the Slovak Republic.

Horn, B. Introductory statement.

Kjemtrup, K. Urban streets.

Kjemtrup, K. Road signs, markings and working zones.

Lamm, R. Design of motorways and rural roads with special emphasis on traffic safety.

Legac, I. & Anic, K. Traffic safety on Cratian roads. Preliminary data and prevention programma.

Liivaleht, J. Road safety in Estonia.

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	Petr Jirava, Czech Technical University, Dept. of Highway Engineering
	Zdeněk Trčka, Pragoprojekt, Prague
	Oktar Vacín, Directorate of Motorways Prague
	Jitka Vranková, Ředitelství Dálnic Praha, závod Brno
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	István Langó, Kecskeméti Közúti Igazgatóság
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	Péter Monics, Székesfehérvári Közúti Igazgatóság
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	Kārlis Stapāns, Ministry of Transportation, Road Maintenance Div.
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	Vitalii Ion Mrug, Ministerul Transporturilor
Netherlands	Pim Slop, SWOV
	Fred Wegman, SWOV
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	Lech Kwiecien, Regional Board of Public Roads
Rumania	Maria Lascu, National Administration of Road Safety
	Aurel Strat, Rumanian Road Administration
Slovakia	Jindrich Celnar, Direktorate of Motorways
	Jana Vandlíčková, Institute of Road and Transport Administration
United Kingdom	Geoff Maycock, Transport Research Laboratory
OECD	Burkhard Horn,
PCO TEM	Krystyna Kostro
	Petr Pospisil

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Romanian experience and programs concerning infrastructure and road safety

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National Road Administration
OECD Workshop B3 on infrastructure design and road safety.
Praque, 15-18 November 1994

It is a fact that Romania adhered to all European or International Agreements and Conventions concerning road signs and minimal necessary infrastructure elements of the road networkaction at international level which during the past three decades readapted it at least each decade.

In this context, while for the new roads the geometric elements have been adapted according to the standards, for the existent network been done only a few improvements in order to assure a higher degree of road safety.

This being the infrastructure situation of the road network, emerged the necessity to adapt it by programmes function the quick rhythm of changes in the structure and intensity of the traffic, in order to assure the minimal necessary conditions of traffic safety. This especially for the national roads with international traffic, in touristic crowded areas, border crossing points, economical areas, where have been granted the necessary conditions for the surface of the road, number of ways, geometric characteristics for acceptable speed, visibility in longitudinal and cross profile, vertical road signs and during past years horizontal ones, too.

According to the importance of the road sector and by type of vehicles which traffic it, improvement works have been done in longitudinal and flat profile of the sectors with inclination higher than 4%, adding supplementary ways for low speed vehicles, for road turns with width and overhightening not in accordance with the standards, for black spots such as top hill turns lacking visibility. Sometimes these works forced us to change the road traject, to make cleanings and huge overfillings, to build (..) brigdes and maintain the old space.
Other works were enlargement of the road platform in order to eliminate obstacles from the sides of the road and install safety parapet.
Simultaneously with the reinforcement of the road network by the yearly programs of execution works were built refuge sideways with adequate traffic sign system, arrangement of all the access points to the reinforced sector, to assure water draining in order to diminish the risk of bowling up.

In order to diminish the risk of skidding it has been paid attention to the uniformity of road surface, the water-proofing and protection of the existent road coverings and to make surface asphaltic treatments at least each 5 years.

By programs it is assured vertical signalization of the roads with retroreflectorisant panels of big size on European roads and of normal size on the others; at the most important intersections there are presignalising panels in suspended position or aside the road.

Taking into consideration the problems which appear in the field of traffic safety, correlated with the infrastructure state of the network we organise training-checking courses for the execution staff and the teams in charge with the control and methodology, either for winter period tasks or warm season.

We are preoccupied also by environmental maintenance and preservation in proper conditions: plantations aside the roads, in intersection areas, refuge and parking places.

At regional and national level there kept a record or these programs pointing the normalisation of the infrastructure, reaching the traffic safety goals and improvement of the road network, using a informatic system which spread to the country level of the road administration. The data base it is in an advanced state of creation and will represent a basic tool for road management problems.
With the international financial support (World Bank, BIRD, BERD) there are on-going execution works such as:

- rehabilitation of the road network
- arrangement of border passing points
- vertical and horizontal signs for European roads
- improvement of charge capacity class of the brigdes

Ivan Legac, Karlo Anić

TRAFFIC SAFETY ON CROATIAN ROADS - - PRELIMINARY DATA AND PREVENTION PROGRAMME

1. Facts about Croatia, Croatian Roads and Transport

The Republic of Croatia comprises 57 000 km^2 and a population of almost as much as 4.8 million, Zagreb, its capital having about 900 000 inhabitants. In regard of its traffic-geographic position, it has an extreme transit significance for certain European countries and in linking Europe and Asia.

The main roads network is about 27 500 km long, out of which 81% is with modern roadway (3). So far, 287 km of motorways and 73 km of semi-motorways (fast roads) have been constructed so far, and an extensive programme of roads and bridges reconstruction is in preparation, as some 70 major bridges have been destroyed or damaged by the aggressor, and the damage on the road network is estimated at appr. 1 billion USD.

An international bidding for financing of the construction of about 650 km of motorways, worth about 4-5 billion USD has also been published.

In the year of 1990, 1.24 million motor vehicles were registered, out of which 795 000 is passenger cars. The registered vehicles also include 5 900 buses, 41 000 lorries, 27 000 special vehicles and company cars, 171 000 motor bicycles and 181 000 tractors. In the year of 1993, the number of motor vehicles registered was 743 000, out of them 646 000 passenger cars. In the same year, the number of registered motor bicycles was reduced to only 10 000.

Number of motor vehicles registered in the period 1981-1990 showed the annual increase of average 2.6%, while in the period 1985-1990 the annual traffic increase was average 6.5%. On 270 km of main roads outside of inhabited places, the average annual daily traffic in the year of 1990 was exceeding 12 000 of vehicles.

The territories occupied in 1991 have disconnected the main road routes: the Zagreb-Županja motorway and the road Zagreb-Plitvice-Split.

2. Safety in Road Traffic

Traffic accidents are monitored by the Ministry of Internal Affairs, which has regularly been publishing annual bulletins on safety in road traffic for twenty years now. During investigation, the officers of the Ministry collect the data about the accident, which are very similar to those in other countries. These data are processed and distributed in a classical way, which is about to be modernized and standardized, however, almost all data on traffic accidents are free for access to the purposes of investigation and other purposes.

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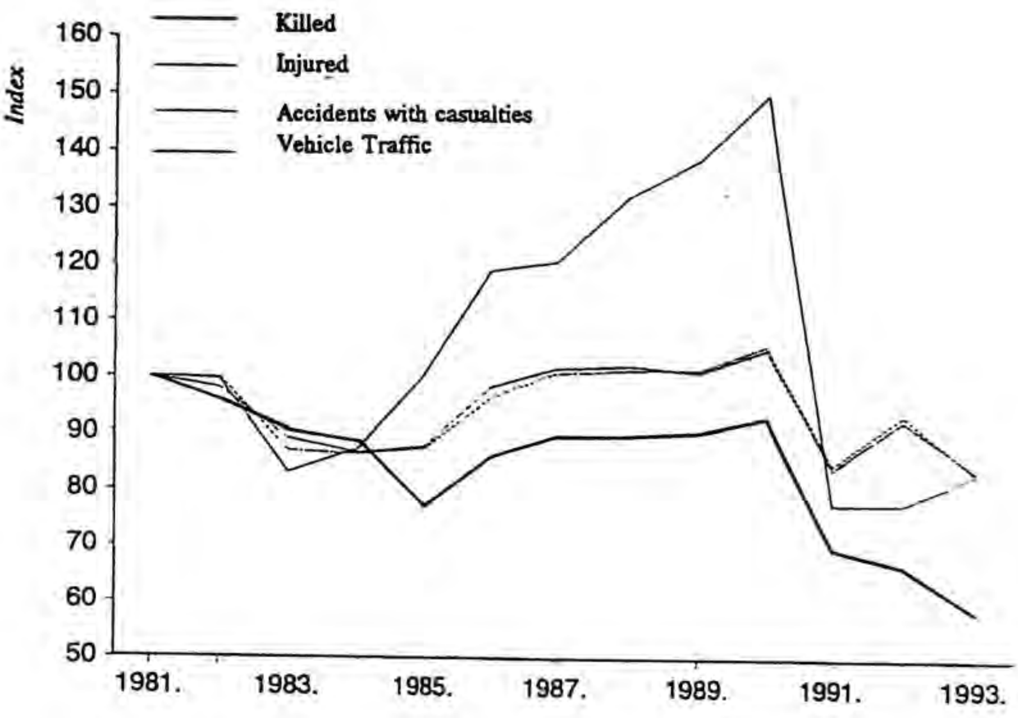

Figure 1: Traffic and road safety tendencies 1981-1993

Compared to the old one, the new Law on safety in traffic of 1992 raised the allowed speed of vehicles by type of road and vehicles. Speed limitation on motorways was raised from 120 km/h to 130 km/h, and on the roads designed not solely for motor vehicles, from 80 km/h to 90 km/h. For buses and freight vehicles, the limitation was placed on 90 km/h instead of previous 80 km/h.

The allowed level of alcohol in blood in Croatia is 0.05% for non-professional drivers and 0.00% for professional drivers.

The statistics of traffic accidents in periods 1981-1990 and 1991-1993 in its general indicators is already showing considerable variations in safety of the road transport in pre-war, war and post-war periods.

Figure 1 illustrates both the Croatian road traffic tendencies and the tendencies of the basic road safety indicators by indices which are most appropriate for such an illustration. Until 1991 security was growing, in 1991 falling, then again growing in the period 1991-1993, which is symptomatic of the war and general safety situation.

The largest number of persons killed in car accidents was recorded in Croatia in 1979 (1605) and 1980 (1603). The largest number of injured was also recorded in 1980 (2).

The risk of occurrence of traffic accidents of all kinds in the observed period was 8-9 accidents per every million of vehicles/kilometres a year. On major roads, the annual number of killed persons per million of vehicles/kilometres was reduced from 0.12 to 0.09.

Most of the victims in these accidents are drivers (46%), then passengers (35%) and pedestrians (19%). The percentage of the killed in the same categories was 45%, 26% and 29%.

About 79% of all the victims were killed and wounded in inhabited places, i. e. by categories, 78% of drivers, 69% of passengers and 95% of pedestrians. Distribution of the killed is somewhat different: in inhabited places it is 70% of all killed persons (by categories, 88% of pedestrians, 68% of drivers and 55% of passengers). Even 78% of severely injured passengers were injured in the accidents that occurred in the inhabited places (2).

On average 6.6% of accidents with killed or injured persons there is one child up to 14 years of age killed or injured. every ninth killed or injured person is a child, practically every second of them as a pedestrian.

Car crashes prevail over all other types of accidents constituting 58% of accidents with all consequences; 44% of all killed persons get killed in car crashes, and 50% of all injured persons get injured that way (1).

3. Road Traffic Accidents in Croatia 1991-1993

Table 1 contains basic figures on traffic accidents, the situation and causes being largely a consequence of war and immediate post-war conditions in the Republic of Croatia.

Table 1. Traffic accidents in Croatia 1991-1993

Year	Number of accidents		Number of casualties	
	Total	W/casualties caused	Killed	Injured
1991	53 297	11 599	1 020	15 845
1992	56 815	12 758	975	17 517
1993	58 188	11 529	855	15 596
1991-1993	168 300	35 846	2 850	48 958

In the period 1991-1993 the number of killed persons was considerably reduced compared to the number of accidents with casualties caused: while in the pre-war period av. one killed person was recorded on every ten accidents with casualties, in the period 1991-1993 one killed person was recorded on a little less than 13 accidents.

When it comes to children, the greatest change was in their part in the total number of casualties - in the pre-war period every ninth casualty was a child, and afterwards appr. every eleventh.

In 1 549 accidents with casualties, the cause of accident was attributed to objective causes (improper condition of vehicle 20%, road damage 64%).

In the period 1991-1993, the basic structure of accident causes was retained, so that 97% of accidents were caused by drivers. In the accidents involving pedestrians, about 60% were caused by drivers.

4. Conclusions on Safety Work and Prevention

Ministry of Maritime Affairs, Transport and Communications and Ministry of Internal Affairs, along with the Croatian Council on Traffic Safety, are the highest administrative bodies dealing with road traffic safety.

