Proceedings of ROAD SAFETY AND TRAFFIC ENVIRONMENT IN EUROPE in Gothenburg, Sweden, September 26-28, 1990

- Campaigns and Publicity
- Information and Enforcement
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Papers presented at the seminar were as follows: National Road Safety Politics - A Contradictory and Suppressed Field of Decision Making (Koeltzow,K); Motorway Driving Speed Reduction and the Associated Public Information Campaigns in the Netherlands (Liedekerken,P C); Campaigns against Drunken Driving among Young Drivers (Studsholt,P); Effectiveness of the 1988 Police National Motorway Safety Campaign (Christie,N); Improvement of Traffic Safety by Local Public Relations Campaigns (Schlabbach,K); Comedy on TV to Promote Traffic Safety (Wittink,R D, Nelissen,W J A and Hagenzieker,M P); Road Safety as Business - Vision or Reality? The Brazilian Example (Correa,J P); New Way of Broadcasts for Motorists (Melchers,W); Automatic Monitoring and Enforcement of Traffic Highway Violations (Ayland,N, Sommerville,F and Siviter,J); Can Road Traffic Law Enforcement Permanently Reduce the Number of Accidents? (Bjoernskau,T and Elvik,R); Vehicle Accident Data Recorder (Fincham,W); The Scope of Automatic Detection and Enforcement Systems (Rothengatter,T).

Keywords:

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PREFACE

The Swedish Road and Traffic Research Institute (VTI) and the Bundesanstalt für Strassenwesen (BASt), Federal Republic of Germany, were jointly organizing this international conference. The objective was to review and examine some specific road safety issues and the increasing environment problems in road traffic in different countries.

The following areas, within the field of Road Safety and Environment, were presented
- vehicles
- city planning
- speed
- vulnerable road users
- future traffic and RTI
- environment
- campaigns and publicity
- information and enforcement

Linköping October 1990

Kenneth Asp

Proceedings of ROAD SAFETY AND TRAFFIC ENVIRONMENT IN EUROPE in Gothenburg, Sweden, September 26-28, 1990:

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- Opening
- Vehicles

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- City Planning
- Speed

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- Environment

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**CAMPAIGNS AND PUBLICITY**

**National Road Safety Politics - A Contradictory and Suppressed Field of Decision Making**
Karin Køltzow, Institute of Transport Economics, Norway

**Motorway Driving Speed Reduction and the Associated Public Information Campaigns in The Netherlands**
Peter C Liedekerken, Ministry of Transport and Public Works, the Netherlands

**Campaigns against Drunken Driving among Young Drivers**
Per Studsholt, County Council Administration of Northern Jutland, Denmark

**Effectiveness of the 1988 Police National Motorway Safety Campaign**
Nicola Christie, Transport and Road Research Laboratory, United Kingdom

**Improvement of Traffic Safety by Local Public Relations Campaigns**
Klaus Schlabbach, Town Planning Authority Darmstadt, Federal Republic of Germany
Comedy on TV to Promote Traffic Safety
Roelof D Wittink, Institute for Road Safety Research (SWOV), Will J A Nelissen, Research & Marketing bv and M P Hagenzieker, SWOV, the Netherlands

Road Safety as Business - Vision or Reality?
The Brazilian Example
J Pedro Correa, Volvo Road Safety Program Brazil

New Way of Broadcasts for Motorists
Walter Melchers, Traffic Police Nordrhein-Westfalen, Federal Republic of Germany

Automatic Monitoring and Enforcement of Traffic Highway Violations
Nicholas Ayland, Fraser Sommerville and Jeremy Siviter, Castle Rock Consultants, United Kingdom

Can Road Traffic Law Enforcement Permanently Reduce the Number of Accidents?
Torkel Bjørnskau and Rune Elvik, Institute of Transport Economics (TØI), Norway

Vehicle Accident Data Recorder
William Fincham, Queen Mary and Westfield College, United Kingdom

The Scope of Automatic Detection and Enforcement Systems
Talib Rothengatter, Traffic Research Centre, the Netherlands
ROAD SAFETY AND TRAFFIC ENVIRONMENT IN EUROPE

Gothenburg, Sweden

September 26-28, 1990

WEDNESDAY SEPTEMBER 26

OPENING

9.30 - 11.30

Chairman: Mrs Monica Sundström, Director General, Swedish Road and Traffic Research Institute (VTI), Sweden

Opening Speeches
Mrs Gunnel Färm, Deputy Minister of Transport and Communications, Sweden
Prof Dr Heinrich Praxenthaler, President, Federal Highway Research Institute (BASt), Federal Republic of Germany
Mrs Monica Sundström, Director General, Swedish Road and Traffic Research Institute (VTI), Sweden

Motorization and Trends in Road Traffic
Prof Dr-Ing Karl-Heinz Lenz, Federal Highway Research Institute (BASt), Federal Republic of Germany

Traffic and Environment - What is the Problem?
Mr Börje Thunberg, Research Director, Swedish Road and Traffic Research Institute (VTI), Sweden

Traffic Safety facing Year 2000: Challenge for the Automotive Industry
Mr Jan Crister Persson, Vice President Engineering, Volvo Car Corporation, Sweden
WEDNESDAY SEPTEMBER 26

VEHICLES

13.00 - 16.30

Chairman: Prof Dr-Ing Karl-Heinz Lenz, Federal Highway Research Institute (BASt), Federal Republic of Germany

The Use of Simulation to Improve Vehicle Design
Mr François Badin, Institut National de Recherche sur les Transports et leur Sécurité (INRETS), France

Vehicle Development and Road Safety
Dr Christa Michalik, Austrian Road Safety Board, Institute of Traffic Education, Austria

The Role of the Motor Vehicle in Traffic Engineering of the Future
Dr Joachim Schmidt, Deutsche Automobilgesellschaft mbH (DAUG), Federal Republic of Germany

Automotive Crash Safety Engineering - Time for a New Approach?
Mr Hugo Mellander, Volvo Car Corporation, Sweden

The Daimler-Benz Driving Simulator - Research for Road Safety and Traffic Environment
Dipl Inf Volkhard Schill and Mr Joachim Stritzke, Daimler-Benz, Federal Republic of Germany

The VTI Driving Simulator
Prof Staffan Nordmark, Swedish Road and Traffic Research Institute (VTI), Sweden

Protection Effects of Child Restraints - Experiences from Accidents and Sled Tests with Carry-Cots
Dipl-Ing K-P Glaeser, Federal Highway Research Institute (BASt), Federal Republic of Germany
WEDNESDAY SEPTEMBER 26

CITY PLANNING

13.00 - 16.30

Chairman: Prof Niels O Jørgensen, Technical University of Denmark, Denmark

Traffic Management by Design in One Family Housing Areas
Architect Jens Bjørneboe, Norwegian Building Research Institute (Norges Byggforskningsinstitutt), Norway

Pedestrian Safety and Delay at Crossing Facilities in the United Kingdom
Dr J G Hunt, University of Wales College of Cardiff, United Kingdom

The Safety of Cycling Children. Effect of the Street Environment
Dr Lars Leden, Technical Research Centre of Finland, Finland

Analysis of Traffic Safety regarding Public and Individual Transport
Prof Dr-Ing Uwe Köhler, University of Kassel, Federal Republic of Germany

Urban Traffic Network - A Spatial Approach
Prof Dr S Olof Gunnarsson, Chalmers University of Technology, Sweden

Comparison of Road Safety in Different Cities
Dozent Dr sc techn H-J Neumann, Transport University (Hochschule für Verkehrswesen), German Democratic Republic

VTI RAPPORT 365A
THURSDAY SEPTEMBER 27

SPEED

9.30 - 13.00

Chairman: Mr Gunnar Carlsson, Research Director, Swedish Road and Traffic Research Institute (VTI), Sweden

Effects of Speed Reducing Measures in Danish Residential Areas
Ms Ulla Engel, Senior Research Scientist, Danish Council of Road Safety Research, Denmark

A Case Study Evaluating Traffic Warning Devices with Respect to Operating Speeds and Accident Rates
Prof Dr-Ing Rüdiger Lamm, University of Karlsruhe, Federal Republic of Germany

Area Wide Traffic Calming Measures and Their Effects on Traffic Safety in Residential Areas
Prof Dr-Ing Werner Brilon, Ruhr-University Bochum, Federal Republic of Germany

Statistical Distribution of Speeds on German Motorways
Dr Dirk Heidemann, Federal Highway Research Institute (BASt), Federal Republic of Germany

Drivers' Attitudes and Beliefs towards Speed Limits and Speeding on Dutch Motorways
Dr Ton Rooijers, Traffic Research Centre (VSC), The Netherlands

FUTURE TRAFFIC AND ROAD TRAFFIC INFORMATICS (RTI)

(WORKSHOP)

14.00 - 17.30

Chairman: Prof Kåre Rumar, Swedish Road and Traffic Research Institute (VTI), Sweden

Test Site West Sweden: Learning RTI and Demonstrating Its Usefulness
Mr Lars-Erik Sjöberg, National Swedish Road Administration, Sweden

Future Traffic and RTI. Status report of the Federal Republic of Germany
Dr Ing Jürgen Behrendt, Leitender Regierungsdirektor, Federal Highway Research Institute (BASt), Federal Republic of Germany

Evaluation of the Perspectives of Driving Aids based on Short Range Transmission Links between Ground and Vehicles and between Vehicles
Mr Yves David, INRETS-CRESTA, France

RTI - Current Global Projects
Mr Tage Karlsson, Director, Volvo DRIVE-SECFO, Belgium

VTI RAPPORT 365A
THURSDAY SEPTEMBER 27

VULNERABLE ROAD USERS

9.30 - 13.00

Chairman: Prof Dr S Olof Gunnarsson, Chalmers University of Technology, Sweden

Riding a Moped: Acquisition of Basic Skills and Mental Effort
Dr Marcel Wierda, Traffic Research Centre (VSC), The Netherlands

An Intelligent Traffic System for Vulnerable Road Users
Mr Oliver Carsten, Senior Research Fellow, Institute for Transport Studies, United Kingdom

Traffic Related Knowledge, Attitudes and Risk Perception in Dutch Secondary School Children: Consequences for Traffic Education
Dr Jan Brinks, Traffic Research Centre (VSC), The Netherlands

Lifestyle, Leisurestyle and Traffic Behaviour of Young Drivers
Dr Horst Schulze, Federal Highway Research Institute (BASt), Federal Republic of Germany

ENVIRONMENT (WORKSHOP)

14.00 - 17.30

Chairman: Mr Göran Friberg, Director, Swedish Environmental Protection Board (SNV), Sweden

Total Environmental Impact of the Car
Mr Ulf Jansson, Volvo Car Corporation, Sweden

Environment. Status report of the Federal Republic of Germany
Dr Klaus Becker, Federal Environmental Agency (Umweltbundesamt), Federal Republic of Germany

Status report from the Netherlands
Dr M P J Pulles, Center for Energy and Environmental Studies (IVEM), The Netherlands
FRIDAY SEPTEMBER 28

CAMPAIGNS AND PUBLICITY

8.30 - 12.30

Chairman: Prof Dr Günter Kroj, Federal Highway Research Institute (BASt), Federal Republic of Germany

National Road Safety Politics - A Contradictory and Suppressed Field of Decision Making
Ms Karin Køltzow, Research Officer, Institute of Transport Economics (TØI), Norway

Motorway Driving Speed Reduction and the Associated Public Information Campaigns in the Netherlands
Dr Peter Liedekerken, Ministry of Transport and Public Works, The Netherlands

Campaigns against Drunken Driving among Young Drivers
Mr Per Studsholt, Section Eng, Danish Society of Engineers (Nordjyllands Amt), Denmark

The Effectiveness of the 1988 Police National Motorway Safety Campaign
Ms Nicola Christie, Transport and Road Research Laboratory (TRRL), United Kingdom

Improvement of Traffic Safety by Local Public Relations Campaigns
Dipl-Ing Klaus Schlabbach, Town Planning Authority Darmstadt (Bauderzernat Stadtplanungsamt), Federal Republic of Germany

A Comedy on TV to Promote Traffic Safety
Dr R D Wittink, Institute for Road Safety Research (SWOV) and Dr W J A Nelissen, Research & Marketing, The Netherlands

Road Safety as Business - Vision or Reality? The Brazilian Example
Mr J Pedro Correa, Volvo do Brasil, Brazil
FRIDAY SEPTEMBER 28

INFORMATION AND ENFORCEMENT

8.30 - 12.30

Chairman: Prof Dr Karl-Heinz Lenz, Federal Highway Research Institute (BASt), Federal Republic of Germany

A New Way of Broadcasts for Motorists
Mr Walter Melchers, Der Innenminister des Landes NRW, Federal Republic of Germany

Automatic Monitoring and Enforcement of Traffic Highway Violations
Mr Nicholas Ayland, Castle Rock Consultants, United Kingdom

Can Road Traffic Law Enforcement Permanently Reduce the Number of Accidents?
Mr Torkel Bjørnskau and Mr Rune Elvik, Research Officer, Institute of Transport Economics (TØI), Norway

A Vehicle Accident Data Recorder
Dr William Fincham, Queen Mary and Westfield College, United Kingdom

Enforcement: The Scope for Automotive Detection and Information Systems
Dr Talib Rothengatter, Traffic Research Center (VSC), The Netherlands
List of participants Road Safety and Traffic Environment in Europe September 26-28, 1990

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Danish Road Directorate
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Municipality of Odense
Central Police Traffic Committee
Newspaper Vi Bilagare

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Kuratorium für Verkehrssicherheit
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National Road Safety Politics - A Contradictory and Suppressed Field of Decision Making

Karin Køltzow
Research Officer
Institute of Transport Economics (TøI)
Norway
NATIONAL DECISION MAKING IN ROAD SAFETY

By Karin Koltzow and Terje Assum, Research Officers
Institute of Transport Economics, Oslo, Norway

Background

The amount of knowledge concerning efficient road safety measures is great. Nevertheless, road safety measures are not implemented in such an extent or as fast as necessary to reduce the number of road accidents considerably.

The purposes of the project

The values, knowledge and experience of decision makers are considered important as to the implementation of road safety measures. The attitudes and knowledge of important national decision makers within road transport and road safety were therefore studied to answer these questions:

- What are the main barriers to more efficient decision making within road safety?
- How can road safety research contribute to reducing these barriers?
- Can road safety work be more efficiently organized?
- What other ways to reduce the barriers?

Moreover, the project is also supposed to contribute to a better communication between decision makers and the research community. Participating in the project will supposedly make the decision makers more interested in road safety. The research officers will learn about the application of research findings.

Method

30 national decision makers (politicians and civil servants) were interviewed. For every item in the interview they were given a short text to read concerning an everyday road traffic situation. Then a somewhat surprising question was asked. The results of these interviews were summed up and fed back to the decision makers. Then they were interviewed again, concerning the results of the first interviews. The results of the second interviews were summed up and reported to the interviewees, and then discussed in a seminar.

Results

The paper will present the main results of the project.
NATIONAL ROAD SAFETY POLITICS - A CONTRADICTORY AND SUPPRESSED FIELD OF DECISION MAKING

Karin Køltzow
Research Officer
Institute of Transport Economics, Oslo

1. AIM OF THE RESEARCH PROJECT

The aim of the project has been to investigate what decision-makers at a high level, professionally or politically related to road politics, include in the concept "change of attitude" when this is put forward as a road safety countermeasure. Other questions to be elucidated in the project were decision-makers’ understanding of various traffic safety countermeasures and their effects, and how they look upon road safety in general. It was especially important to get more knowledge about decision-makers’ problems within this field. In short: The project should reveal decision-makers’ attitudes towards road safety. The country was Norway.

2. SAMPLE AND METHOD

About 30 professionals and politicians participated throughout the research period (1986-90) to enlighten the above questions. 90 per cent of the sample were men, reflecting the biased sex-distribution among decision-makers on this level in this field.

As a first job in the project the main questions to be answered were further elaborated and complemented in order to show lack of knowledge in the field. This elaboration formed the basis for the interview instruments.

During the first interview (winter 1986/87) the interviewees were presented with short cuts from newspapers, periodicals and research reports. These cuts were not neutral in relation to matters of road safety or mobility, but were chosen to represent important issues in the field - issues that our sample was supposed to be familiar with. When one of the interviewees had read the presented cut - one cut at a time - he or she was asked a question which we presumed was a bit surprising in relation to the presented text. The interviewees had as much time as they wanted to give their answers. In addition, they were, if necessary, always asked to give reasons for their answers. This procedure was selected for several purposes: We wanted the interviews
to be as close as possible to the decision-makers’ daily tasks and problems, we wanted to engage the decision-makers so that they should want to participate actively during the interview, and we wanted their personal points of views when "taken a bit unaware". We also hoped that our somewhat untraditional approach would lead the interviewees to remember the project at least through the project period. We felt that this "unaware"-approach in particular was necessary to get sincere replies, contrary to the formal and restricted answers decision-makers at this level are usually willing to give. Each interview, both the first and the second, lasted about 2.5 hrs.

Results of the first interview were used as examples, or cuts, through the second interview (winter 1988/89). Thus the interviewees got the chance to go more into depth as to the data from the first interview. Results of the two interview rounds were finally presented together with draft for proposed countermeasures, and groups of the interviewees were gathered in seminars for final discussions.

Data have been analysed qualitatively in order to identify important obstacles to road safety policy.

3. DEFINITIONS

Attitude as a concept may be defined in very different ways. Based on a literature survey we have in this project defined attitude in the following manner:

"An attitude consists of the values, knowledge and experiences governing a person’s points of views and actions relative to a subject and in a certain situation."

Effective road safety measures are usually defined as measures with a documented accident reducing effect. In the project we have extended the definition somewhat:

"Effective measures will singlehandedly or by interaction with other measures produce necessary knowledge in order to change behaviour and in a concrete way organize for such a change."

This definition was chosen not to reject educational and informational measures which seldomly are documented as directly accident reducing, but which may have a necessary sustaining effect.
4. Results

4.1 Demands of "Change of Attitude" Tell about Evasiveness -

The decision-makers in the project say that the expression "change of attitude" is being used in an evasive and unprecise way as some sort of "refuge". The interviewees say this is common, and some of them also confirm it indirectly through their answers. They say that it is noncommittal and usual to put forward a demand for change of attitude when problems are getting obtrusive and something must be done. There is unwillingness to apply substantial solutions, and it is often "the others" who are directed to change their attitudes.

The material shows at the same time how important desired attitudes are - among decision-makers and among road traffic users, but that it will be difficult to change road users' behaviour when education and information are the preferred measures for influencing attitudes. For most of the interviewees talking about change of attitude is synonymous to talking about education and information - which, similar to the concept of change of attitude, is being talked about noncommittally. Furthermore education and information are often measures that shall be taken care of by "the others" - first and foremost by the school system. Many of the decision-makers are evasive as to their own responsibility, and talk about education as the magic formula that will solve the accident problem.

When questions are more penetrating, the interviewees' answers show that education and information must be comprehensive and expensive measures if change of "attitude" and behaviour is the aim - at the same time most of them are aware that an effect on behaviour cannot be guaranteed.

Education and information are, in other words, being set forward in an easy, noncommittal way which sometimes also tells about evasiveness as to own responsibility. However, the interviewees also express confidence in education as an established measure, and their answers demonstrate how dependent the educational measures are of a road and traffic system which prepares for the desired behaviour.

4.2 Unwillingness to Apply Road Related Measures

The interviewees are very clear as to which types of measures are most effective to influence behaviour
(effect on accidents, not cost-effectiveness). They rank road related measures on top, and measures related to surveillance, police enforcement and sanctions as number two. Information, education and change of attitude are mentioned as the third main area.

When the interviewees mention which measures they believe politicians will apply (nearly fifty per cent of the sample were politicians) and at the same time take into consideration costs of the measures, they maintain the ranking but their answers also show that the measures will be applied to a lesser degree - in particular because of the costs.

When the decision-makers state which measures of the main groups

- road and traffic measures,
- police enforcement and sanctions,
- information and educational measures,

they are working with, the answers imply that measures are being applied to an even lesser extent.

In other words the decision-makers have sufficient knowledge about effective measures - experts have, of course, better knowledge than politicians - but their answers also show that the knowledge is being applied in an evasive way. This indicates a potential of action on the one hand as well as inherent impediments that prevent action on the other hand.

4.3 Several Conditions Explain Why the Application of Road Safety Measures is Difficult and Why the Demand for Change of Attitude Becomes a Way Out

One important factor which is demonstrated through the decision-makers' answers is that traffic safety is secondary to the demand for mobility. Economic and industrial life and car organizations require mobility for an increasing number of vehicles. Lack of mobility in urban areas is a visible problem which is experienced by many people daily. It counts for politicians to work for a better road system, and for professionals the task is a challenge. Road safety is not visible as a target - "no one can make a career out of road safety" says a prominent politician in the project. Road safety work is fragmentary and difficult - and no one is praised for the accidents that do not occur. That too many occur is another matter, but 400 road users are not killed in one accident, so that the cry for coun-
termeasures and national assistance to the bereaved can be heard. Traffic injuries are daily events which seldom are being summed up by politicians, experts or mass media to the epidemic they really are. Politicians and experts within the road sector are tied up with the demands for mobility - experts within the field of traffic safety are few and they seldom have final authority to pull matters through.

The conflicting interests between mobility and traffic safety is in other words substantial. In addition the interview material demonstrates that the lobbying and pressure for increased mobility are substantial and well organised, while the contrary must be said about the pressure for traffic safety.

Another difficult fact is "the car is freedom, and freedom is difficult to touch". Because the car means freedom, and because we have made ourselves dependent upon the car as the transportation system, decision-makers in the project do agree that restrictions on car use are to a very small degree politically acceptable. At the same time most of them state that it is important to work for a change here, but that very good arguments must be put forward.

The facts that mobility carries weight, and that "the car is freedom", result in road safety being pushed aside. The weak organising of road safety policy at a high level is also contributing. These facts are being reflected in a weak rooting among some of the people who should commission the traffic safety tasks. Instead of being "driving" forces for road safety, loyalty is more tied to what these decision-makers suppose will be accepted politically than to what should constitute an effective and purposeful road safety policy. The decision-makers are aware of this; and they do express it. Most of them do not want it to be like that, but they are tied up in a system that does not favour road safety. The result is that those who should be in charge of decisions at the top level are asking for motivated people, a substantially stronger pressure for road safety, and they want a considerable strengthening of the organization of the national road safety policies. They say that there is room for change, but that road safety is a hard purpose to pursue and that it is difficult to carry through appropriate measures.