There are certain authorities dealing with traffic safety on the district and city levels, but there has been a considerable delay in the beginning of work on organization of traffic safety, due to war and other conditions.

Most important agencies and companies having greatest impact on traffic safety include companies such as public firm "Hrvatske Ceste" (Croatian Roads), Croatian Centre for Vehicles (carrying out technical inspection of vehicles) and Croatian Auto Club (HAK).

In the prevention system, special attention is paid to traffic education in kindergartens and primary schools. Drivers training is obligatorily carried out in driving schools, where driving exams are done as well.

Promotion of traffic safety is rarely present in Croatian television, some attention is dedicated to it only occasionally. However, there are frequent radio broadcasts on traffic safety.

A series of researches have pointed out at numerous spots in the traffic network where large number of accidents is happening year by year. Some 300 of such spots were discovered, yet there is but few of them where steps have been taken to improve the situation. Better roads are certainly one of the requirements of safer traffic. This is particularly obvious in the field of motorways. Croatian experience is a confirmation of the value of world experiences: for instance, on the Zagreb-Karlovac motorway there were 0.001 killed persons per million Vehicles/kilometres in 1988 (0.34 wounded), while on the three main and most dangerous there were average 0.14 killed persons per million vehicles/kilometres.

Spots, road routes and areas of increased danger in traffic deserve priority in implementation of the safety programme, especially because some ways to improvement require neither a lot of time nor money. It was in the years of war that placement of obstacles for forced vehicles' speed lowering on critical spots, because other measures did not produce satisfactory results.

Our opinion is that the new National Road Safety Programme, along with roads and signalization reconstruction and construction of modern roads and motorways, will be of decisive significance for any considerable increase in the safety level of road traffic.

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Measures to Improve Transport Safety
on the National Public Road Network

1. Accident statistics

In 1993 there were 19.500 accidents involving injuries on the overall road network while, of these, 10.800 concerned the national road network. The number of fatal accidents was 1.462, of which 1.088 happened on roads managed by the Ministry.

The number of accidents dropped by 20% as against 1992, however, though the performance of the vehicle fleet (km/year) fell by 27%, the size of the vehicle fleet continued to increase by 1-2 % in the same period (see Figure 1). The statistics show that, though environment pollution attributable to road traffic decreased proportionately to the drop in traffic volume, the reduction in the number of accidents was of smaller rate. Hence the probability or risk of accidents increased. This was underlined by the relative accident index (accident/10 million vehicle-km) which showed an increase of 11%.

2. Description of the public road network

The accident risk in Hungary amounts to 159% of the European average. The rate is much favourable for the built-in areas (109%) than for the rural areas (174%) though the figure for the motorways (107%) is satisfying (see Figure 2). On the other hand, supposing 100 accidents, twice as may people die in road accidents on the motorways in Hungary as in the other European countries. This means that, though the motorway network is 3-4 times safer than the entire road network, the severity of accidents on motorways show a rather unfavourable picture.

The index of accident density on motorways (accident/100 km) is similar to the average on trunkroads while one-fourth of this value was experienced on the secondary roads.

The relative accident index (accident/10^7 *vehicle km)of the road networks managed by the Road Directorate show a remarkable deviation.

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in 1993: 2.7 to 6.5
(the value was 1.5 for motorways at the same time)

To explore the relationship behind this deviation a more detailed analysis would be necessary to provide a basis for more efficient allocation of funds devoted to improving traffic safety.

The situation has been the worst in the areas managed by Szeged, Debrecen and Nyíregyháza Road Directorates for a couple of years. The values of indices are mainly affected by the traffic load, average daily traffic and the ratio of urban sections within the network. This is underlined by the very unfavourable accident statistics on the Szeged urban section of trunkroad No 5 and road No 43.

3. Measures aiming at transport development in 1994

The funds allocated to national public roads of altogether 30 thousand km length in 1993 and 1994 were as follows (in HUF million):

	Maintenance	Development	Other (institutions, debt service)	Total
1993	8.089	16.572	10.244	34.905
1994	12.000	22.360	12.378	46.738

The development of the motorway network has continued. A link has been established between Motorways M1 and M5 by opening Expressway M0 (by-passing Budapest) to traffic. Its main importance stands at relieving the capital and termination of a TIR route which has prevailed for long years between Towns Komárom, Székesfehérvár, Dunaföldvár and Kecskemét. The completion of the section by-passing Town Győr of Motorway M1 is also of importance from the aspects of environment protection and traffic safety. Currently, the construction of by-passing or relieving sections for six cities are underway.

The completion of two important bridges has been scheduled for this year: the one over River Tisza at Cigánd-Dombóvár and an overpass at Szőlő Street, Orosháza, the latter has been designed to eliminate a black spot. Within a road upgrading program the development of urban sections at Towns Baja and Kaposvár have been nearing completion.

In 1994 three round-about intersections will be completed, six major intersections will be reconstructed, traffic light control will be established for ten locations and altogether 70 intersections will be developed from the considerations of capacity increase or traffic safety. Within one year 89 cycle lanes will be constructed at a total value of HUF 365 million.

4. Measures designed to improve traffic safety

- The amendment to the Traffic Code introduced in 1993 and 1994 exclusively aimed at improving traffic safety. Immediate advantages have been resulted by the introduction of 50 km/h speed limit within built-in areas. The measurements show that the average speed has dropped by 10% and speed distribution has been more homogenous than it used to be before. The efficiency of measures has been improved by the simultaneous and considerable raising of fines, more intensive enforcement by the police and resuming P.R. activity at a higher level. The number of accidents in built-in areas shows a positive trend (see Figures 3 and 4), however, certain increase can be experienced in the first half of 1994.

- From the aspect of safety, the introduction of compulsory daytime use of subdued lights for vehicles has been unevitably a useful measure. Some 80% of the drivers use subdued lights on the national public roads. The efficiency is planned to be further increased by improved P.R. for the foreign drivers and placing warming panels along the Austrian border. Through these measures the risk of accident is intended to be reduced on rural road sections.

- To improve the situation on motorways, the emphasis should be put on operation. Higher average speed calls for higher level of service: primarily in terms of pavement evenness, visibility of traffic engineering facilities both the day and the night time, access to hard shoulder and regular maintenance of the central reservation. The speedways must be reliably ensured against such situations as animal passing, pedestrians' or bikers' movement (either along or across the road) or traffic of slow vehicles. Further black spots are constituted, in general terms, by the end-junctions of motorways: their respective arrangements should be regularly revised. The urban approach sections are often exposed to congestion; the traffic flow is to be continuously monitored and computer-aided traffic control is to be introduced for the most critical bottlenecks. By indicating compulsory speed, the congestions can be avoided or handled without accidents.

- Within the category of expressways, for the so-called "semi-motorways", painting symmetric deviding stripes can be of satisfactory effect up to a capacity use 70-80%. Above this value the number of accidents starts to grow again. This will probably characterize Expressway M0 and trunkroad No 8 being of four traffic lanes: to separate the two directions of traffic flow, concrete barriers of New-Jersey type seem to be advisable. Some countries of advanced motorization also examine cross-sections and intersections which would properly correspond to the category of expressways and provide an unambiguous arrangement for the drivers (see Figure 5).

- On the basis of the advantages of the existing round-about intersections, a new guideline was issued this year. The number of round-abouts to be constructed yearly should be increased. The relatively higher construction costs of such intersections would well return in terms of improved safety and environment protection.

- Various technical tests were conducted addressing improved safety of rail-road level crossings. One of the considerations was to avoid the unnecessary extension of the existing wide range of road signs. Instead of the speed bumps, which seem to be a rather rude intervention, transversal speed reducing lanes (allowed by the previous modification of the Traffic Code) with informatory pavement markings have been proposed. On the completion of the corresponding tests, similar arrangement will foreseeably proposed for the rail crossings.

- The arrangement of urban section at Nyergesújfalu designed with a view to traffic relief and observing the inhabitants' transport demand, has been of great success. On the basis of the same principle and having drawn the lessons from this first project, speed reducing "islands" of this type are under construction within the framework of road rehabilitations at the outer parts of several settlements. This solution will probably be more and more widespread due to the increasing claim for traffic safety and environment protection.

- A separate part of the Road Fund provides for the development of cycle lane network. In addition, joint efforts are made by neighbouring settlements or regions to establish cycle lanes for the most popular routes. On this area the objective of improving traffic safety is also promoted by tourism- and other local business - oriented interests.

- The improvement of traffic safety has been contributed to by the issue of uniform technical guidelines of nationwide application which would encourage uniform practice to be followed in traffic control and traffic engineering by the road managers. An other aim is to support the local governments in their related activity, though our efforts, regrettably, were of little success so far. Last year technical guidelines were prepared regarding the placing of road signs, pavement markings and information panels, the establishment of road links and fuel stations and the development of cycle lanes and their corresponding guiding system. The guidelines of traffic engineering for the local governments were issued jointly by the Ministry of Transport, Communication and Water Management (MTCWM) and the Ministry of Interior.

5. Plans for the future

- The Economic Committee of UN elaborated a modification to the European Treaty on Transport and Traffic Signs, which will serve as a basis for upgrading the Traffic Code and Decree No 20/1984(XII. 21.) by the Ministry of Transport.

- Our intention is to encourage, by professional discussions and continuous monitoring, the experts to adopt the technical guidelines issued in 1993 and 1994.

- Further steps are planned in the direction of diversified speed control which would contribute to environment-friendly and homogenous flow of traffic. The allowed speeds should correspond to the geometrical and visual design of the particular road sections. Together with establishing the Hungarian speedway system the design objectives and cross sections of expressways should be clarified with providing for their future development into motorways. The conditions of qualifying certain separate and upgraded road sections (e.g. trunkroad No 8) as expressways and the impacts of raising speed limit up to 100 km/h on safety should be assessed. The drivers would require allowed speed of 70 km/h on approach sections subject to the intensity of pedestrian and cycle traffic. The road geometry should be adjusted to the speed limit of 50 km/h on urban sections. The European endeavour, "Tempo 30" can only be effective in built-in areas, if the effects of traffic signs are promoted by other facilities of traffic engineering requiring the reduction of speed.

- More details (to be assessed at more locations) are to be learnt about the flow and momentary volume of traffic. The basis for the operation of dynamic traffic control systems would be the automatic traffic counting, forwarding the data to a centre without delay, and the availability of evaluating algorithms for data processing. The saturation of the network on certain road stretches calls for the development of such systems (e.g. MARABU-centre for Expressway M0, urban traffic control centres operating with traffic lights).