Through all the material we also see a distinction between the experts' and the politicians' answers. Politicians express far more indecisive opinions, and naturally weaker professional knowledge than the experts. This is manifested through the fact that the interviewees mean that proposals and arguments of the experts are extremely central and important as a foundation for more effective road safety policies. The question is, however, how to avoid that the politicians will "gag"
the experts when unpopular proposals shall be debated -
The material also shows that this can be the case -

4.4 Decision Makers Must Acknowledge the Suffering
Caused by the Epidemic and the Insufficiency
of the Prophylactic Work

The interviewees in the project say that to increase
the inner acknowledgement of the insufficient road
safety policy is as important as the reorganization
that has to be done. Arguments linked to the demands
for more mobility are mainly related to economy and te-
chnical solutions. Motivation for a more intense road
safety policy can only originate through increased
consciousness about the extent of the problem - about
the anxiety, the suffering and the deterioration in
quality of life and standard of life that accidents
lead to. The project brought children's requirements
for safe traffic systems and the child accidents into
focus. The results showed that children are a periphe-
ral element in decision-makers' daily work - though the
decision-makers do not wish children's problems to be
peripheral. The interviewees' working days do, however,
not yield time and place for children. Economy and
established items are governing the interviewees' daily
work. Economy will probably always control priorities
in the field, and if presentations are being formed in
a strict economic and technical language, this will in-
fluence the way of thinking and restrict which rooms of
consciousness that shall count when priorities are
being made - road safety versus mobility, requirements
of children versus requirements of industrial and eco-

nomic life -

Through the project the interviewees express the need
of putting into words the inadequacy they feel for the
undone things. They say that it relieves to reflect and
acknowledge in a difficult field.

When it comes to the inner pressure for change, we must
probably, anyhow, conclude that road safety is likely
to be the loser also in the future if not the whole
field and the need for increased efforts are being
lifted up through a substantial and lasting period. It
is also important that the public administration makes
use of a language fit for describing technical soluti-
ons and costs as well as care, suffering, demands for
security and safety. Such a language is necessary to be
able to argument for increased use of countermeasures
to reduce the epidemic of traffic accidents.
5 Proposals

5.1 Discussion of the Concept "Change of Attitude"

Attention must be called upon among decision-makers on national, county and municipal levels to the shallow and noncommittal use of the concept "change of attitude" and of the measures information and education. A small handbook about pitfalls and possibilities connected to the demand for change of attitude should be written.

5.2 Marking of the Extent of the Epidemic

Road accidents must be considered an epidemic. Because accident risk per travelled km from a professional point of view can be described as low, and because accidents disperse evenly throughout the year, the epidemic is seldomly illustrated as the heavy public problem it in reality is. To make decision-makers as well as the general public more conscious of the problem, we suggest that one Sunday be proclaimed free from motorized road traffic. The intention is to mark the correlation as well as the conflicting relationship between mobility and road safety, and to challenge mass media to shed light on the epidemic and the need for effective countermeasures.

5.3 Drawing Attention to General Principles for Influencing Erroneous Road User Behaviour

Cost- and time demanding conditions must be taken care of:

a) The exact type of behaviour to be changed must be defined, and an analysis must be carried out of how the traffic system sustains the desired behaviour or the undesired behaviour.

b) Based on such an analysis, measures related to road and enforcement must be decided by professionals.

c) Information and education must in most cases be regarded as supporting, not as directly behaviour-forming measures, and must be applied so that

- the accident problem and the behaviour to be changed must become known for the road users
the road users must recognize that the problem is important
the road users must wish that something be done with the problem
the information must describe and explain which countermeasures must be carried out and to which extent
d) The professionals must be clearly commissioned to present proposals for effective measures to the politicians, to follow up the matter throughout the decision-making process, and to carry out the practical work immediately when decision is passed.

5.4 Influencing Decision-Makers' Behaviour

It is important to express directly that the principal purpose of any transportation system is mobility. This is necessary both in order to give clearer priority to measures promoting road safety and to measures promoting mobility. This seems also necessary to enable decision-makers to decide upon the achievement level for reduction of accidents. Road safety is not an automatic consequence of road construction and road reconstruction.

A cooperation with motor organizations and organizations within economic and industrial life must be organized, both in order to investigate what traffic safety measures these parties are willing to accept, and to find out what the organizations can do to create accept for countermeasures among their members.

Because of the lack of balance between forces lobbying for increased mobility and forces lobbying for increased road safety, professionals should be encouraged to use mass media to a much larger extent to inform the population about the accident problem and the need for measures. Politicians need explicitly expressed accept from the population to be able to decide on countermeasures that can give rise to resistance among organizations working for increased mobility or among special interest groups.
5.5 Reorganizing of the National Traffic Safety Work

The interviewees stressed that substantial changes are necessary in order to strengthen traffic safety work. We therefore propose:

* A separate Department of Road Safety must be established within the Ministry of Transport and all matters concerning road safety must be taken care of there.

* Executive road safety work must be organized at top level in the Public Roads Administration and a function as an Executive Director of Traffic Safety be established.

* Responsibilities and division of work between the Ministry of Transport and the Public Roads Administration must be clarified and determined.

* If traffic safety work in the Ministry and in the Public Roads Administration is not given such weight that higher priority and more effectiveness are secured, a Directorate of Road Safety should be established.

* Common information work about the accident problem and the need for effective measures must be reorganized and reinforced. Existing road safety organizations seem not to have fulfilled the function demanded for as pressure organ. The Road Safety Council should function as such an organ, and we propose that the mandate and the number of member organizations should be extended correspondingly, and an independent and effective secretariat be established.

* Economic forces are strong, and should also be exploited for traffic safety purposes. It is important to show what the existing risk level costs. This appears by summing up

\[ \text{accident costs} + \text{countermeasures costs} = \text{NOK 13.4 billion per year} \text{ (figures from 1987/88)} \]

If responsibility for road accident costs is being administered by the road authorities and not by the social security system the use of road safety measures will be stimulated. Such a shift will lead to a transfer from treatment of injuries to prophylactic road measures.
* A more explicit stressing of the road authorities' responsibility for the accident problem will probably increase the accident-preventing work. This must, however, not lead to a breakdown of drivers' responsibility to adapt driving to road and weather conditions.

5.6 **Goals for Risk Reduction and for Use of Measures, Nationally, and Locally**

Goals for risk reduction are now set up in the counties. Such goals must also nationally be decided upon for accident reduction as well as for use of measures. In the project the experts' proposals for measures are looked upon as very important. The experts should therefore hammer out schemes for implementing measures, and rewards must be given to counties when goals are attained.

5.7 **Earmarking of Part of the Public Patrol Tax for a Traffic Safety Foundation**

An earmarked foundation can provide for financing of rewards as mentioned above.

This is reasonable because financial means to road safety will then increase in proportion with traffic, which - if implementation of measures is not increased - will lead to more accidents.

5.8 **Further Research**

The report recommends several research tasks to be performed, for instance:

* A survey of what road safety measures the motor organizations and organizations within economic and industrial life can accept and can influence members of the organizations to accept.

* An investigation of effects on accidents of liberalization steps within vehicle and driving regulations.

* An investigation of impediments as well as of means for increasing traffic safety work in counties and municipalities.
Motorway Driving Speed Reduction and the Associated Public Information Campaigns in the Netherlands

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HIGHWAY DRIVING SPEED REDUCTION AND PUBLIC INFORMATION CAMPAIGNS IN THE NETHERLANDS

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Abstract

Since May 1st 1988, a speed limit of 120 km/h has been in operation on the Dutch highways. Certain parts which however have a speed limit of 100 km/h, due to traffic safety and environmental protection reasons. These areas are clearly indicated by road signs. This new policy of driving speed differentiation has been combined with intensive public information campaigns and law enforcement (i.e. police control).

This paper deals primarily with the public information campaigns and their contribution to the overall effect of the driving speed policy up till now.

The public has been informed widely by three multimedia campaigns in the past two years. The objective of the first campaign was two fold; primarily to increase the knowledge of the new driving speed limits, and to increase the perceived chance of apprehension. Both the second and the third campaign were aimed at changing attitudes, intentions, social norms and behavior of specific target groups. Recently, a specific campaign is held for truckdrivers, one of the 'hard to reach' groups, who have a speed limit of 80 km/h.

The campaigns made use of several media: TV commercials, newspaper advertising, highway billboards (with the slogans 'here 100' and 'driving too fast costs too much'), leaflets and audiovisual aids (like a special audio cassette for truckdrivers).

In order to determine the effectiveness of both the public information campaigns and the increased police control activities, several evaluation studies have been carried out. The conclusions drawn are based on trend analyses of the registered average driving speeds on both the 100 and 120 km/h sections, the reported driving speeds and the 'preference' driving speeds.

Motives for choosing driving speeds and opinions about the new speed limit policy are also measured periodically.

The main conclusion up till now is that the majority of the road users agree both with the social need for speed reduction and with the current speed limits. The public information campaigns can be judged as being successful in this respect. The personal stimulus to reduce speed however, was insufficient. Especially the perceived chance of apprehension has decreased, because of the lack of continuity of visible police control activities. In other words; public information alone can hardly change behavior. A well designed balance of information and law enforcement is essential for the social acceptance of any speed reduction policy. The paper will present the results of the evaluation studies and trend analyses as mentioned above and will clarify both the potential and proven impact of public information within the process of behavioral change.
1. Introduction

Since the 1st of May 1988, the speed limit on Dutch motorways has been raised from 100 km/h to 120 km/h, but on certain sections however the 100 km/h limit was maintained due to traffic safety and environmental protection reasons. These 100 km/h sections include 17% of all the motorways, leaving the other 83% with a limit of 120 km/h. This new policy of driving speed differentiation has been combined with intensive public information campaigns and law enforcement (i.e. increased police control).

This paper deals primarily with these public information campaigns and their contribution to the overall effectiveness of the new speed limit policy. In the past two years the public was informed by three multimedia campaigns. The objective of the first campaign was primarily to increase the knowledge of the new speed limits and to increase the perceived chance of apprehension. Both the second and the third campaign were aimed at influencing and changing attitudes, intentions, social norms and behaviour of specific target groups. A special campaign was held for truck drivers, whose speed limit remained 80 km/h, as they were considered a "hard to reach group".

2. Driving speeds; the changed policy

Before the 1st of May 1988 the speed limit on Dutch motorways was 100 km/h. In the preceding years however the social acceptance of this limit was extremely low. The extreme and average driving speeds especially had increased to a level which gave the 100 km/h little credibility, which in this aspect is the key word for the acceptance of any speed limit policy. Both this non-acceptance and the negative effects on traffic safety and environmental protection had demanded for the new speed limit policy, that was initiated on the 1st of May 1988. The main objective being to create a credible and controllable system of speed limits on the motorways, aiming at reducing both the extreme- and average driving speeds. Therefore, the general speed limit was raised to 120 km/h, except on selected sections which remained 100 km/h. While this may sound like a paradox; increasing the speed limit in order to reduce the driving speeds, in reality the essence of the new system was to reduce the average driving speeds by a more consistent, logic differentiation and stronger policing activities.
The new speed limit policy made use of three basic instruments:

1. Differentiation of the speed limits in 120 and 100 km/h
2. Intensifying law enforcement activities (i.e. police control)
3. Public information campaigns

Figure 1. summarizes these instruments, in relation to the intermediate effects on speed behaviour and the ultimate effects on traffic safety, environmental protection, fuel consumption and accessibility/traffic flows.

Figure 1. Policy instruments, intermediate and ultimate effects

The above framework was used for the evaluation of the speed limit policy, the results of which were reported to the Dutch parliament in November 1989. The following paragraph explains the outlines, media usage, target groups and objectives of the information campaigns held.

3. Public information campaigns

Public information is essential during any obvious change of policy, especially in particular one involving a new speed limit, which aims to change peoples behaviour. Communication becomes an valuable instrument in order to reach the public and attain their acceptance of the measures taken.
Communication with the road users concerning the new speed limit consisted of two steps; firstly to inform the public about the new limits and the policy measures taken and secondly to create a greater public acceptance of these measures which would ultimately lead to a change in behaviour.

Since April 1988, four information campaigns have been held. The first of which consisted of three phases. The fourth campaign was specifically directed at truck drivers being a "hard to reach group".

In the following section an overview is given of the campaigns held.

3.1 The first campaign; April 1988 - July 1988

The objectives:

The main objectives of the first campaign were:
1. To inform the public about the new speed limit differentiation, starting from 1st. of May 1988.
2. To inform the public that law enforcement activities, especially police control, would increase substantially
3. To inform the public about the way the remaining 100 km/h sections were to be indicated

The message:

The basic message to the public was that from the 1st. of May, the speed of 120 km/h was the absolute maximum speed limit in the Netherlands. The exceeding of which would not be tolerated. Combining an increased police control and higher penalties, the new policy aimed at increasing the perceived chance of apprehension.

This message was to be communicated as direct and clear as possible, without mentioning the underlying reasons for the speed limit differentiation.

The media:

As the target group of the first campaign was the entire road user population only the mass media were used. The four major media being (national) newspaper advertisements (starting a few days before May first), magazine advertisements, television commercials, leaflets and bill boards at parking- and picnic places beside motorways.

3.2 The second campaign; October 1988 - December 1988

The objectives:

The objectives of the second campaign were:
1. To change attitudes, social norms and behaviour in favour of the new speed limits, especially those towards the 100 km/h sections.
2. To persuade the road users that the reasons for the speed limit differentiation were sound focusing on traffic safety, environmental protection and
fuel consumption. Special attention was also given to the target groups businessmen and truck drivers. Research showed that both these groups had to be considered as "hard to reach".

3. To consolidate any change in speed behaviour

The message:

Research showed that the logic behind the differentiation in 120 and 100 km/h sections was not understood by many drivers. In particular the choice and location of the 100 km/h sections needed a better explanation by clarifying the underlying reasons for the differentiation policy. The increase in police control was also in this campaign part of the message.

The target groups:

Besides informing all drivers in the Netherlands some specific target groups were chosen in this campaign such as businessmen, driving instructors, truck drivers and employers and policemen.

The media:

The campaign made use of newspaper and magazine advertisements, leaflets and printed media at a large car exhibition. Most of them directed at the identified target groups. In order to clarify the 100 km/h sections of the motorways, large billboards with the slogan "Here 100" were placed in the verge.

3.3 The third campaign; March 1989 - May 1989

The objectives:

Periodic measurements of the actual driving speeds showed that the average driving speed increased slowly in the first year of the new policy. Although businessmen make very frequent use of the roads they were not being reached effectively by the ongoing measures. The main objective of the third campaign therefore was to "stigmatize" the drivers who would not accept any speed reduction. Due stigmatisation of this group the desired behaviour of others was affirmed.

The message:

In order to achieve the stigmatisation of the "hard to reach" group businessmen, the message became more aggressive and direct. Slogans like "Driving too fast is vandalism" were used. The message referred also to the increased threat of being caught by the police. Research had previously shown that this group were little influenced by arguments such as traffic safety and environmental protection.

The media:

The third campaign only used printed media, in particular newspaper advertisements, and was less intensive than the two campaigns before.
The target groups:

As previously mentioned, this campaign was primarily focused on the "hard to reach" group of businessmen and others who would not accept the speed limits. By focusing all the attention on this group of drivers, tacit approval was given to those who did accept the limits and this they confirmed in their behaviour.

3.4 A special campaign for truck drivers; August 1989 - December 1989

The objectives:

While the speed limit remained at 80 km/h for trucks and buses there was minimal acceptance of this speed limit. Research during the earlier campaigns showed that most truck drivers display a strong resistance to the speed limit policy and in particular to their limit of 80 km/h. It was also shown that truck drivers could not be reached by the use of "traditional" media such as printed advertisements. In other words, if behavioral changes are a long term objective in any campaign, they are very difficult to achieve and therefore the objective of the campaign was primarily to persuade truck drivers that there were unarguable reasons for a speed limit of 80 km/h. Thus the objective was not to change the immediate behaviour of truck drivers, but to create a desired environment for behavioural change in the long term.

The message:

The message of this campaign was that not driving faster than 80 km/h was an essential part of a professional and responsible image. In other words; being a "good" driver means not driving faster than 80 km/h.

The media:

Realising that truck drivers were unapproachable when using the printed media, it was decided to try an audio cassette. This tape could be played in the cabin and contained "road music" and spoken information about the reason for the 80 km/h limit which was embedded in the general information about the profession now and in the future. The tape, which was distributed free to almost 40,000 truck drivers, could be ordered by the employers. Apart from the audio cassette a videotape and posters were also distributed to employers.

The target groups:

Essential in the campaign process was the cooperation of employer organisations and individual employers. In terms of effectiveness, organisations, unions and employers functioned as intermediaries towards the individual driver.
In the following section, the communication with the road users is complemented by some remarks concerning the initiated and free publicity.

4. Initiated and free publicity

The change of the driving speed policy was accompanied by much initiated and free publicity, especially short before and after the change. It is important to overlook the content and amount of free publicity for two reasons:

1. The organized information campaigns are not the only source of information people receive. Both free publicity and the campaigns influence the public's reaction on policy changes. If the free publicity is negative about a policy change, it will influence the effectiveness of any organized communication.

2. Partly it is possible to act directly in creating free publicity. Well timed press conferences and also written press reports are instruments to be used to initiate publicity.

Research has shown that one of most predictable determinants of speeding is the *perceived* chance of apprehension. Separate from the *actual* chance of apprehension, the perceived chance can be influenced by communication. The credibility of the speed policy however is partly determined by a realistic balance between this actual and perceived chance of apprehension. The first campaign mentioned, which aimed at informing the public about increased police control, led to an increased perceived chance of apprehension. The free publicity a few month after May 1st 1988, starting date of the new speed limits, showed that the actual chance of getting caught was not as high as suggested by the campaign. This contrariety led to a reduced credibility of the policy. This example shows the importance of free publicity in creating public acceptance of policy and demonstrate that the role of free publicity should not be underestimated.

5. Results

Figure 1 shows the overall evaluation framework of the new speed limit policy. Public information campaigns is one of the policy instruments. The effectiveness of the speed policy is determined by the integration of these instruments, in particular the integration of public information and law enforcement activities. Therefore the individual effects of public information are difficult to separate. Trend studies since early 1988 have however identified changes in knowledge, attitudes, reported speed behaviour, preferable speeds and actual speed behaviour. Priority has been given to trend studies because the issue of behavioral change concerning driving speeds is an ongoing long term process. The effectiveness of the speed limit policy should therefore be judged in terms of changes in the *process* of behavioural change and not only with the use of single and short term data. The main results which can be linked to the information campaigns are the following:
1. The first campaign and the resulting free publicity has led to a high level of knowledge concerning the changed speed limits and to a clear visible acceptance of the arguments for changing the speed limit policy. Together with the increased law enforcement activities, the average driving speeds on both the 120 km/h and 100 km/h sections dropped in the first months.

2. Television was most successful in informing the public about the new speed limits. The use of bill boards in the verge of the motorways during the second campaign was very effective in giving attention to the 100 km/h sections. The greater public attention of bill boards has led to the prominent use of this medium in the current 1990 campaign. The audio cassette used in the campaign for truck drivers was effective in reaching this group and will be used again in the next campaign for truck drivers.

3. The majority of drivers agree with the arguments of traffic safety (especially for the 100 km/h sections), environmental protection and the saving on fuel consumption for the speed limit differentiation.

4. In terms of attitudes, social norms, reported behaviour and actual behaviour, drivers who drive primarily for private reasons achieve the desired level. The acceptance of the speed limits among drivers who use their car for business reasons, including truck drivers, was the least.

5. The average driving speeds increased slowly a few months after the first of May and although the social acceptance of the arguments for speed limita-tion has increased, the personal stimulus for driving not faster than allowed has been insufficient. This can be explained by a decreased perceived chance of apprehension, due to a less visible policing which has shown to be more effective than the number and range of penalties.

6. Conclusions

The main objective of the speed limit policy since the first of May 1988, was to reduce the average driving speeds on the Dutch motorways. In essence, the key to reduce these average speeds was a credible and controllable system of differentiated speed limits.

The message to the public was relatively complicated; 120 km/h as the absolute limit, except for sections which remain 100 km/h. Persuasive communication and increased policing should have enforced this message.

The policy was successful in the first months after the initial date. The majority of the public excepted the underlying reasons for speed limits and the visibility of police presence led to an increased perceived chance of apprehension.

Except from some “hard to reach” groups, the social norm was positive and the average driving speeds dropped to an acceptable level. At that point, the realised behavioural change should have turned into the consolidation of that change. In practice, the initiated campaigns suggested a “police threat” which couldn’t be fulfilled and although the societal acceptance was realised, the personal stimulus for continuing of the behaviour changed failed to be realised and within a few months the average speeds have increased slowly, but are still remaining beneath the level before the first of May 1988.
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Campaigns against Drunken Driving among Young Drivers

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County Council Administration of Northern Jutland
Denmark
Campaigns against drunken driving amongst young drivers.

The county council administration for Northern Jutland in Denmark has carried out two campaigns against drunken driving amongst young drivers.

In Denmark drunken driving is a serious problem especially amongst young people. The 18-24 year olds conduct 5-10% of the car driving in Northern Jutland but are involved in 38% of the accidents due to drunken driving. In the county the number of traffic accidents with drunken drivers involved has been rather constant 500 per year. Drunken driving is especially a problem during summer. Half of the accidents are registered in the 4 summer months May, June, July and August.

Both campaigns were based on direct mail to the young people.

The first campaign started on the 27th of April 1988. On this date 28,000 young people in Northern Jutland - all from 17 to 19 years of age and some of the 16 and 20 year olds - received a personal letter from the county. The letter included a tape with music especially composed by a famous Danish popgroup. The lyrics in the song established that drinking and driving is a bad mixture.

In the letter was also enclosed a pool coupon concerning drinking and driving. The young people could win money prizes and T-shirts with the campaign slogan.

Later an analysing institute made a survey of how the young people had received the campaign. The analysis showed, that amongst the young people, who had received a personal letter, 91% had listened to the music, 70% had discussed the campaign with others and only 4% did not like the campaign.

The result in terms of the number of police-reported traffic accidents is shown in the diagrams below. A reduction of 20 accidents caused by drunken 17-19 years old drivers gives a saving of 7 million D.kr. On top of this human sufferings and tragedy of losses have been saved. The campaign cost 0.5 million D.kr. excluding administration.
In the last months of the year and the first months of 1989 the number of traffic accidents with drunken 17-19 old drivers slowly was increasing to normal level. Therefore a new campaign was needed.

The second campaign started on the 26th of April 1989 when the same group of young people received another personal letter with a new music tape, a pool coupon and a poster with a beautiful girl pointing a gun at you saying "Freeze - drunk driving won't get you there".