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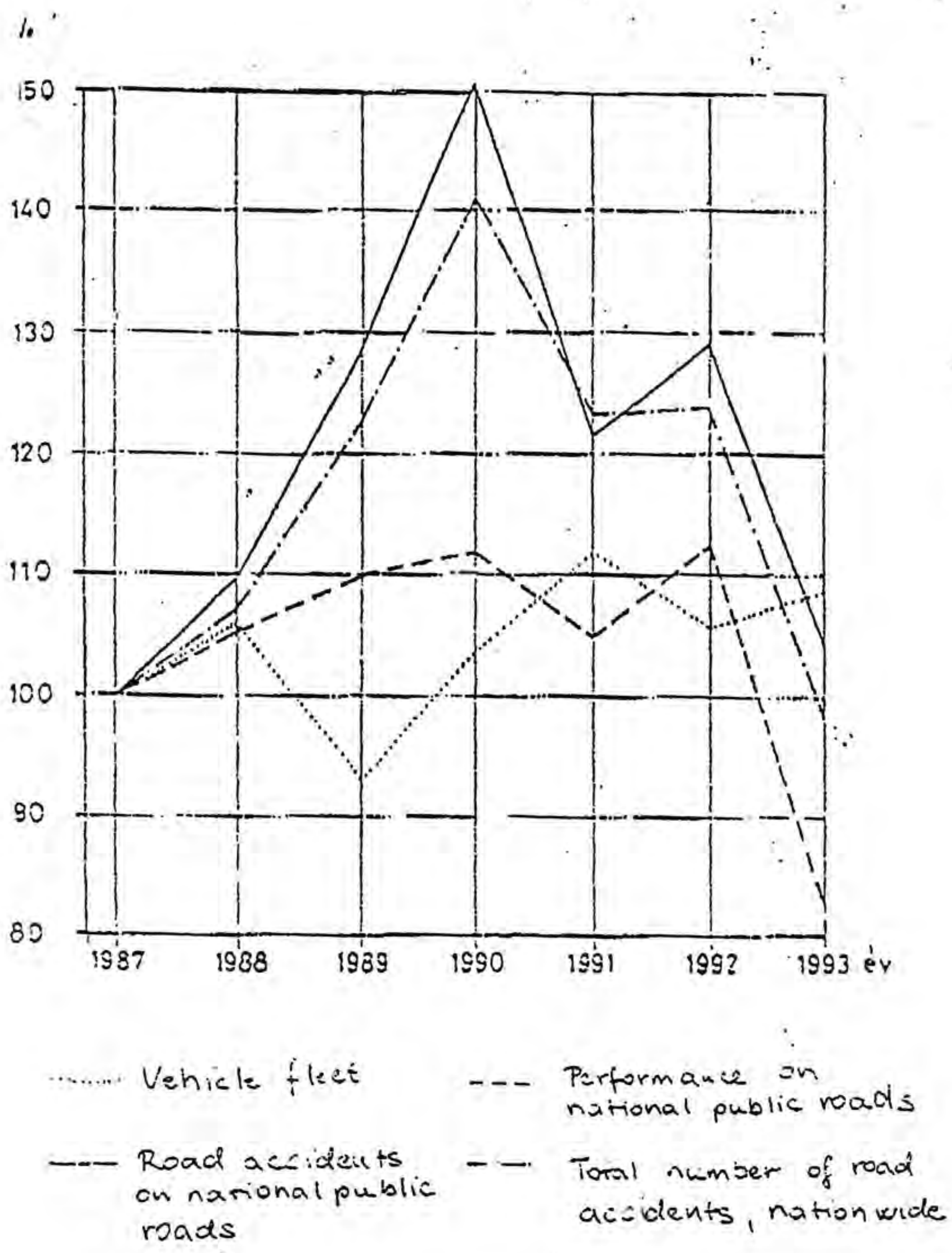
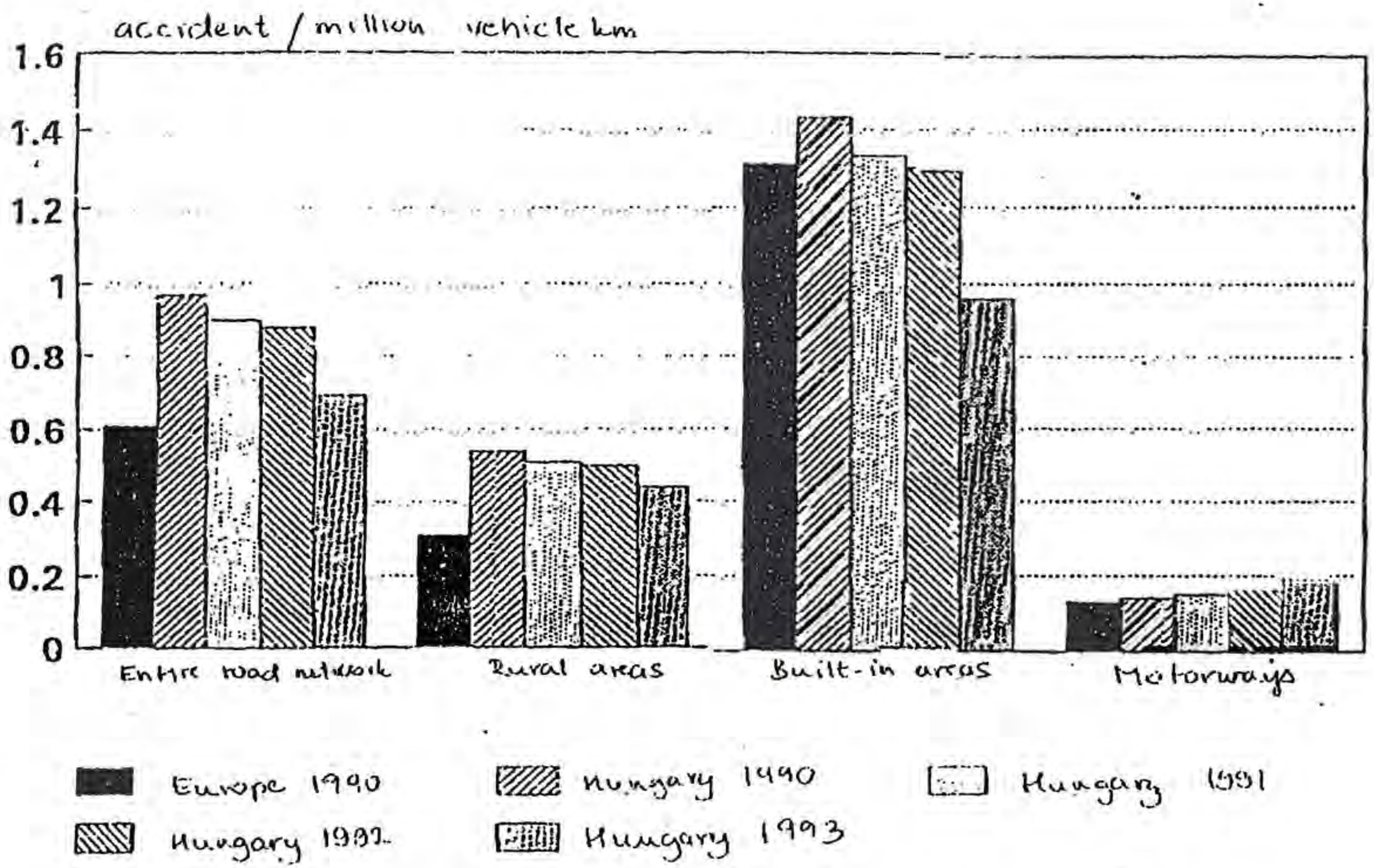
Figure 1



TRENDS

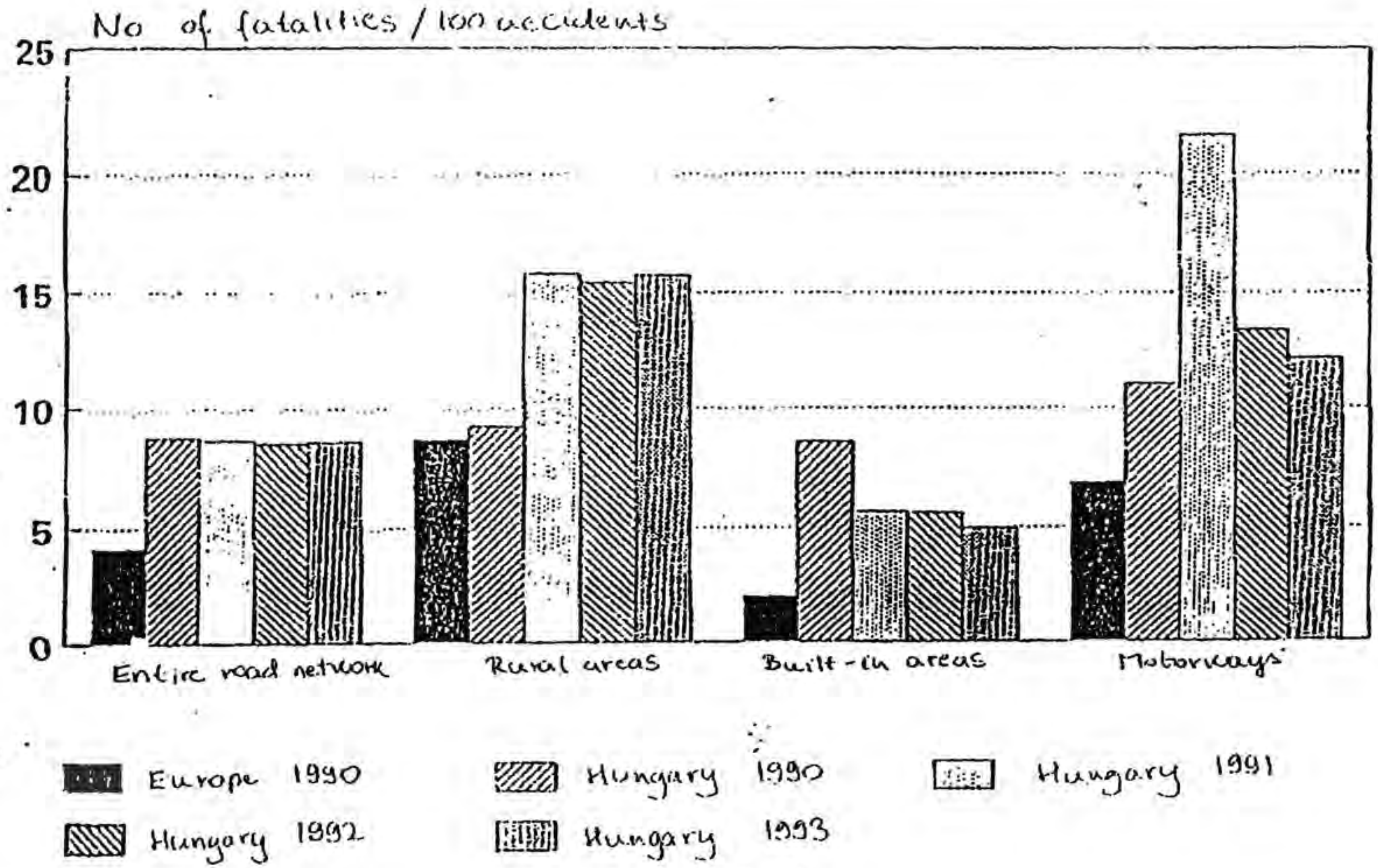
IN THE NUMBER OF ROAD ACCIDENTS, PERFORMANCES, AND THE VEHICLE FLEET AS COMPARED TO 1987

(1987 = 100%)



TRENDS IN THE RISK OF ACCIDENTS IN COMPARISON WITH EUROPE

Figure 2



SEVERITY OF ACCIDENTS IN COMPARISON WITH EUROPE

Figure 3

Monthly number of persons killed in road traffic accidents

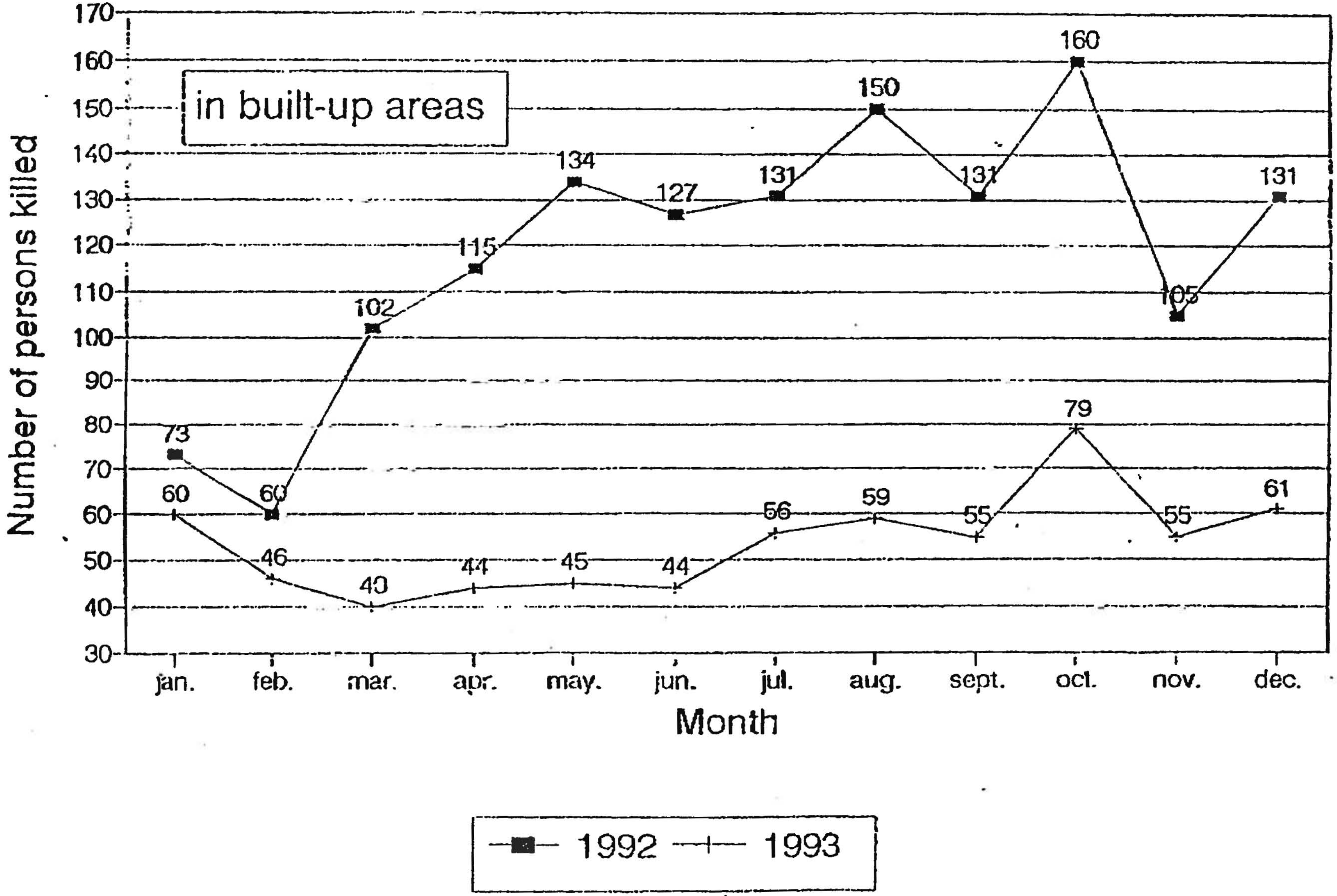
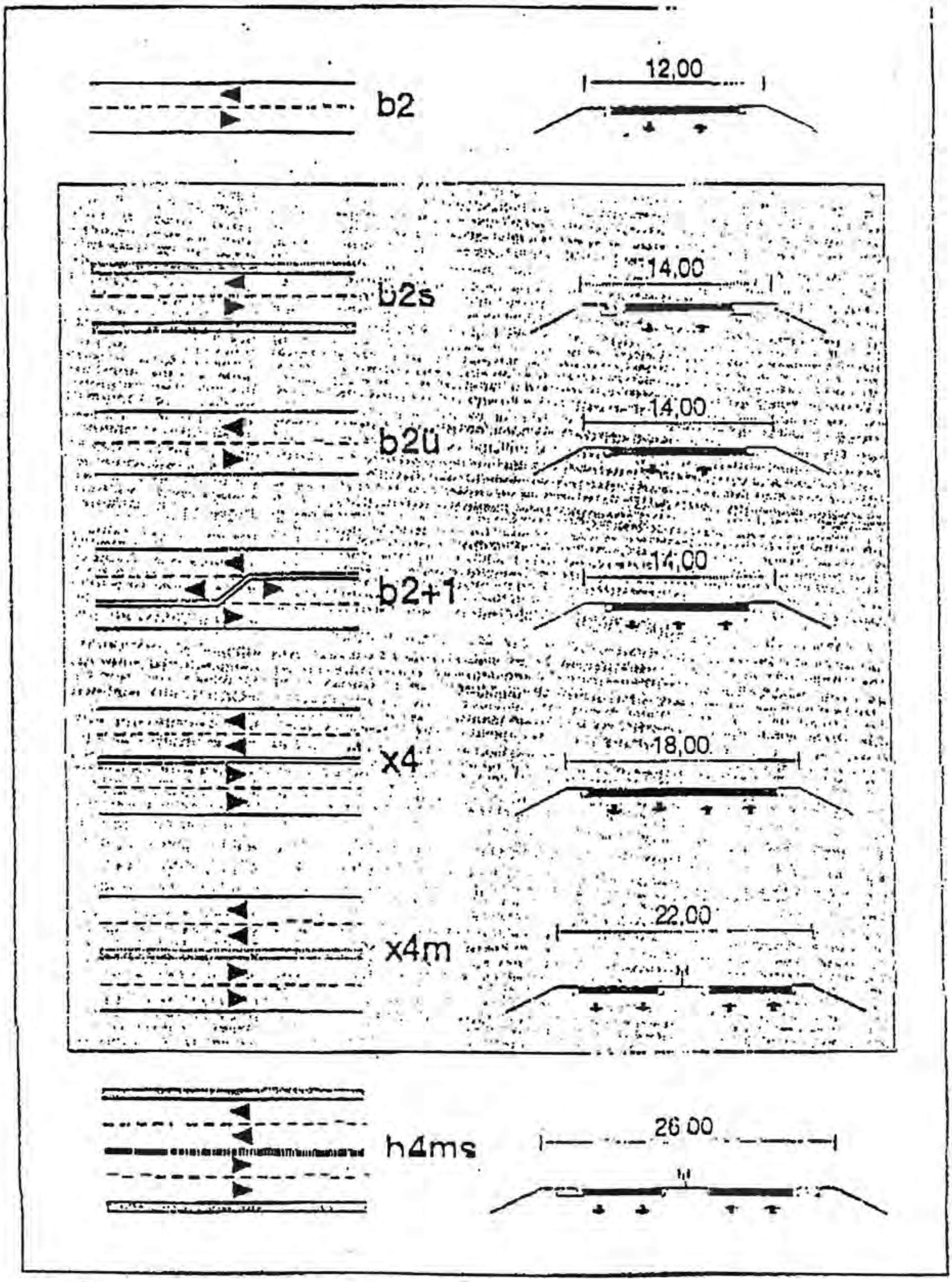


Figure 4

Figure 5



OECD Workshop B3

ROAD SAFETY IN THE SLOVAK REPUBLIK

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Prague, November 15-18, 1994

1) Preface

Road safety is an important issue of major concern in both industrialised countries and countries with economies in transition. In my paper I would like to present an access to the road safety on the road network in Slovakia.

2) General Road Data

Slovakia has a total population of 5.3 million and an area of 49,026 sq.km (approx.108 per sq.km). In Slovakia the road network is devided into

- motorways
- class I,II,III roads
- urban roads and unclassified roads.

Motorways and classified roads create the National Road Network and are owned by the State. The role of the State is to build, operate and maintain the state road network in accordance with transport, planning and enviromental policy.

General Road Data

Type of Road	Length (km)
motorways	198
class I,II,III roads	17,727
international "E" roads	1,390
urban roads	19,300

Density of Road Network

Type of Road	km/1,000 sq.km
motorways	4,03
class I,II,III roads	361,78
urban roads	394,01

Traffic Density (Motorway,Year Average of Daily Densities)

Motorway	1992	1993	1993/1992
D-2	11,948	10,696	0,86
D-2 Lafr.Bridge(Bratislava)	13,528	16,234	1,20
D-61Port Bridge(Bratislava)	31,620	34,782	1,10
D-61Bratislava-Trnava	8,236	9,876	1,20
D-1 Ivachnova-Hybe	5,405	4,355	0,81
D-1 Presov-Budimir	4,377	5,467	1,25

Total Traffic Accidents on the Road Network

Item	1985	1990	90/85
traffic accidents total	26,413	35,213	1,33
- fatalities	455	662	1,45
- serious injuries	1,760	2,469	1,40
- light injuries	5,883	8,165	1,39
damages (million CSK)	124,5	197,7	1,59

Number of Vehicles (1990):

passenger cars.......	895,550
trucks..............	69,107
special cars.........	53,137
buses...............	14,301
tractors............	67,056
Total....	1,099 mill.

3) Traffic Safetv

At present in Slovakia traffic accidents number more than 50,000 per year. Approximately 1/4 of them involves injuries to persons. Accidents on roads increase the number of disabled persons partly or entirely incapacitated for work.

In the field of traffic safety the efford is necessarily directed towards reducing the absolute number of traffic accidents as well as alleviating the severity of their impact. The goal can be achieved only by productive cooperation and harmonization among road users, decision-makers and road authorities.

In 1994 the Road Institute (UCHD Bratislava) elaborated the handbook dealing with basic approach to the road accident registration representing the base for a determination of dangerous sections on the road under investigation. The basic activities are as follows:

- *road accident registration*
- *road accident evaluation (damages)*
- *steps to be done for removal of the accident cause*
- *financial evaluation of steps mentioned above*

The accident data base, kept by the Police Traffic Board, provide information on all accidents registred by the police and involving personal injury. The accident data are recorded on computer and can thus be edited and sorted by various criteria.

The main goal in the evaluation of road accidents is to select dangerous points and sections on a road. Following criteria have been accepted to determine the critical accidental section:

motorway - more than 3 accidents/250m/year
road - more than 6 accidents/500m/year

The results of the traffic accident evaluation create the base in practical application of preventing accidents and ensuring that traffic needs are satisfied to an optimum and acceptable extent. The activities leading to the improvement of the traffic safety can be devided into three groups:

- *immediate measures (for example: speed reduction, warning traffic signs etc.)*
- *short-time measures (for example: extent of road, additional traffic lane, separated lane for cyclists, redesign of dangerous section etc.)*
- *long-time measures (by-passes, interchanges, cooperation between road authorities and decision-makers etc.)*

4) *Enviromental Protection*

Ecological considerations are very important factors in the design and construction of roads. In the form of an Enviromental Impact Study each new road design has to be investigated and approved /Slovak National Council Law No. 127/94/. When protection requirements demand engineering structures, the preffered solution is to provide them in the form of landscaped walls or noice barriers in parallel to the road

With regard to existing roads, more emphasis is to be placed on the collection and controlled drainage of surface water and the protection of potable water and groundwater reserves.

5) *Outlook*

The only factor than we can be reasonably certain of is that traffic will continue to grow. Recent forecasts of future mobility and traffic predict that passenger traffic will grow by up to 60 percent by 2010 in developed countries. In CEEC countries the percent of traffic increase is expected to grow much more.

It is essential to continue the activities described in this report in all fields of road traffic. They include improvements in automotive engineering, road layout and routing, behaviour of road users, road operation and administration etc.

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OECD WORKSHOP
"INFRASTRUCTURE DESIGN AND ROAD SAFETY"

Prague, November 15 - 18, 1994

Josef Mikulik
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PRESENTATION OF ROAD SAFETY PROBLEMS IN THE CZECH REPUBLIC

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1. General overview

Accident results in 1993 in the Czech Republic :

- 152 157 accidents
- 1 355 fatalities (24 h)
- 5 629 serious injuries
- 26 821 slight injuries,

are the worst during the last 20 years.

The long term development shows the enormous increase of accidents and their consequences after 1987. This increase is similar to the changes in the end of 60's. If we compare the development of motorisation and fatalities (as a representative figure of accidents) shown in Fig.1, we can see the direct relation to the czech historical years - 1968 and 1989.

The development of the road unsafety reflects very clearly all the economical, social, and political changes in our society. Generally, in this relation we can find the main explanation of the present bad state of safety not only in our country, but also in the other CEE countries.

Since 1987 (in this year we achieved the safety level comparable with the most developed countries) untill 1993 were the accidents numbers almost doubled (Fig.2). Within this period motorisation was increased only by 26%. It means, that the influence of society changes, mentioned above, is very significant. Sorry to have to say, but the numbers for the ten months of 1994 are higher than the ones in 1993.

A hope for solution:
In 1990 was established by the Czech governmant the "Czech Governmantal Council for Road Safety". This body, in which are representatives of the ministries and organisations involved in road safety, should coordinate and initiate all safety activities. On the level of this council was agreed the "System program of road safety increase", which indicates the main activity directions.
The Ministry of Transport, which is responsible for the safety activities connected with roads, contracted Transport Research Center to elaborate an "Action plan". This action plan based on the " System program " will precise the concret steps and their priorities for safety improvement on roads.

2. Location of accidents

Most of accidents (74,2 %) happened on the roads in built - up areas, what is almost the same like in 1987. In the contrary, the rate of the most serious conseqences on the road outside built - up areas increased from 48 % to 53 %. In numbers it means, that in built - up areas each 178th accident ends with a fatality, meanwhile outside built - up areas each 57th.

Location of accidents and their relations according to the road clasification indicates the following table.

	motorways	roads of ... class		
		1st	2nd	3rd
number of accidents	2683	29031	20724	15345
number of fatalities	46	454	311	208
number of injuries	421	8001	6558	5068
lenght [km]	389,6	6493	14344	34719
vehicle km [10^9]	2,1	12,3	7,9	5,0
ac./100 km	688	447	144	44
fat./100 km	11,8	7,0	2.2	0,6
inj./100 km	108	123	46	15
ac./veh km	1,3	2,4	2,6	3,0
fat./veh km	0,02	0,04	0,04	0,04
inj./veh km	0,2	0,7	0,8	1,0
ac./fat.	58	64	67	74
inj./fat.	9,2	17,6	21,1	24,4

Tab.1: Accidents characteristcs according to road clasification

These numbers confirm as to the vehicle kilometrage the high safety of design parameters of motorways. The worse they are, the higher the risk is to be expected.

On the other side, the high density of accidents on the motorways and the roads of the 1st class means the necessity of the carefull choice of suitable measures. The higher severity of accidents on these roads is closely connected with the higher traffic speed. A reevaluation of the speed limits and the strict enforcement of their obeying would be necessary.