Furthermore a movie spot was produced to be shown with the advertisements in all cinemas in Northern Jutland for 8 weeks during the summer. The campaign cost 0.8 million D.kr. excluding administration. The result on the number of accidents is shown in the diagrams below.

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</tr>
</thead>
<tbody>
<tr>
<td>0 - 16 year</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3.0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>17 - 19 year</td>
<td>44</td>
<td>42</td>
<td>32</td>
<td>31</td>
<td>37</td>
<td>37.2</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>20 - 25 year</td>
<td>73</td>
<td>67</td>
<td>85</td>
<td>58</td>
<td>57</td>
<td>68.0</td>
<td>63</td>
<td>34</td>
</tr>
<tr>
<td>26 - 99 year</td>
<td>87</td>
<td>107</td>
<td>107</td>
<td>120</td>
<td>97</td>
<td>102.6</td>
<td>92</td>
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<tr>
<td>Sum</td>
<td>211</td>
<td>218</td>
<td>225</td>
<td>212</td>
<td>193</td>
<td>211.8</td>
<td>175</td>
<td>153</td>
</tr>
</tbody>
</table>
CAMPAIGNS AGAINST DRUNKEN DRIVING AMONG YOUNG DRIVERS

Per Studsholt
Section Engineer, B.Sc.
County Council Administration
of Northern Jutland, Denmark

1. INTRODUCTION

This paper concerns two campaigns to prevent drunken driving among young drivers carried out by the County Council Administration of Northern Jutland in Denmark.

The county covers 1/10 of Denmark's area and has a population of approximately 1/2 million people. Among many things the county council administrates the hospitals, the public health services and the 1,400 km main roads in the county. The 7,700 km local roads are administrated by the municipalities.

2. DRUNKEN DRIVING IS A BIG PROBLEM

During the 5 year period from 1983 to 1987 the police in Northern Jutland yearly reported 500 traffic accidents with drunken drivers involved - that is drivers with 0.5 o/oo alcohol or more in their blood. (The legal limit is 0.8 o/oo). This means that almost 1/4 of all reported accidents were caused by drunken drivers. Yearly 23 were killed and 330 injured in these accidents.

The problem is especially big concerning 18-24 year old drivers. They conduct 5-10% of the cardriving, but are involved in 38% of the traffic accidents with drunken drivers. In the case of these accidents following characteristics have been found:

- 95% of the involved drivers are men,
- 50% of the accidents are registered in the four summer months May, June, July and August,
- 50% of the accidents are registered during week-ends.
3. CAMPAIGN IDEA

The County Council decided that an effort should be made to reduce the number of traffic accidents with drunken young drivers involved.

Together with an advertising agency the administration put up a strategy for a campaign. The main target group was to be the 17-19 year olds - the age when young people get their driving licence. Some of the 16 year olds and 20 year olds were to be included as well.

Drinking and driving does not belong together was to be the message, and it should be given the young people in their own way of communication. Furthermore the message was to be as direct and concentrated that the target group would feel that it concerned them personally.

These considerations pointed towards a campaign based on music tape sent as direct mail.

4. THE FIRST CAMPAIGN

4.1 Campaign Concept

On the 27th of April 1988 all 28,000 in the target group in Northern Jutland received a personal letter from the county. The letter included a tape with music especially composed by a famous Danish popgroup. The letter and the lyrics in the song established that drinking and driving is a bad mixture.

In the letter a pool coupon concerning drinking and driving was also enclosed. The young people could win money prizes and T-shirts with the campaign slogan: "Styr din brandert - lad bilen stå" meaning "Be cool when you are drunk - don't drive".

5,000 posters were distributed to educational institutions, sports clubs, driving schools and other places where young people meet. The local newspapers, radios and TV stations covered the campaign very well.

The price of the campaign was 0.53 million D. kr. including 0.23 million D. kr. for the music tapes and 0.11 for the postage. Administrative expenses concerning the county council personnel are not included.
4.2 Survey

Three weeks after the young people had received the letter an analysing institute made a survey of how the target group had reacted to the campaign.

The analyses showed that 91% of the receivers of the letter had listened to the music. 70% had discussed the campaign with others and only 4% did not like the campaign. 96% could recognize the slogan. Furthermore the survey showed that the target group now overestimated the number of traffic accidents with drunken drivers involved while the pool-contest showed that the number was underestimated at the start of the campaign.

4.3 Result in Terms of Traffic Accidents

The result in terms of policereported traffic accidents was surprisingly good. The average number of reported accidents with drunken 17-19 year old drivers in the summers of 1983-87 (May-August) was 37. As shown in the diagram below the number fell to 17 in the summer of 1988.

<table>
<thead>
<tr>
<th>Age</th>
<th>83</th>
<th>84</th>
<th>85</th>
<th>86</th>
<th>87</th>
<th>Average 83-87</th>
<th>88</th>
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<tbody>
<tr>
<td>0-16 years</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3,0</td>
<td>3</td>
</tr>
<tr>
<td>17-19 years</td>
<td>44</td>
<td>42</td>
<td>32</td>
<td>31</td>
<td>37</td>
<td>37,2</td>
<td>17</td>
</tr>
<tr>
<td>20-25 years</td>
<td>73</td>
<td>67</td>
<td>85</td>
<td>58</td>
<td>57</td>
<td>68,0</td>
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<tr>
<td>26-99 years</td>
<td>87</td>
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<td>107</td>
<td>120</td>
<td>97</td>
<td>103,6</td>
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<tr>
<td>Sum</td>
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<td>218</td>
<td>225</td>
<td>212</td>
<td>193</td>
<td>211,8</td>
<td>180</td>
</tr>
</tbody>
</table>

* drivers: cars, motorbikes, mopeds, bicycles, pedestrians
It is remarkable that only the group of 17-19 year olds - who had been the main target group of the campaign - had a big drop in the number of reported accidents.

The diagram below shows that all of Denmark during the summer of 1988 had a big drop in the number of traffic accidents with drunken 17-19 year old drivers of cars and motorbikes compared to the previous 4 years. In Northern Jutland the drop in this group was 11 times bigger than in the group of 20-99 year olds. In the rest of Denmark the drop in the group of 17-19 year olds only was 1.7 times bigger than in the group of 20-99 year olds.

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of drunken drivers of cars and motorbikes involved in traffic accidents during the summer months (May-August).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Northern Jutland</td>
</tr>
<tr>
<td></td>
<td>Average 1984-87</td>
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<tr>
<td>0-16 years</td>
<td>1</td>
</tr>
<tr>
<td>17-19 years</td>
<td>30</td>
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<tr>
<td>20-99 years</td>
<td>144</td>
</tr>
</tbody>
</table>
During the last months of the year and the first months of 1989 the number of traffic accidents with drunken 17-19 year old drivers slowly was increasing to normal level. Therefore a new campaign was needed. See the diagram below.

<table>
<thead>
<tr>
<th>Month</th>
<th>83</th>
<th>84</th>
<th>85</th>
<th>86</th>
<th>87</th>
<th>Average 83-87</th>
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<tr>
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<td>12</td>
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<td>10,2</td>
<td>2</td>
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<tr>
<td>June</td>
<td>9</td>
<td>15</td>
<td>8</td>
<td>7</td>
<td>4</td>
<td>8,6</td>
<td>3</td>
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<td>July</td>
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<td>10</td>
<td>6</td>
<td>12</td>
<td>10,6</td>
<td>6</td>
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<tr>
<td>August</td>
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<td>7</td>
<td>10</td>
<td>6</td>
<td>9</td>
<td>7,8</td>
<td>6</td>
</tr>
<tr>
<td>September</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>5,4</td>
<td>4</td>
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<tr>
<td>October</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>4,6</td>
<td>6</td>
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<tr>
<td>November</td>
<td>2</td>
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<td>4</td>
<td>7</td>
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<tr>
<td>December</td>
<td>8</td>
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<td>4</td>
<td>7</td>
<td>3</td>
<td>6,4</td>
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<td>January</td>
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<td>3</td>
<td>0</td>
<td>1,8</td>
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<td>February</td>
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<td>4</td>
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<td>6</td>
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<tr>
<td>March</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>10</td>
<td>3</td>
<td>4,8</td>
<td>4</td>
</tr>
<tr>
<td>April</td>
<td>7</td>
<td>13</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>6,4</td>
<td>4</td>
</tr>
</tbody>
</table>

* drivers: cars, motorbikes, mopeds, bicycles, pedestrians
5. THE SECOND CAMPAIGN

5.1 Campaign Concept

The second campaign started on the 26th of April 1989 when all young people from 17 to 19 years of age and some of the 16 and 20 year olds received a personal letter from the county.

The letter included a folder, a music tape, a pool coupon and a poster with a beautiful girl pointing a gun at you saying "Freeze - drunk driving won't get you there". The girl was supposed to remind the receivers of the policesergent in the popular TV-series "Dempsy and Makepeace".

Again the lyrics in the song advised not to drive when you have been drinking. It was quite controversial that both the slogan on the posters and the lyrics in the song were in english.

Furthermore a movie spot was produced to be shown with the advertisements in all cinemas in Northern Jutland for 8 weeks during the summer period. The movie showed the girl in the poster making her boyfriend drop his car keys by pointing her gun at him.

Like in the first campaign 5.000 posters were distributed to places where young people meet.

All buspassengers in the county had the opportunity to test their knowledge about drinking and driving. Posters with the pool coupon were hung in the buses at the start of the campaign and later a coupon with the correct answers was shown.

The campaign cost 0,76 million D.kr. including 0,14 million D.kr. for the music tape, 0,10 million D.kr. for the postage and 0,27 million D.kr. for producing and showing the movie spot. Expenses for administration by the county council personnel are not included.

5.1 Result in Terms of Traffic Accidents

As shown in the following diagram the second campaign did not succeed in keeping the number of accidents among 17-19 year old drivers as low as the first campaign, but it is still remarkable lower than in the years before the two campaigns.
Number of traffic accidents with drunken drivers* during summers (May-August) in Northern Jytland.

<table>
<thead>
<tr>
<th>Age</th>
<th>83</th>
<th>84</th>
<th>85</th>
<th>86</th>
<th>87</th>
<th>Average 83-87</th>
<th>88</th>
<th>89</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-16 years</td>
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<td>3</td>
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<tr>
<td>17-19 years</td>
<td>44</td>
<td>42</td>
<td>32</td>
<td>31</td>
<td>37</td>
<td>37.2</td>
<td>17</td>
<td>20</td>
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<tr>
<td>20-25 years</td>
<td>73</td>
<td>67</td>
<td>85</td>
<td>58</td>
<td>57</td>
<td>68.0</td>
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<td>36</td>
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<tr>
<td>26-99 years</td>
<td>87</td>
<td>107</td>
<td>107</td>
<td>120</td>
<td>97</td>
<td>103.6</td>
<td>96</td>
<td>105</td>
</tr>
<tr>
<td>Sum</td>
<td>211</td>
<td>218</td>
<td>225</td>
<td>212</td>
<td>193</td>
<td>211.8</td>
<td>180</td>
<td>164</td>
</tr>
</tbody>
</table>

* drivers: cars, motorbikes, mopeds, bicycles, pedestrians

It is not surprising that the second campaign appears to have less effect than the first campaign. The first direct mail to the target group had the benefit of being unusual and surprising to the receivers.