The influence of speed is also possible to follow in the break - down of accidents and their consequences according to their places.

	number of		
	accidents	fatalities	injuries
straight stretch	73155	705	13683
curve or shortly behind it	30679	417	8981
junction	36748	204	8967

Tab. 2: Places of accidents

The main cause of accidents in curves or shortly behind them is speeding (62,8 %).

The high frequency of accidents and injuries on junctions should be an impuls for improving their design parameters and signing, too.

There are three fundamental design standards in our country as follows:

- for motorways and highways outside built-up areas,
- for roads in built-up areas,
- for junctions.

All of them are revised in present time.

3. Accident causes

In the accident statistic are registrated 66 diferent causes of accidents. The break - down of the most frequent according to the road classification is demonstrated in the following table (procentage from all accidents caused by driver).

According to the statistics, 90,5 % of accidents are caused by drivers.

	motorways	roads of ... class		
		1st	2nd	3rd
unsufficient attention to driving	42,5	10,6	11,8	11,7
speeding in accordance to surface conditions	16,7	13,0	14,4	14,2
not keeping safe distance	13,3	22,3	10,1	4,6
driving in oposite direction	0,3	3,4	5,3	8,7
speeding in accordance to design parameters	0,2	5,9	10,6	16,1
not giving way	0,1	6,8	7,5	6,6

Tab.3 : Main causes of accidents

The overview shown above confirms very clear relation between causes of accidents and technical parameters of roads, and enables to find the suitable and efficient measures for safety improving.

Almost a half of accidents on motorways is caused by the "borring way of driving", and in the connection with the high speeds it leads to serious consequences.

As worse are the design parameters of roads, that higher is share of accidents caused by speeding in accordance to design parameters and driving in oposite direction.

Practically the same share of accidents caused by speeding in accordance to the surface conditions (wet, icy, muddy) is not only a problem of driver's behaviour, and of course, of ipmrovement of their education and skills, but also of the better care of road administrators for the maintance of carriageways.

4. Vulnerable road users

In accidents in 1993 there were killed 335 pedestrians and 122 cyclists, injured 5810 pedestrians and 4457 cyclists.

Break-down of these consequences according to their locations and the share from the whole numbers is indicated in the following table and in appendix.

	pedestrians				cyclists			
	fatalities		injuries		fatalities		injuries	
	Nr.	%	Nr.	%	Nr.	%	Nr.	%
built-up areas	233	41	5253	26	70	11	3503	17
outside built-up areas	102	13	557	5	52	9	954	8

Tab.4: Consequnces of vulnerable road users accidents

These tragic numbers, one of the worst in Europe, are the results of the unsufficient road infrastructure in our country on one side, and of irresponsible behaviour of vehicle drivers on the other side.

The problem of cyclists accidents is much worse, if we take in account relativly low frequency of cyclists traffic on our roads.

Still in this year will be published by the Transport Research Center (contracted by the Ministry of Transport) a guide book dealing with promoting of cyclist traffic and planing, and constructing its infrastructure.

5. Signing and marking of roads

To anybody of us is clear the importance of road signing and marking for road safety.

It is very difficult to expres exactly how many accidents were caused by an unsuffiecient, wrong or even missing road signing and marking. Practically each black spot we've invastigated had these failures.

To give only a general impression, we have evaluated from the accident statictics, that more then 17% of all accidents were caused by not obeying the road signing.

Our institute , on behalf of the Ministery of Transportation, is already for long time invlolved in the solution program of this problem. In this year will be published the guideline for marking of work zones on roads. An elaboration of guidelines for usage of marking and signing on roads is running and will be published in 1995. In 1995 will also start the preparation of guidelines for orientation road signing.

6. Roadside safety

The safe road conditions are influenced also by the space next to roads. The main problems in this case in our country are rigid obstacles - especially trees along the roads. The fact is, that the tree alleys are representing the "picture " of our country. On the other side this kind of accidents has very serious consequences. The severity of crashes from 1993 is documentated in the table Nr.5.

This table is the proof that the crashes with rigid obstacles are really a serious problem. The share of these accidents is 16.6% of all accidents, but the share of fatalities is 26.9% !!

crashes with	number of		accidents / fatal.
	accidents	fatalities	
train	332	50	7
pedestrian	5953	330	18
rigid obstacle	25258	364	69
going vehicle	72730	444	164
animal	2559	5	512
one car accident	4274	8	534
standing vehicle	24752	33	750
tram	1168	1	1168

Tab.5: Severity order of crashes

7. Black spots

The accident statistic in the Czech Republic shows that 40% of accidents happen on 3% of lenght of roads - on the black spots.

Long term investigation of these places, testing different measures and practical solutions made by our institute shows, that mostly by using very small costs there can be achieved very good results. The most important condition is to make the throughout analysis of infrastucture, traffic, and accident circumstances resulting in the knowledge of the real causes of accidents.

Just now we are finishig the first part of guidelines for solving of black spots, dealing with indentification and analysis of black spots. The second part, which will bring the practical measure suggestions, is going to work out with SWOV, to utilize the experiences of other countries.

8. Economical backgrounds

The last one, but also the most important problem is, that all safety improvements need money to realize them.

From this point of view there is necessary to asses the accident costs to make possible :

- evaluation of costs caused by accidents for society

- to prove the effects of road safety improvements.

To promote these two points, BESIP contracted with our institute to elaborate the cost of accident consequences. We took in account:

a) direct cost : - health care
- material damages

b) indirect cost : - insurence
- social reimbercement
- police
- court
- production losts

From the evaluation of these items we've calculated the lost of accident consequences as follows:

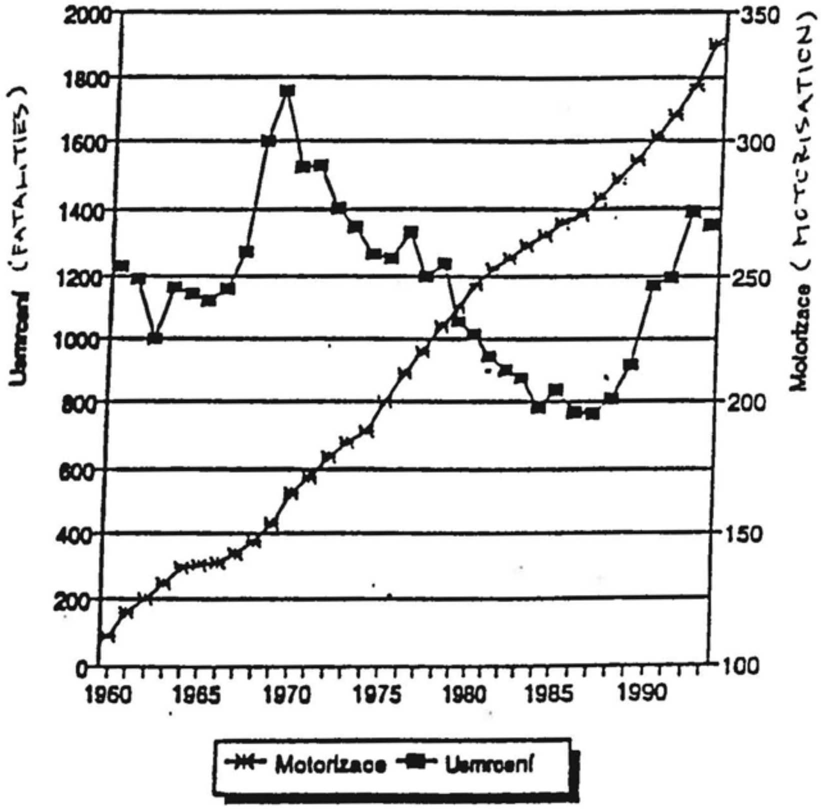
- fatality	3.493.000 Kč
- serious injury	1.126.000 Kč
- slight injury	93.000 Kč.

On the base of these results we found the total costs caused by accidents in 1993:

17.615 mil Kč

We hope that this number could be an impuls for road safety investments...

FIG. 1



Obr. 1: Vývoj motorizace a počtu smrtelných následků nehod

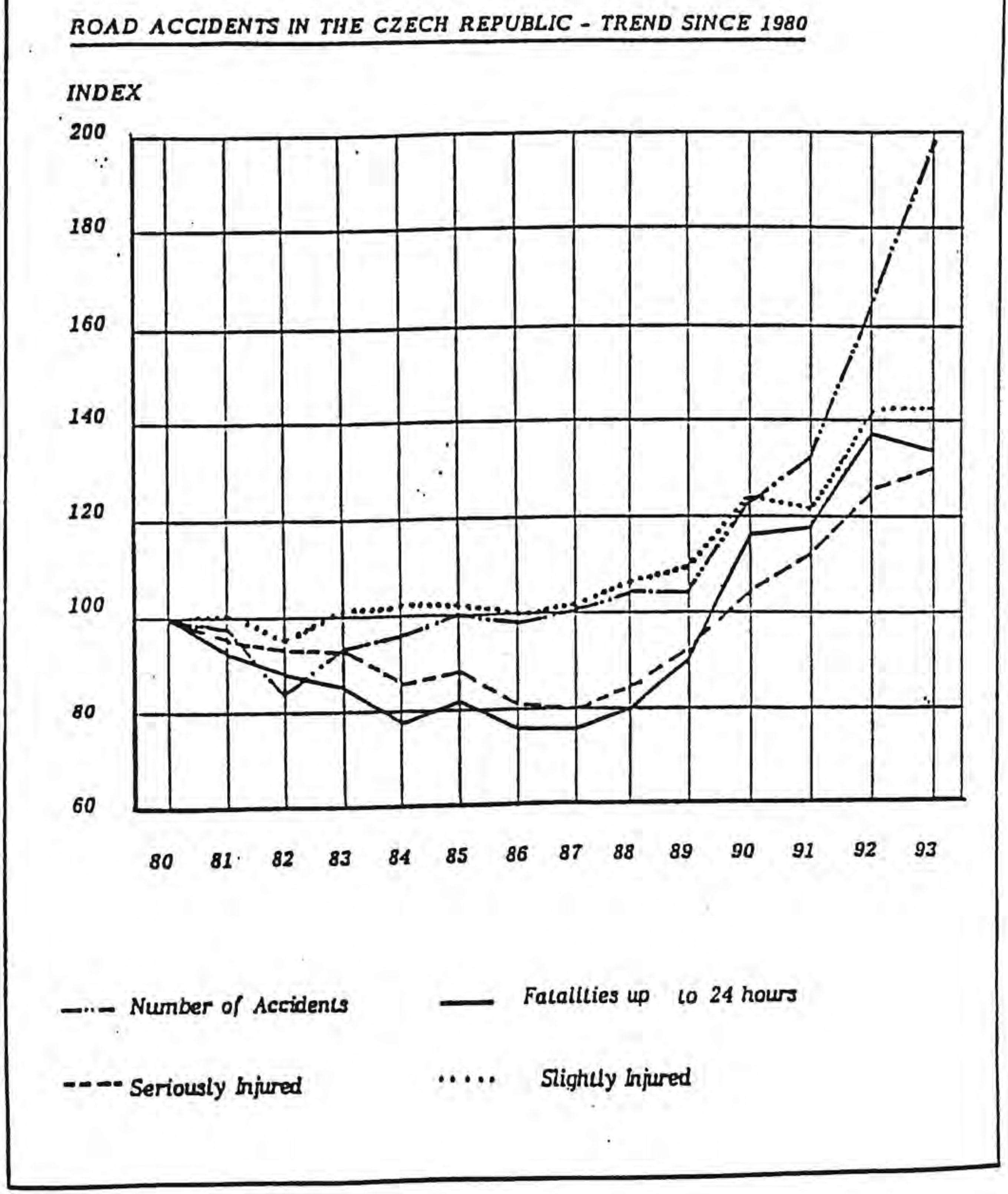
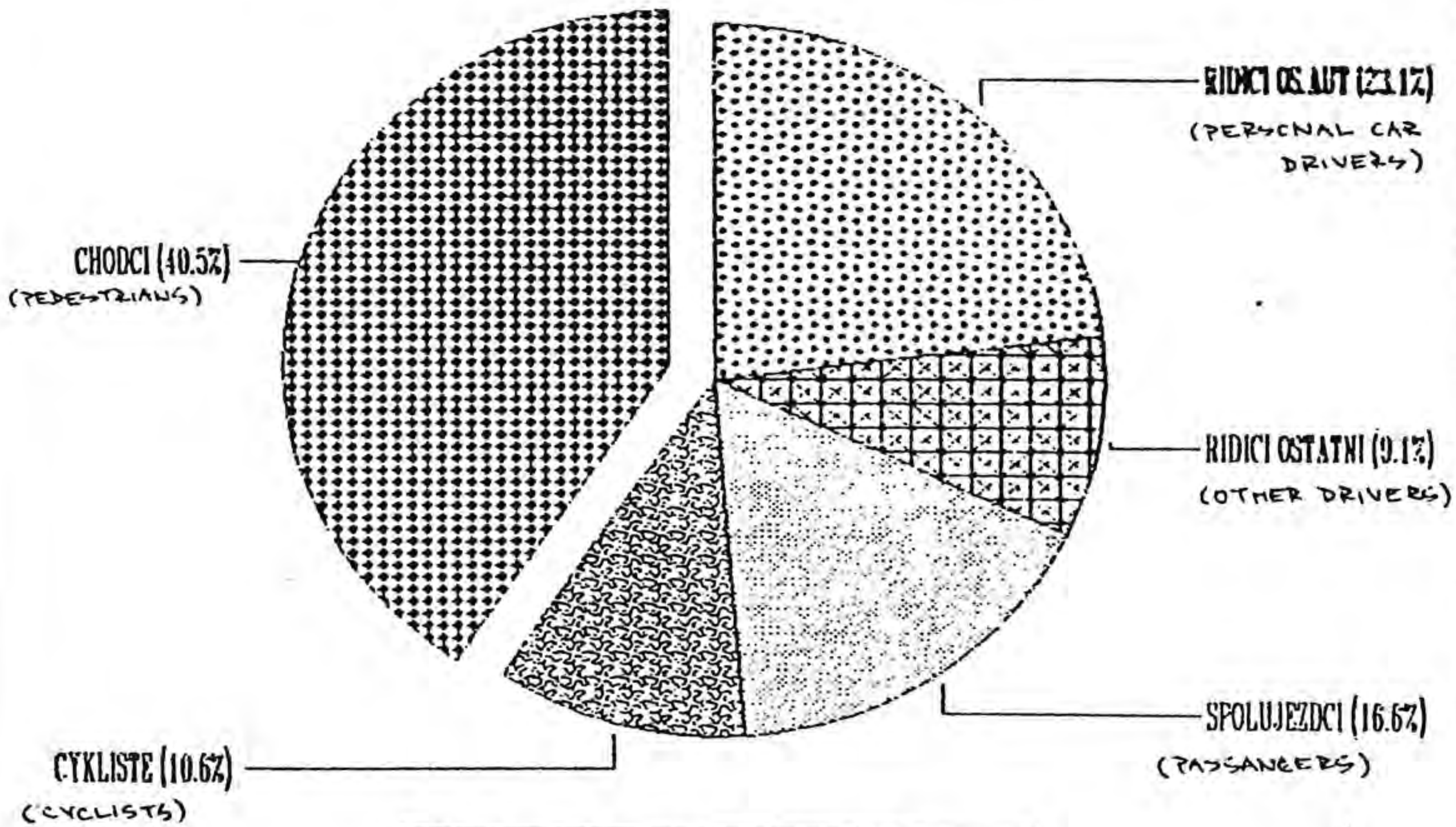