The pool coupons in the buses and especially the movie spot in the cinemas spread the second campaign out wider among all young people than the first campaign. Maybe this can be some sort of explanation why there was a drop in accidents with drunken 20-25 year old drivers involved. Furthermore all the 20 year olds and some of the 21 year olds had received the campaign material the year before.

6. EVALUATION

6.1 Results

In the County Council Administration we are quite sure that our campaigns have promoted a new acknowledge of drunken driving among young people.
During the summer of 1990 half of the counties in Denmark have followed in the footsteps of Northern Jutland. Based on direct mail and music tapes 6 counties have carried out local campaigns against young peoples mixture of drinking and driving. Furthermore all 17-20 year olds in Denmark have received a direct mail from the Danish Council of Road Safety Research concerning the same problem.

It is not proved that the drop in the number of traffic accidents among drunken 17-19 year olds alone is an effect of the campaigns but the drop appears to be more than a coincidence.

The drop in number of accidents with drunken 17-19 year old drivers from the average of 37.2 accidents during the summers 1983-87 to 17 and 20 accidents in the summers of 1988 and 1989 gave savings of 9 million and 7.7 million D.kr. On top of this human sufferings and tragedy of losses were saved.

6.2 Campaign experience

Compared to other campaigns which the county has carried out the two mentioned campaigns have given following new experiences to be used in the future:

- the target group must be limited and not cover too widely concerning age,
- campaigns with local information are considered more relevant by the receiver,
- the personal appeal (direct mail) gives a better impression of the receiver being the precise target of the campaign,
- the campaign can last for a short period of time but it must hit directly and hard,
- most campaigns can not be expected to have a long lasting effect.
The Effectiveness of the 1988 Police National Motorway Safety Campaign

Nicola Christie
Higher Scientific Officer
Transport and Road Research Laboratory
United Kingdom
THE EFFECTIVENESS OF THE 1988 POLICE NATIONAL MOTORWAY SAFETY CAMPAIGN

BY

NICOLA CHRISTIE AND CHARLES DOWNING, TRANSPORT AND ROAD RESEARCH LABORATORY.

ABSTRACT

In July 1988 the Police launched a National Motorway Safety Campaign to improve drivers' behaviour and help reduce motorway accidents. Previous campaigns were run in 1985 and 1986. The themes of the campaign were 'Keep your distance' and 'Watch your speed'. The campaign involved national and local publicity with the focus on Service Area Exhibitions. A policy of high police presence and enforcement was recommended during the campaign. Interview surveys and traffic data measures were taken before, during and after the campaign.

Results showed that high awareness of the campaign was achieved by free national and local TV and radio coverage with more than two thirds of drivers having heard of the campaign. Exhibitions were far less effective in achieving awareness. Recall of the main themes was relatively poor, the prevalence of non-campaign themes (ie. general road safety themes not selected for the campaign by the organizing committee) seeing to have interfered with recall. Less than half the drivers interviewed (33%) said that their behaviour would be affected by the campaign and most did not identify themselves as the target audience. Knowledge communication with regard to stopping distances was extremely poor. There was a slight increase in awareness of the
police during the campaign though few drivers said this had influenced their driving. Behavioural measures suggest that the campaign had little effect on speed or close following. Overall the findings suggest that excessive speed and close following behaviour are extremely resistant to modification through traditional publicity techniques and alternative strategies need to be researched.
THE EFFECTIVENESS OF THE 1988 POLICE NATIONAL MOTORWAY SAFETY CAMPAIGN

N Christie
Higher Scientific Officer
Transport and Road Research Laboratory

1. INTRODUCTION

In July 1988 the Police launched a National Motorway Safety Campaign to improve drivers' behaviour and help reduce motorway accidents. In 1987, more than 9000 people were injured on British motorways, of which, nearly 2000 were killed or seriously injured.

As a measure to combat motorway accidents the Association of Chief Police Officers (ACPO) Traffic Committee has mounted national campaigns in 1985, 1986 (to contribute to European Road Safety Year) and again in 1988. This paper reports on the evaluation of the 1988 campaign.

2. AIMS OF THE CAMPAIGN

The aims of the campaign were to help reduce motorway accidents in the following ways:

1. By informing the public of the risks of poor motorway driving especially in relation to close following and excessive speed for the conditions.

2. By improving drivers' awareness of good driving practice on motorways.

3. By increasing drivers' awareness of police enforcement activity on motorways during the campaign in order to influence their driving.

3. THE CAMPAIGN

The campaign was scheduled to run for 9 days in July (21 - 29th) and consisted mainly of exhibitions sited within Motorway Service Areas throughout England and Wales.

Two main themes were selected for the campaign:

1) Keep a safe distance from the car in front
2) Select a safe speed for the conditions

A range of publicity material was produced to support the campaign. For example, a booklet on safe motorway driving was produced for distribution at each participating motorway.
service area. A display panel designed in the style of the booklet was also made available to each campaign site. A video on motorway driving featuring a well known personality from national radio and television was produced and supplied to every manned site. The Department of Transport commissioned their advertising agency to produce a series of posters and radio commercials with the theme 'DON'T GET DEAD CLOSE'. There were also car bumper and dashboard stickers with the slogan 'KEEP YOUR DISTANCE'. Some displays and exhibitions were manned by the police with support from other agencies. Others were unmanned and as a consequence the publicity profile varied at different sites.

ACPO Traffic Committee recommended to participating forces a policy of high police presence and enforcement during the campaign. Those forces which supported this policy pledged an increase in manpower and vehicles above usual strengths. It was agreed by the Committee that the priorities for enforcement should be offences involving excessive speed and following too closely.

The campaign was launched at New Scotland Yard to give the campaign a high profile. Members of the national media were invited and this achieved extensive coverage in national and local news media.

4.EXPERIMENTAL DESIGN

The campaign was evaluated by interviewing members of the public at motorway service areas and by collecting speed and following distance data before, during and after the campaign. In order to assess the relative effectiveness of different levels of publicity and enforcement*, 4 motorway service areas were chosen:

1) one with both high publicity and high enforcement profiles
2) one with both low publicity and low enforcement profiles
3) one with high publicity and low enforcement profiles
4) one with low publicity and high enforcement profiles.

There were no control sites because the campaign was national.

4.1 Public opinion surveys

An interview survey was conducted at each site during three 5 day phases - before, during and after the campaign. Approximately 1500 interviews were completed at each phase.

Interviews took place in the car park when drivers were returning to their cars from the service buildings.
The questionnaires were designed to assess campaign effectiveness in terms of standard criteria including campaign impact, the extent to which it communicated relevant road safety knowledge, recall and comprehension of the main messages, degree of personal identification with the advice given and the ability of the campaign to motivate a behavioural change.

4.2 Behavioural measures

Traffic Data Units (TDUs) were installed to measure traffic flows, vehicle speeds and following distances. Each TDU essentially consisted of a microprocessor programmed to receive feedback about traffic behaviour from digital loop detectors secured in shallow grooves cut into each lane of the road surface.

TDUs were installed approximately 3 miles beyond each of the service areas used for the interview surveys. This interval was selected to allow for driving to reach a level of normality after exiting the service area and to avoid any major maintenance schemes liable to cause disruption and delays to traffic.

Data were collected before, during and after the campaign on the same days as the interview surveys.

* Definition of publicity and enforcement levels:

A high profile publicity level consisted of an exhibition manned by at least two police officers and members of other organisations like the RAC and the AA. A range of publicity items were used including videos, caravans, crashed cars, eye-sight testing equipment, slide shows, leaflets, booklets, stickers, etc.

A low profile publicity level would be an unmanned display with minimal literature and displays.

A high profile enforcement level was one where manpower and vehicles were increased above normal strengths.

A low profile enforcement level was one where normal manpower and vehicle levels were maintained.
5. RESULTS

5.1 Awareness of the campaign

During the campaign a high proportion of drivers (67%) reported that they knew that the Police Motorway Campaign was running that week. This high awareness seems to have been mainly achieved by free national and local television and radio coverage (mentioned by 49% and 46% of the sample respectively). It is interesting to note the relative success of radio which implies that it is an important media for reaching the driver whilst he is driving. The Service Area Exhibitions in which considerable man hours were invested were comparatively less effective in achieving awareness (mentioned by 24% of the sample). Therefore the national media coverage was a more effective way of making the public aware of the campaign.

The Service Area Exhibitions had a low impact on drivers. Only 27% (398) of all drivers sampled during the campaign said that they had visited an exhibition somewhere.

5.2 Recall of campaign themes

Recall of the central themes of the exhibitions was not good as 60% of drivers who visited an exhibition mentioned themes other than the central themes of the campaign. Of the actual themes, 'Keep your distance' was mentioned by 41% of respondents as the main theme and was more effectively recalled than 'Select a safe speed for the conditions' mentioned by 29%. Thirteen percent did not know what the themes were. At the high profile publicity sites there was a tendency for the main messages and in particular 'Keep your distance' to be better recalled.

TRRL staff visited the survey sites and photographed and observed the exhibitions. Visit reports and photographs suggest that themes other than those selected by the organizing committee were promoted and contributed to a diluting of the impact of the two main messages.

5.3 Effect of exhibitions on behaviour (self-reported)

A third (33%) of those drivers who visited an exhibition reported that the campaign would affect the way they drove on the motorway. Of these, 52% said that they would drive more carefully and 42% said they would drive at a lower speed. Only 20% said that they would follow at a safer distance. This suggests that reducing speed is a more 'top of mind' (ie. quickly recalled) behavioural response than following at a safer distance despite the evidence that the latter was generally more effectively communicated by the publicity.
Respondents were also asked if they thought other drivers' behaviour would be affected by the campaign. Fifty four percent thought that it would. The disparity between the proportion of drivers who said their own driving would be affected by the campaign (33%) compared to other drivers (54%) suggests respondents did not sufficiently identify themselves as the target audience.

5.4 Effect of the campaign on perceived risk

There was a significant** increase during the campaign in the number of drivers (44%) who mentioned 'close following' as one of the main causes of motorway accidents (see Table 1).

However, there was no significant increase in the number of drivers (49%) who mentioned 'driving too fast for the conditions' as one of the main causes of motorway accidents (see Table 2). 

**In this study, a result is described as significant if its probability of occurring by chance was estimated to be less than 1 in 20.

### TABLE 1

<table>
<thead>
<tr>
<th>site</th>
<th>before %</th>
<th>before no.</th>
<th>during %</th>
<th>during no.</th>
<th>after %</th>
<th>after no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH PUBLICITY</td>
<td>44</td>
<td>164</td>
<td>40</td>
<td>150</td>
<td>44</td>
<td>164</td>
</tr>
<tr>
<td>HIGH ENFORCEMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOW PUBLICITY</td>
<td>43</td>
<td>159</td>
<td>48</td>
<td>181</td>
<td>34</td>
<td>124</td>
</tr>
<tr>
<td>LOW ENFORCEMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOW PUBLICITY</td>
<td>31</td>
<td>116</td>
<td>40</td>
<td>150</td>
<td>39</td>
<td>146</td>
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<tr>
<td>HIGH ENFORCEMENT</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HIGH PUBLICITY</td>
<td>35</td>
<td>130</td>
<td>48</td>
<td>172</td>
<td>42</td>
<td>154</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVERALL</td>
<td>38</td>
<td>569</td>
<td>44</td>
<td>653</td>
<td>40</td>
<td>589</td>
</tr>
</tbody>
</table>

VTI RAPPORT 365A
TABLE 2

Percentage and number of drivers who mentioned 'driving too fast for the conditions' as one of the main causes of motorway accidents by site and phase.