ROAD ACCIDENTS IN THE CZECH REPUBLIC - TREND SINCE 1980
INDEX
200
180
160
140
120
100
80
60
80
81
82
83
84
85
86
87
88
89
90
91
92
93
Number of Accidents
Fatalities up to 24 hours
Seriously Injured
Slightly Injured

FIG. 3

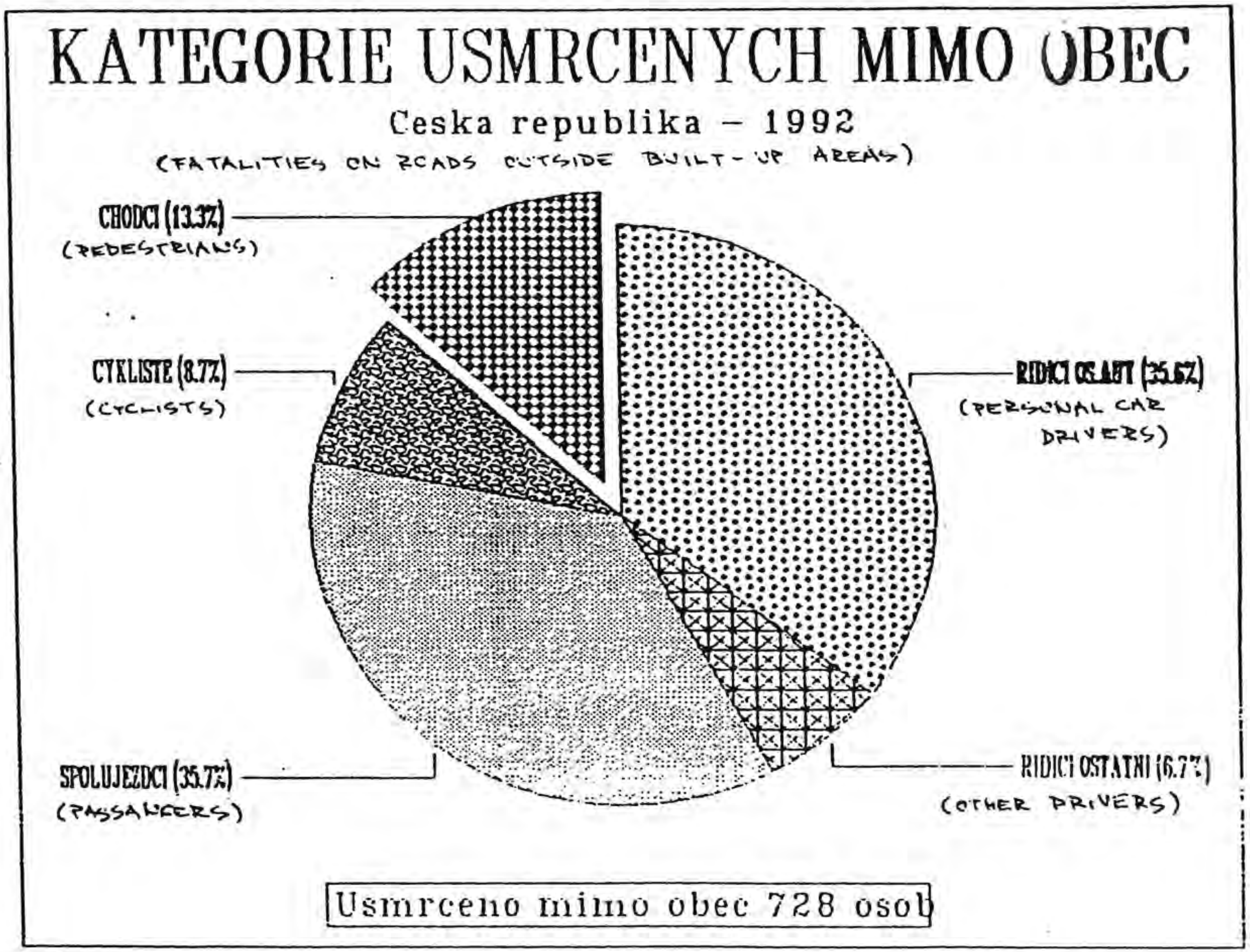
KATEGORIE USMRCENYCH V OBCI

Ceska republika – 1992

(FATALITIES ON ROADS IN BUILT-UP AREAS)



Usmrceno v obci 667 osob


KATEGORIE USMRCENYCH MIMO OBEC
Ceska republika - 1992
(FATALITIES ON ROADS OUTSIDE BUILT-UP AREAS)
CHODCI (13.3%)
(PEDESTRIANS)
CYKLISTE (8.7%)
(CYCLISTS)
SPOLUJEZDCI (35.7%)
(PASSANGERS)
RIDICI OS.AUT (35.6%)
(PERSONAL CAR DRIVERS)
RIDICI OSTATNI (6.7%)
(OTHER DRIVERS)
Usmrceno mimo obec 728 osob

Road Fund Administration of the Czech Republic

is engaged in sector of traffic safety namely in:

I. Traffic accident analysis from the point of view of the impact both of road design and of maintenance on safety.
II. Proposals for remedial measures
1) short-term or immediate solution
2) long-term solution
III. Other activities

I. Accident analysis

1) Accident analysis being subdivided according to territorial administrative structure as well as to importance of roads is made on annual basis. The consequences of traffic accidents are further grouped to units according to the structural elements of roads and of defaults both in terms of their structure and/or maintenance. In addition to severity of accidents, also the concentration of accidents and relative accident rate are recorded, i.e. relation of occurence of traffic accidents to road section length, traffic volume or traffic performance.

2) In addition to annual monitoring of the road network in total, accident analysis is made on the basis of topical requirements, also for limited areas or for selected roads.

3) A list of accident blackspots is regularly being compiled to serve as a basis for assessement of order of urgency for improvements. It is also used for fixing volumes of funds required to carry out remedial measures on such spots aiming at increasing traffic safety.

4) Further on, summaries or other types of accident analyses are made on individual requests for assessement of existing roads (rehabilitation, improvements) and of road projects proposed for implementation.

II. Proposals for safety measures

1) short-term or immediate solution

This type of solution concerns first analysis elaboration without delay and selection of optimum solutions on spots where a sudden or dangerous growth of number of traffic accidents with serious consequences has occured.

2) Long-term decision making

This kind of proposals involves more complicated and more expensive solutions. They are either less urgent, or they require a broader and more comprehensive approach taking into account the whole local or traffic context in view of the general outlook.

III. Within the scope of traffic safety research, various research projects are carried out or contributed to.

Traffic security control on the highways of the Ukraine by refinement of way terms

Zabyshny A.S.
Kiev State Highways Scientific-Research Institute (SHSRI), Ukraine.

Ukrainian State Corporation on constraction, repairing and well-maintaining of automotive highways much attention gives to the security of highway traffic both under working out of design solutions and under service of well-maintaining of highways.
In Kiev State Highway Scientific-Research Institute (SHSRI), that belongs to the Corporation, was worked out the system of traffic security control by refinement of way terms.
This system cover such list of scientific-applied works:

- analysis of kilometer distributions of way-transport occasions (WTO) on the concrete highway for detection of the localities and places their concentration by the special worked out compound criterion;
- observation of detected localities and places of the concentration of WTO on the highway and installation of the lacks of way terms;
- development of compound actions for the improvement or way terms directed on the raising of traffic security and their realization by highway organisations.

The compound criterion includes a quantity of WTO that occured on the concrete way's kilometers during the latest three years, factual and calculated hedge of intensivities of the traffic and coefficients of the occasions.
On the ground of these results it was stated, by the carried out investigations of factual kilometer distributions of WTO along the length of highways with the appication of probabilistic methods, that unsatisfactively terms are the ways such that respect to the criterion:

$$m >= 4\ WTO;\ t = 3\ Years;\ N_Д = N_М < N_p;\ П_Д = П_М > 0.4, \quad (1)$$

where:
M - is a quantity (level) of WTO, that occureed during the latest 3 years on observed kilometers;
t - is a period of analysis of the kilometer distributions of WTO (years);
$N_Д$, N_M - are the factual mean-years intensivity of traffic on the localities and places concentration of WTO respectively (auto/day);
N_p - is a hedge of the mean-year intensivity of traffic with level m of WTO and
$П_Д = П_M - 0.4$ (auto/day);

$П_Д$, $П_M$ are the coefficients or occasions on the localities and places of concentration of the WTO respectively:

$$П_Д = \frac{10^6\ m}{365\ .\ t\ N_M\ 1} \quad (2)$$

where l is a length of the way's locality that is equals to 1 km,

$$П_M = \frac{10^6\ m}{365\ .\ t\ N_M} \quad (3)$$

$$N_p = \frac{10^6\ m}{365\ .\ t\ П_Д\ 1} \quad (4)$$

$$N_M = \frac{10^6\ m}{365\ .\ t\ п_M} \qquad (5)$$

In connection with these facts by localities of concentration we mean the kilometers of highways where during the latest years, the quantities of WTO are equal to 4 and more, and value the occasion's coefficient is more 0.4 as intensivity of traffic is less then hedg, that is the condition (1) is true.
Localities of the concentration of WTO are the cross-roads and adjoined ways in one level, steep ascents and descents, curves in the plan of a small radions, ground pedestrian crossing, railway crossings, that are guarded and aren't guarded, artificial buildings, stands for stopping and parking of cars, bus stops, and other elements of ways or their related combinations of unimportant (insignifant) stretches as conditions (1) satisfied.
Of long standing practice of work for refinement of way terms on the localitics and places of the concentration of WTO has confirmed the high effectivity of carried out system of traffic security control on the highways of common usage of the Ukraine, that belongs to above-mentioned Corporation. In fact, under carring out of compound worked out measure the WTO and heavity of their consequenses are decreased to the random distributed value that don't exceed the levels 0-3 WTO during three years from the beginning of carring out of the first measure, Concentration of WTO are practically vanished.
It's easy to estimate the increasing of the traffic security on the localities and of the concentration of WTO on the hase of quantity of WTO by the method "to and after". It's the result of improvement of the way terms by the worked out compound measures:

$$\Delta = \frac{\sum_{1-1}^{n} Z_Д - \sum_{1-1}^{n} Z_п}{\sum_{1-1}^{n} Z_Д}\ .\ 100 \qquad (6)$$

Where
Δ - is an index of the increasing of traffic security by refinement of way terms, in percents;

$\sum_{1-1}^{n} Z_Д$ - is a summary quantity of WTO on the localities and places their concentration during the latest three years until fulfilment of compound worked out measures by increasing of traffic security;

$\sum_{1-1}^{n} Z_п$ - is a summary quantity of WTO on the localities and places their concentration during the successive three years from the beginning of fulfilment of the first measure;

$1 = \overline{1\ ,\ N}$ - is a quantity of localities and places of concentration of WTO.

Three-years period stated by investigation to affer carring out of compound measures on increasing of traffic security is necessary and sufficient a minimal period that show the conformity to natural laws of factual diistributions of WTO.
Dependance (6) allows to carry out an estimation of the increasing of traffic security on the

individual localities and places of concentration of the WTO by their sum on the concrete highways and set of highways.
Practic usage of the system of traffic security control is especially profitable and effective if the material-financial resourses that hand over repairing and well-maintaining of highways are limited.
It's connected with purposeful increasing of the traffic highway security by the improvement of way terms on the localities and places of the concentration of WTO where a way terms do not sastisfy to the requirements of bully formed traffic in the guaranice of it security.

MINISTRY OF TRANSPORT OF THE REPUBLIC OF LATVIA
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In Latvia with its territory of 64 thousand square kilometres there are 20538 kilometres of state highways. 7894 km or 38,4% of these roads are with black pavement. The state road network according to the importance of the roads is divided into main state roads (1568 km), 1st class roads (5521 km) and 2nd class roads. State roads are supervised by the Ministry of Transportation of the Republic of Latvia. which carries out maintenance, repairs and reconstruction of roads in the limits of allocated financial resources. The management and maintenance of state roads is carried out by 26 local road administrations, one in each administrative district.

The usage, management and preservation of roads is determined by the law "On roads".

In addition there are approximately 40 thousand kilometres of roads under the jurisdiction of rural municipalities and other owners. 40% of the total length of rural roads are in bad condition. The problem of organizational principles of the maintenance and development as well as the financing system of these roads still is not solved in the government level.

Regarding the quantitative characteristics Latvian road network fully satisfies the needs of the national economy. Regarding the widening of road network (construction of new roads) only the construction of city bypasses or the completion of earlier started objects is possible.

For the present the main problem is the improvement of qualitative characteristics of the state road network - the guaranteeing of the comfort, safety and continuity of the traffic. In order to achieve these characteristics following activities are carried out:

1. road maintenance in summer and winter including necessary renewal and modernizing of technical means of traffic regulation;

2. normative repairs of road pavement;

3. reconstruction of separate road section according to traffic intensity.

Unfortunately due to the crisis of national economy since 1991, the financing of road sector from state budget is more than insufficient and in 1994 it is 10% the minimal necessary amount. Recently the rehabilitation of leveling course (normative repair) is fully stopped. The amount of maintenance works such as pothole patching on black pavements. surface treatment, grading of gravel and crushed stone pavements, reestablishing of road signs and winter road maintenance. as well as traffic safety improvement activities are reduced considerably.

If the finances for routine and periodic road maintenance are not be found, the consequences will be catastrophic.

Authorities of Ministry of Transportation and road branch actively are working in the procurement of credits for the rehabilitation of black pavements and the implementation of wet salt technology in winter road maintenance in the regions with intensive traffic. We hope that these activities will improve the condition of roads at least a little.

In the past the questions of road traffic safety were solved only by the Ministry of Internal Affairs. For the present the Ministry of Internal Affairs is dealing with the supervision and regulation of traffic.

All other matters starting with the working out of legislative acts, training of drivers, vehicle registration and annual technical inspection, are solved by the Road Traffic Safety ~~Administration~~. Directorate

New vehicle registration numbers, which answer the requirements of European Union, are implemented in Latvia.

For the present the change of driver licenses is going on in Latvia. New licenses fully answer the requirements of 2nd Directive of European Union.

The work of road supervision is carried out by controlling the condition of road pavement and supplementary structures, as well as the conformity to the normative requirements.

The design documentation is being checked very seriously in order to answer all requirements of traffic safety after the completion of construction works.

The system of recording and analysis of road traffic accidents is improved. The results of analysis are published in the newspapers and broadcasted in TV and radio. Accident data are also used in the informing of the parliament and government about the bad situation in the terms of number and gravity of road traffic accidents.

Since ~~January~~ 1, 1994. the law "On Road Traffic" is effective. It has determined the legal framework of road traffic, and described the structure of the road traffic management. In the law there are provided general regulations of traffic safety, procedure of vehicle registration and defined the rights and duties of road traffic participants as well as other questions connected with the road traffic.

The working out of Latvian Road Traffic Regulations has come to the last phase. The principles of these regulation have not been changed but details are more practical and answer the requirements of leading European countries.

I hope that this brief report has shown to the audience the willingness of Latvia to go further in the improvement of traffic safety.

TECHNICAL CENTER OF ESTONIAN ROADS

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Road Safety in Estonia.

Estonia is located in north-eastern Europe, on the eastern shore of the Baltic Sea. It is bounded on north by Finland on the Gulf of Finland, on east by Russia on the opposite shore of Lake Peipsi, on south by Latvia and on west by Sweden west of the Baltic Sea. The area is 45215 sq. km and population ca 1,6 million. Estonia is the smallest one of the Baltic States, it is still larger than Holland or Denmark. The distance across east ta west is 400 km and north to south 300 km. The average elevation is only 50 m. There are over 1000 lakes, Lake Peipsi is one of the largest in Europe.

The Republic of Estonia was declared on Feb. 24,1918. Estonia is divided into 15 counties, all the counties have 10-18 communes. Tallinn's, the capital of the Republic of Estonia, population is 446,000.

Estonia has a public road network of 14,77[illegible] km. There are 1,190 km main roads, 2,6[illegible] km basic roads and 10,957 km local roads. Other roads (non Estonian Road Administration) constitutes the major part of the road network (28357 km of totally 4312[illegible] km). Number of bridges and viaducts on public roads are 827. Total length of bridgis and viaducts are 19,105 m. Only 54 % of the roads have a pavement (8,056 km). The most important highways are between Tallinn - Narva, Tallinn - Tartu and Tallinn - Pärnu (Via Baltica). The Via Baltica is a north-south transport corridor through the Baltic countries connecting them, to Finland in the north and to

Poland in the south, and then further to Central Europe. The route (193 km in Estonia) serves traffic in and between the Baltic countries and provides a new connection between north--eastern and Central Europe.

The speed limit in urban areas is 50 km/h, on roads 90 km/h and on motorways up to 110 km/h in summer.

The road traffic situation in the republic is bad. The road safety situation was stable until 1988, although even then the accident risk was much higher and the level of motorization lower in Estonia than in West Countries. After 1988 the situation began to deteriorate and the number of casualties increased rapidly. The worst year in the region was 1991. At the same time, the level of motorization increased sharply in the country. The increase in the accident rate and in the level of motorization is shown on the figure 1.

The road safety situation changed dramatically under the pressure of the socio-political upheavals that effected Eastern Europe in the late 1980 s and early 1990 s. At the same time contatcts with Western neighbours made people possible to import new or second hand cars. As a result the motorization level started to rise (fig. 2) In this situation, some of drivers, especially young ones and owners of expensive new western cars, seem to associate personal freedom with indifference to limits and rules and some of them , drive very aggressively. On the other hand the behaviour of part of pedestrians and bicyclists is unresponsible. Drunken driving and a very aggressive way of driving have become a real problem specially during a few last years. As elsewhere, speeding and faulty driving are a common cause of fatal accidents.

Even the traffic legislation has been unsatisfactory, but it is in progress. The teaching of road safety at schools is, however, unsatisfactory.

The road network in the three Baltic republics is relatively dense (fig. 3), but it has not been maintained sufficiently. Economic difficulties are responsible for the cut in road investments and maintenance. Most of the surfaces on main roads are in need of repair. Average age of main and basic roads are 15,7 years (01.01.92).

Money for roads in various countries:

1. Germany	(1993)	-	560.000 EEK/km
2. Denmark	(1992)	-	344.000 EEK/km
3. Spain	(1992)	-	307.000 EEK/km
4. Sweden	(1993)	-	164,000 EEK/km
5. Finland	(1993)	-	164.000 EEK/km
6. Estonia	(1993)	-	12.800 EEK/km
	(1994)	-	17.800 EEK/km

In Estonia long term safety plans have been done already. In practice this plan have been a list of countermeasure without real financing and action plans.

To make a good traffic safety program, it must be based on the state wide safety goal.

To change the goal into action plans for traffic safety organizations, a state wide action plan is needed. In the action plan is decided which are the main parts of the safety work during a few next years. The action plan should be done using cost - benefit analysis data based on independent traffic safety studies. International cooperation can be used.

The most effective safety improving actions depend on the situation of traffic safety work done in the country. The use of seat belts, the avoidance of drunken driving and the speed limit system are almost always actual.

Regional safety plans are neended to carry out the actions planned in the state wide action plan. The regional plan can be based on the regional traffic safety checking.

Using the positive and negative experience of western countries it is possible to avoid the mistakes of western countries and improve the situation.

Co-operation between the road administrations of Denmark, Finland and Sweden and their counterparts in Estonia is already defined by agreements.

An effective rescue system in crucial to a safe road infrastructure. Prompt rescue of road accident victims has saved numerous lives in the Nordic countries.