<table>
<thead>
<tr>
<th>site</th>
<th>before %</th>
<th>before no.</th>
<th>during %</th>
<th>during no.</th>
<th>after %</th>
<th>after no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH PUBLICITY</td>
<td>59</td>
<td>221</td>
<td>42</td>
<td>157</td>
<td>54</td>
<td>201</td>
</tr>
<tr>
<td>LOW PUBLICITY</td>
<td>48</td>
<td>180</td>
<td>50</td>
<td>189</td>
<td>43</td>
<td>156</td>
</tr>
<tr>
<td>LOW ENFORCEMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOW PUBLICITY</td>
<td>48</td>
<td>181</td>
<td>49</td>
<td>183</td>
<td>47</td>
<td>175</td>
</tr>
<tr>
<td>HIGH PUBLICITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOW ENFORCEMENT</td>
<td>44</td>
<td>166</td>
<td>54</td>
<td>194</td>
<td>48</td>
<td>175</td>
</tr>
<tr>
<td>OVERALL</td>
<td>50</td>
<td>748</td>
<td>49</td>
<td>723</td>
<td>48</td>
<td>707</td>
</tr>
</tbody>
</table>

There was also a significant increase in the number of drivers who rated 'close following' as 'very hazardous' during the campaign (92%) compared with before the campaign (89%). This increase was greater at high profile publicity sites.

Overall, there was no significant increase in the number of drivers who rated 'driving too fast for the conditions' on motorways as 'very hazardous' during the campaign (94%) compared with before the campaign (94%). However, there was evidence of an increase at the high profile publicity sites.

Of the potential hazards on motorways presented to respondents, 'driving too fast' and 'close following' were rated by over 90% of respondents as being 'very hazardous' (see Table 3).
TABLE 3

Percentage and number of respondents who rated specified hazards on motorways as 'very hazardous' and who mentioned each hazard as a main cause of motorway accidents (all sites and phases combined).

<table>
<thead>
<tr>
<th>specified potential hazards on motorway</th>
<th>rated as 'very hazardous'</th>
<th>mentioned as a main cause of motorway accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>no.</td>
</tr>
<tr>
<td>driving too fast for the conditions</td>
<td>93</td>
<td>4154</td>
</tr>
<tr>
<td>close following</td>
<td>90</td>
<td>4029</td>
</tr>
<tr>
<td>poor lane use</td>
<td>84</td>
<td>3765</td>
</tr>
<tr>
<td>tiredness and fatigue</td>
<td>77</td>
<td>3449</td>
</tr>
<tr>
<td>poor use of indicators</td>
<td>75</td>
<td>3361</td>
</tr>
<tr>
<td>bad weather</td>
<td>50</td>
<td>2231</td>
</tr>
<tr>
<td>roadworks/contraflows</td>
<td>45</td>
<td>2020</td>
</tr>
<tr>
<td>heavy traffic</td>
<td>42</td>
<td>1898</td>
</tr>
</tbody>
</table>

5.7 Knowledge Communication: Stopping Distances

There was no significant improvement in drivers' knowledge of the correct stopping distance for a car travelling at 70mph on a dry road during the campaign. Knowledge of stopping distances was extremely poor. Only 8% of the total sample gave precisely correct answers (as given in the Highway Code and campaign publicity material). A further 8% estimated the stopping distance within a fairly accurate range (ie. plus or minus 10% of the correct distance). Overall, over 70% of respondents underestimated the stopping distance!

5.8 Awareness of police activity

Overall, there was a slight but not significant increase in the number of drivers (57%) who reported that they had seen police vehicles on the motorway during the campaign. The greatest increases in awareness were recorded at high profile enforcement sites (see Table 4).
TABLE 4

Percentage and number of drivers who said they had seen police vehicles on the motorway on the day of interview by site and phase.

<table>
<thead>
<tr>
<th>site</th>
<th>before</th>
<th>during</th>
<th>after</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>no.</td>
<td>%</td>
</tr>
<tr>
<td>HIGH PUBLICITY HIGH ENFORCEMENT</td>
<td>56</td>
<td>210</td>
<td>69</td>
</tr>
<tr>
<td>LOW PUBLICITY LOW ENFORCEMENT</td>
<td>48</td>
<td>181</td>
<td>50</td>
</tr>
<tr>
<td>LOW PUBLICITY HIGH ENFORCEMENT</td>
<td>59</td>
<td>222</td>
<td>64</td>
</tr>
<tr>
<td>HIGH PUBLICITY LOW ENFORCEMENT</td>
<td>57</td>
<td>214</td>
<td>43</td>
</tr>
<tr>
<td>OVERALL</td>
<td>55</td>
<td>827</td>
<td>57</td>
</tr>
</tbody>
</table>

Overall, about a quarter of drivers said their driving was influenced by seeing police vehicles on the motorway. Of these drivers, the vast majority (86%) said that they had driven at a lower speed. Only 1% said that they had followed at a safer distance.

Drivers were also asked if they thought that the police were stopping more motorists who drive dangerously on motorways nowadays. Significantly more drivers (29%) during the campaign compared with before the campaign (24%) thought that the police were stopping more drivers on motorways nowadays.

5.9 Effect of the campaign on speed and following distance

The weekly average speed and percentage of traffic close following (headway between vehicles of less than 2 seconds) for each survey site is shown for each lane before and during the campaign in Tables 5 and 6 below. Data from the post-campaign phase has been excluded because of a marked change in weather conditions and the pattern of vehicles (ie cars, Heavy Goods Vehicles - HGVs) making up the flow.
The high dependence of speed and following distance on constantly changing variables such as vehicle flow, the proportion of vehicles which are HGVs, weather conditions incidents such as accidents and roadworks make it difficult to identify campaign effects with any degree of confidence.

Table 5
Mean speed of vehicles per lane by site and phase.

<table>
<thead>
<tr>
<th>site</th>
<th>offside lane before</th>
<th>during</th>
<th>centre lane before</th>
<th>during</th>
<th>nearside lane before</th>
<th>during</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH PUB.</td>
<td>75.7</td>
<td>74.9</td>
<td>68.8</td>
<td>68.5</td>
<td>59.8</td>
<td>59.7</td>
</tr>
<tr>
<td>HIGH ENF.</td>
<td>79.7</td>
<td>80.3</td>
<td>73.7</td>
<td>73.6</td>
<td>62.6</td>
<td>62.6</td>
</tr>
<tr>
<td>LOW PUB.</td>
<td>81.8</td>
<td>80.6</td>
<td>75.9</td>
<td>74.7</td>
<td>63.4</td>
<td>62.9</td>
</tr>
<tr>
<td>LOW ENF.</td>
<td>71.6</td>
<td>78.3</td>
<td>72.5</td>
<td>71.5</td>
<td>60.3</td>
<td>59.8</td>
</tr>
</tbody>
</table>

Table 6
Percentage of total flow close following per lane by site and phase.

<table>
<thead>
<tr>
<th>site</th>
<th>offside lane before</th>
<th>during</th>
<th>centre lane before</th>
<th>during</th>
<th>nearside lane before</th>
<th>during</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH PUB.</td>
<td>33.2</td>
<td>35.8</td>
<td>32.0</td>
<td>36.4</td>
<td>16.3</td>
<td>17.3</td>
</tr>
<tr>
<td>HIGH ENF.</td>
<td>39.1</td>
<td>39.9</td>
<td>36.2</td>
<td>38.0</td>
<td>16.1</td>
<td>16.5</td>
</tr>
<tr>
<td>LOW PUB.</td>
<td>35.6</td>
<td>35.0</td>
<td>33.0</td>
<td>35.0</td>
<td>15.7</td>
<td>16.3</td>
</tr>
<tr>
<td>LOW ENF.</td>
<td>37.6</td>
<td>32.6</td>
<td>30.1</td>
<td>26.6</td>
<td>34.1</td>
<td>33.1</td>
</tr>
</tbody>
</table>
Overall, the behavioural data indicate that the campaign had little or no effect on speed or close following behaviour. The facts that the mean speed in the offside lane is frequently over 80 mph and that more than 30 per cent of vehicles are following at intervals of less than 2 seconds indicate that there is plenty of scope for improvement and that more effective measures need to be found.

5.10 Sex and age differences

The influence of differences in sex and age were investigated in relation to two important aspects of the campaign: 1) Respondents who visited the exhibitions and who claimed that their driving would change; and 2) Respondents who said they had seen police vehicles on the motorways and reported that this had influenced their driving.

Significantly more males (16%) than females (7%) reported having visited the service area exhibition at the survey site. However, of those who had visited an exhibition significantly more females (64%) than males (31%) reported that their driving would be affected. There were no significant differences in the extent to which males and females reported having seen police vehicles or in the way they had reacted to seeing a police vehicle.

Significantly fewer of the youngest respondents (17-24 years) reported visiting a service area exhibition (9%) compared to other age groups (16%). Also, younger drivers aged 25-34 years (22%) were less likely to report that the campaign would affect their driving than other age groups (37%). Significantly less respondents aged 60+ (45%) compared to younger drivers (57%) reported having seen the police and significantly more under 45's (27%) compared to over 45's (21%) reported that seeing a police vehicle had affected their driving.

6. SUMMARY OF FINDINGS AND CONCLUSIONS

1) High awareness of the campaign was achieved by free national and local television and radio coverage with more than two thirds of drivers surveyed having heard of the campaign. These media proved more effective in achieving awareness than service area exhibitions which had been visited by about a quarter of drivers surveyed. Radio proved to be a particularly effective medium. Unmanned low profile exhibitions proved to be notably ineffective.

2) Recall of the campaign themes was relatively poor, and the presence of non-campaign themes (ie. general road safety themes not selected for the campaign by the organizing Committee) seems to have contributed to this by interfering with recall. 'Keep your distance' was more effectively
recalled (41% of respondents) than 'select a safe speed for conditions' (29%).

3) Of the few drivers who said that their driving would be affected by the campaign, most drivers said that they would drive more carefully (52%) and at a safer speed (42%) than follow at a safer distance (20%). Respondents thought that 'other' drivers' behaviour was more likely to be affected by the campaign than their own indicating that many did not identify themselves as targets of the campaign.

4) Overall, there was a significant increase in the number of drivers who rated 'close following' as very hazardous during the campaign and as a main cause of motorway accidents. There was no significant change in the perception of speed as a main cause of motorway accidents. Overall, about 50% of drivers cited driving too fast for the conditions as a major cause of motorway accidents and about 40% cited following too closely.

5) The campaign did not effectively communicate knowledge about safe stopping distances which was extremely poor. The majority of respondents (about 70%) underestimated the distance required to stop a vehicle travelling at 70 mph on a dry road.

6) There was a slight increase in drivers' awareness of police presence on motorways during the campaign. Amongst drivers who had seen a police vehicle on the motorway about a quarter said this had influenced their driving. Of these, nearly all (86%) said that they had reduced their speed, but hardly any (1%) had followed at a safer distance.

7) Behavioural measures suggested that the campaign had had little effect on speed or close following with mean speeds in the offside lanes close to 80 mph and more than a third of drivers following at intervals of less than 2 seconds before and during the campaign.

8) The last finding allied to the survey findings suggest that both excess speed and following too closely are well established behaviours that are extremely resistant to modification through traditional publicity techniques. Police presence seemed to have an immediate but short lived effect on speed, but little or no impact on close following. Research is needed to identify more effective publicity and enforcement strategies particularly with respect to close following and to explore the potential of new initiatives such as chevron markings on the road surface to provide practical guidance to drivers on safe following intervals.
7. ACKNOWLEDGEMENTS

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The author wishes to acknowledge the assistance of Mr. P. Burrell and Mrs. J. Franklin in organizing and supervising the survey and all of the Police forces who co-operated in the survey.