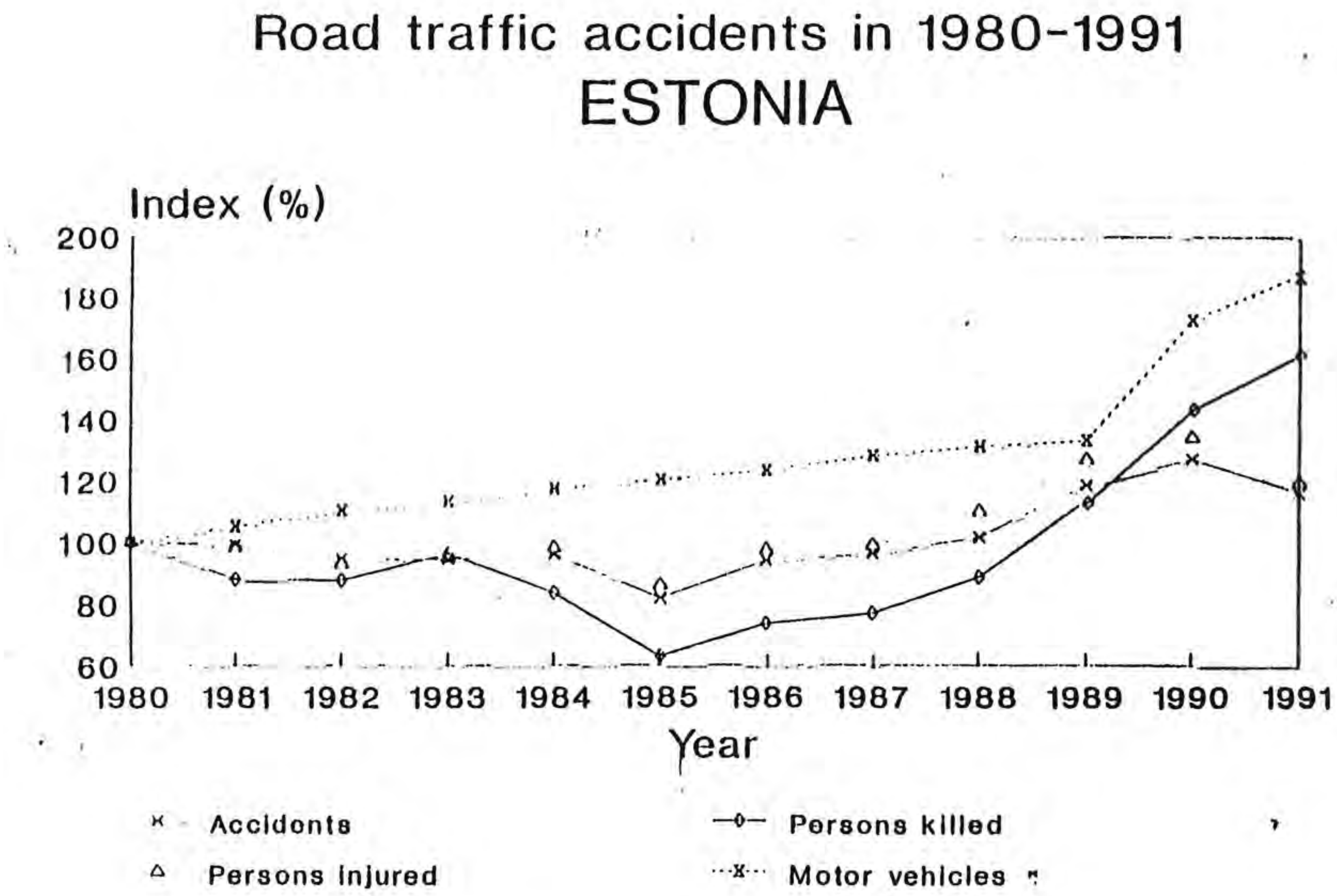


FIG. 1

Annex II, fig. 2.1

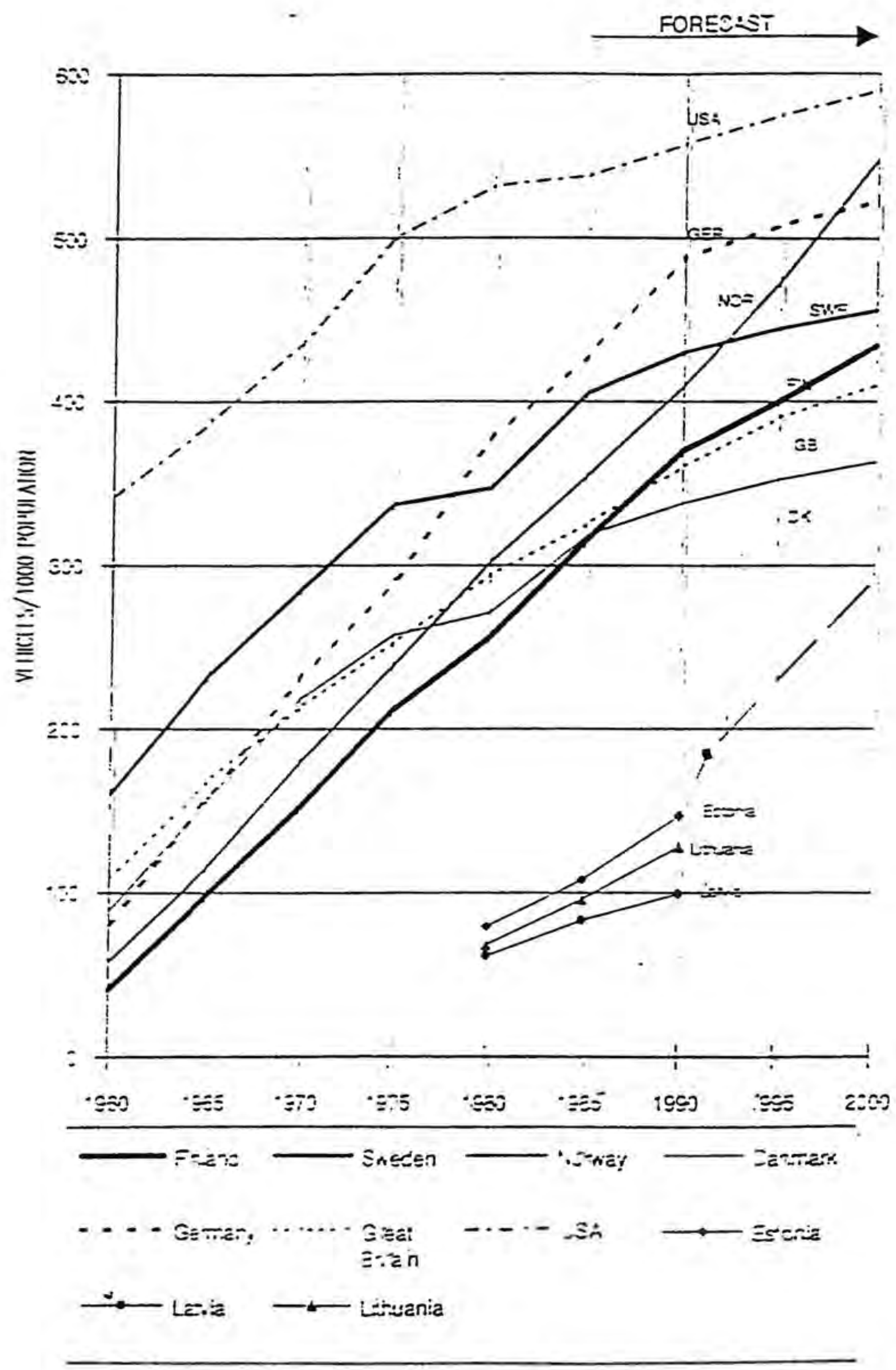


Figure 3. Car ownership

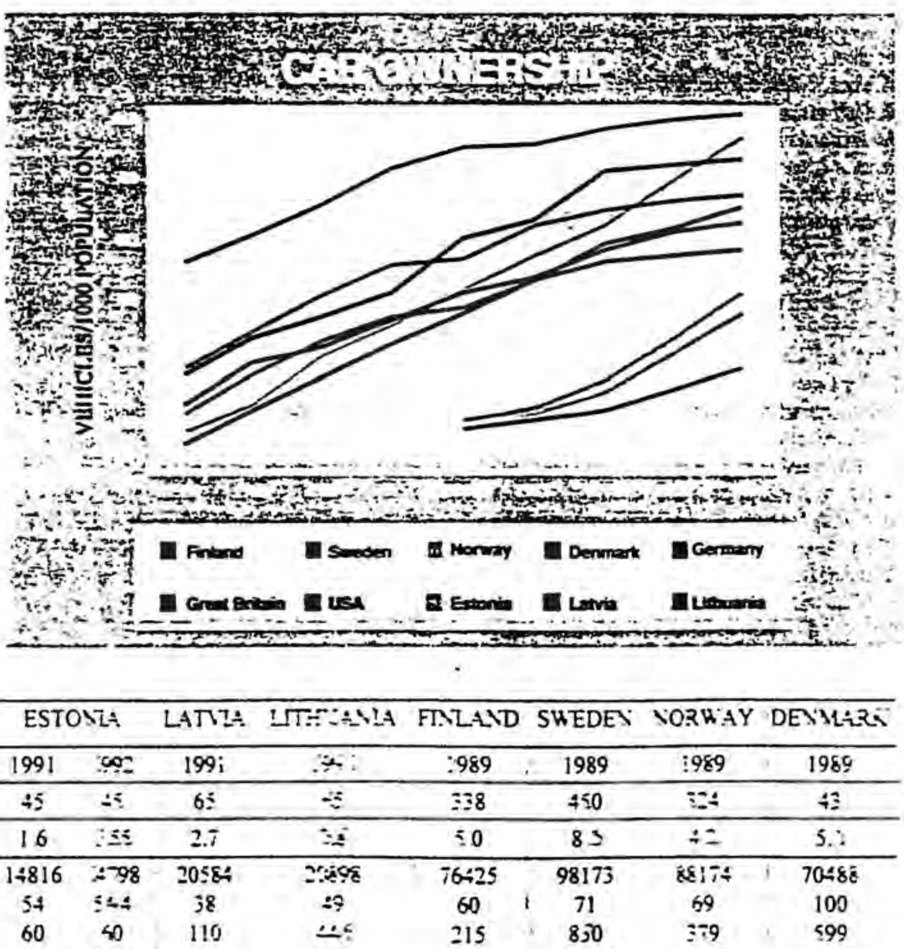
A Pot Hole For Every Car

By Jüri Kirotam

The foreign partners of Baltic firms are surprised when their expensive cars do not last here as long as they used to. Why do they have to buy spare parts so often? Local businessmen are acquainted with the problem, but their desire for image does not allow them to give up buying luxurious cars from abroad which are not made for poor roads. The flow of traffic has not stopped yet and neither has the flow of unsuitable imports. However, this industry is in for a bumpy ride if the cycle continues. For a long time the road building principle in Estonia was to have a paved road lead to every village. Unfortunately, not enough attention has been paid to development of motorways - the backbone of road networks. The building of motorways began in 1976, but only 60 kilometres had been completed by 1993. This slow building rate has ground or screeched to a halt. The Estonian road network has the same traffic density as Latvia and Lithuania. But in comparison with Nordic countries, except Denmark, Estonian figures are the largest. The share of paved roads has gradually grown from year to year and forms 56.2 per cent of total length of public roads. The road network is the biggest and most expensive structure in Estonia. Its total length is 29,675 kilometres: public roads 14,798 kms, district and private roads 14,877 kms. There are 835 bridges (totalling 18,826 kms) on Estonia's public roads. The average length of a bridge is 22.5 metres. But a considerable number of permanent bridges need reconstruction. Many of them are out dated, with dimensions that do not meet the requirements of modern roads and real traffic load. Their carrying capacity needs to be strengthened. The present unsatisfactory condition of bridges is also caused by poor quality of building and building material quality. There are still 13 wooden bridges which are to be replaced. The costs of the tasks that lie ahead loom in the distance. In 1992 the sum for roadkeeping costs was 95.5 million Estonian kroons (EEK). The funds were divided between road maintenance, surface treatment, emergency repairs of bridges, completing unfinished roads and infrastructure. There should have been 3-4 times more money foreseen for roadkeeping costs. For instance, it was possible to do 1085 kilometres surface treatment works, 3.6 kilometres asphalt works and 45 kilometres bitumen gravel works. In comparison with the total length of road network, this forms a very small part. The Institute EST ROAD DESIGN AND ENGINEERING has been engaged in complex road designing since 1956 in Estonia and has travelled the road with us, experiencing all the ups and downs. The number of employees has fallen from 120 to 60. The same has happened in Latvia (from 250 to 122) and Lithuania (from 450 to 275). The dismissed of employees was caused by lack of orders for road design. The Baltic design bureaus productions, in terms of money, are practically incomparable with one another. The following schedule shows the share of design works from state roadfund in 1993.

State	Roadfund	Design works	Share(%)
Estonia	152 mill.EEK	1 mill.EEK	0.7
Latvia	930 mill.LVR	8.1 mill.LVR	0.9
Lithuania	7000 mill.tal.	56 mill.tal.	0.8

The roadkeeping financing would be easier if an excise tax would be enforced. But great changes in the development of infrastructure and service system by the side of the roads will not take place before total economic recovery, privatization, increasing tourism and goods transport demand the building of new routes (VIA BALTICA, VIA HANSEAATICA). Rapid growth of private cars will influence the traffic intensity a great deal. We are at a transportation crossroad. It is critical that we stop, look both ways and plan our journey carefully. ■



	ESTONIA		LATVIA	LITHUANIA	FINLAND	SWEDEN	NORWAY	DENMARK
	1991	1992	1991	[illegible]	1989	1989	1989	1989
Land area, 1000 sq. kms	45	45	65	65	338	450	324	43
Population, millions of inhabitants	1.6	1.55	2.7	3.4	5.0	8.5	4.2	5.1
Public roads, kms	14816	14798	20584	20898	76425	98173	88174	70488
paved, %	54	54.4	38	49	60	71	69	100
motorways, kms	60	60	110	445	215	830	379	599
The public road network density (kms per sq. km	0.33	0.33	0.32	0.32	0.23	0.22	0.27	1.64
Automobiles * 1000's	347	366	386	607	2182	3887	1933	1902
Motocars * 1000's	261	283	283	534	1909	3578	1613	1599
Motocars per 1000 inhabitants	167	185	106	142	383	420	381	311
Road traffic accidents:								
Killed	490	287	923	1093	734	904	381	670
Injured	2130	1228	4543	6638	11492	23531	11490	11645

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