8. REFERENCES


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Improvement of Traffic Safety by Local Public Relations Campaigns

Klaus Schlabbach
Dipl-Ing
Town Planning Authority Darmstadt
Federal Republic of Germany
IMPROVEMENT OF TRAFFIC SAFETY BY LOCAL PUBLIC RELATIONS CAMPAIGNS

During the last decades the point of main effort at the local level was engineering and enforcement. Till now there are only a few experiences about the effects of local PR-campaigns. The paper describes the basis and suppositions for such a conception in the Federal Republic of Germany and the division of labour between federal and local institutions. All the time those campaigns had been done in a centralized manner mainly induced by the German Road Safety Association. This is surely an important task, but a special effort of each individual participant for increasing traffic safety did not happen.

The background of Darmstadt is very suitable for such an experiment, because the city belongs to the "top ten" of the risk statistics. 1986 a first field trial was done in a residential area in Darmstadt (6,900 inhabitants, 75 ha) to find out the conditions for slowing down the speed voluntarily. A professional advertising agency was engaged to develop a concept for graphical communication to convince people for reducing speed in residential areas (30 km/h); no other measures were provided. This innovative approach and the results will be discussed. The reduction of the mean velocity by 11% is surely not enough, but it shows that the soft policy of public relations can be effective under certain circumstances. 1988 the government of the state of Hessen decided to test the French "Minus 10%"-idea as a part of a new traffic safety policy: "Every particular road user should be activated to reduce the number of accidents with injuries by 10% within one year". Two rural districts and the city of Darmstadt take part in this programme which is unique in the Federal Republic of Germany. The results of this second example are very promising; within 12 months the accidents with injuries were reduced by 10,6%. This public relations campaign did not only change the behaviour of
cardrivers, but changed too the awareness of the public and political parties in Darmstadt.

With regard to the European Community 1992 it is suggested to integrate public relations campaigns in a common traffic safety policy as a local approach with central support. The results in other countries (France, Austria) justify this intention.
IMPROVEMENT OF TRAFFIC SAFETY BY LOCAL PUBLIC RELATIONS CAMPAIGNS

K. Schlabbach
Dipl.-Ing.
Town Planning Authority, Darmstadt, West Germany

1. INTRODUCTION

Towns and communities are at the lowest level in the administration hierarchy of traffic safety, but they are also in direct contact with the people. The federal state and the "Länder", as higher-level institutions, can give orders and directives to the communities. For example, traffic control is effected by the police in accordance with the German Road Traffic Regulations; a great number of guidelines from the German Road and Transportation Research Association ensure, that the latest state of the art is responsibly applied and further developed. In the process of legislation, the towns can at best play an advisory role. In this way direct influence on questions concerning f.e. seat-belt-law, driving licences, traffic offences and technical improvements on vehicles, are taken away from the town authorities.

The practical work at the local level is restricted to a great extent to the construction and maintenance of roads in their own area of responsibility and - to a limited extend - to the creation of a "safe" local climate through public relations campaigns. All the time those campaigns had been done in a centralised manner mainly induced by the German Road Safety Association. This is surely an important task, but one of the disadvantages was, that only few people were reached at the local level. A special effort of each individual participant for increasing traffic safety did not happen. The federal political structure of West Germany permits the particular "Länder" a great deal of independence in the field of road safety. In the state of "Hessen", a Road Safety Commission had been set up 1971 which is responsible to the Minister for Economics and Technology. 1974 Darmstadt was the first major town, choosen for a "joint venture" project for reducing accidents. Even though this plan was not realized in the end, it was nevertheless the start of intensive community work to increase the level of road safety in Darmstadt.

2. LOCAL BACKGROUND

Darmstadt lies approx. 30 km south of Frankfurt. The 122 km² urban area is criss-crossed by 330 km of roads. Statistically this means about 80 gm of road for each of the 136.000 inhabitants (status 31.03.1990). This aboveaverage value can be partly explained by the elongated position of the city between the Rhine plain and the Odenwald (15 x 5 km residential areas). Darmstadt is the home of several well-known research institutions and has a Technical University with about 19.000 students. About 105.000
jobs are available, half of which are occupied by commuters. The part of public transport in the modal split is barely 25%. By-passes only exist for the suburbs and in the western part of the central area. That is why a lot of traffic from the southeastern region has to use narrow roads without sufficient capacity during the peak hours. With the continuously increasing level of motorization, Darmstadt belongs to the leading towns in the Federal Republic of Germany (status 31.03.1990: 570 motor vehicles/1,000 inhabitants).

According to this, traffic safety is a great problem. Since 1977, the number of accidents had remained relatively constant at approx. 5,300 accidents per year; 1984, the number increased noticeably and reached about 5,500 in 1989. The situation of pedestrians is particularly serious; they are involved in approx. 3% of all accidents, but they represent 8% of the slightly injured, 20% of the seriously injured and nearly 50% of the fatal accidents. Compared with other German cities, Darmstadt belongs to the "top ten" of the risk statistics (Tab. 1).

| Berlin    | 79 | Ingolstadt | 63 |
| Osnabrück | 71 | Kiel        | 59 |
| Hamburg   | 57 | München     | 59 |
| Bamberg   | 55 | Oldenburg   | 59 |
| Neumünster| 64 | Darmstadt   | 59 |

Tab. 1: Risk statistics 1985 (number of persons involved in accidents/10,000 day-time population)
If the comparison is reduced only to seriously injured and fatal accidents, the position of Darmstadt is below the mean-value (Tab. 2).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Erlangen</td>
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<td>77</td>
<td>158.000</td>
<td>2.905</td>
<td>46</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
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<td>93</td>
<td>130.000</td>
<td>2.422</td>
<td>47</td>
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<tr>
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<td>148.000</td>
<td>2.700*</td>
<td>46</td>
<td>11.9</td>
<td></td>
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<tr>
<td>Siegen</td>
<td>109.000</td>
<td>115</td>
<td>146.000</td>
<td>2.450*</td>
<td>43</td>
<td>11.9</td>
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<tr>
<td>Heilbronn</td>
<td>111.000</td>
<td>100</td>
<td>156.000</td>
<td>2.900*</td>
<td>51</td>
<td>14.5</td>
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<td>Koblenz</td>
<td>112.000</td>
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<td>52</td>
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<td>208.000</td>
<td>4.297</td>
<td>51</td>
<td>11.6</td>
<td></td>
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<tr>
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<td>81</td>
<td>187.000</td>
<td>4.155</td>
<td>56</td>
<td>12.0</td>
<td></td>
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<tr>
<td>Heidelberg</td>
<td>133.000</td>
<td>109</td>
<td>195.000</td>
<td>4.000*</td>
<td>51</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Göttingen</td>
<td>134.000</td>
<td>117</td>
<td>219.000</td>
<td>4.993</td>
<td>59</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>Darmstadt</td>
<td>137.000</td>
<td>122</td>
<td>219.000</td>
<td>4.993</td>
<td>59</td>
<td>9.6</td>
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<tr>
<td>Oldenburg</td>
<td>139.000</td>
<td>103</td>
<td>178.000</td>
<td>4.221</td>
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<td>10.2</td>
<td></td>
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<tr>
<td>Neuss</td>
<td>146.000</td>
<td>100</td>
<td>180.000</td>
<td>3.491</td>
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<td>11.3</td>
<td></td>
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<tr>
<td>Osnabrück</td>
<td>156.000</td>
<td>120</td>
<td>212.000</td>
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<td>71</td>
<td>14.3</td>
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<tr>
<td>Ludwigshafen</td>
<td>157.000</td>
<td>78</td>
<td>244.000</td>
<td>4.389</td>
<td>45</td>
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<tr>
<td>Leverkusen</td>
<td>157.000</td>
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<td>215.000</td>
<td>3.568</td>
<td>42</td>
<td>11.3</td>
<td></td>
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<td>Solingen</td>
<td>160.000</td>
<td>90</td>
<td>190.000</td>
<td>2.867</td>
<td>38</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>Mülheim/R.</td>
<td>176.000</td>
<td>91</td>
<td>210.000</td>
<td>3.425</td>
<td>41</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>Freiburg</td>
<td>180.000</td>
<td>153</td>
<td>240.000</td>
<td>5.200*</td>
<td>54</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>Mainz</td>
<td>187.000</td>
<td>98</td>
<td>260.000</td>
<td>4.247</td>
<td>41</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Kassel</td>
<td>188.000</td>
<td>107</td>
<td>260.000</td>
<td>5.419</td>
<td>52</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>Durchschnitt der deutschen Städte</td>
<td>139.000</td>
<td>122</td>
<td>219.000</td>
<td>4.993</td>
<td>59</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>Västerås (Schweden)</td>
<td>100.000</td>
<td>ca. 130</td>
<td>135.000</td>
<td>1.149</td>
<td>21</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Uppsala (Schweden)</td>
<td>108.000</td>
<td>ca. 115</td>
<td>150.000</td>
<td>831</td>
<td>14</td>
<td>4.0</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 2: Risk statistics (special towns; 100.000 - 190.000 inhabitants, area 80 - 150 km²)

* number of persons involved in accidents
** number of seriously and fatal injured both per 10.000 day-time population
The division of labour within the community administration means that a lot of offices and departments become involved in the complex problem of traffic safety. As a result of the pronounced hierarchical organization - office director, departmental head, subject director and clerk in each case - an enormous amount of co-ordination is required through to a possible idle period. The discussion of such disadvantages has led to a series of proposals aimed at reorganizing the administrative processes. For this purpose the Road Safety Work Force was set up 1984 with the following members:

- Road Traffic Authorities,
- Civil Engineering Office,
- Town Planning Office,
- Parks and Public Gardens Office,
- School Office,
- various police stations,
- local Public Transport Authorities,
- German Child Protection Association,
- Institute for Living and Environment.

This, at first sight, explosive mixture has, in a short period of time, developed into a team with a high level of technical competence. Unfortunately, this competence does not correspond to the appropriate responsibility, since decisions are taken elsewhere. The Work Force analyses the general and local accident figures, drafts and develops traffic related and constructional modifications, gives initiatives for further planning and intensively follows up suggestions and complaints by the affected inhabitants; in short, it carries out the preparatory work for decisions to be taken at a higher level. The personal composition of the group is more or less constant, a fact which promotes personal trust and mutual respect within the Work Force. As a result, it was possible to quickly break down inhibitions which existed at the outset due to the different levels of education and qualifications.

3. PUBLIC RELATIONS CAMPAIGNS

The members of the Road Safety Work Force soon recognized, that all measures had to fail, if the road users would not behave in the right manner. It is well-known, that all legal regulations can be denied in spite of all deterrent penalties, because of the lack of police man power and money for total supervision. And in the same sense all measures of construction cannot force upon safe and compatible traffic flows, because facilities are needed f.e. for fire-brigades and removal of refuse.

The latter is a special problem within traffic calming. 1986 a field trial was done in a residential area in Darmstadt (6,900 inhabitants, 75 ha) to find out the conditions for slowing down the speed voluntarily. A professional advertising agency was engaged to develop a concept for graphical communication to convince people for reducing speed in residential areas.
(30 km/h); no other measures were provided. The central linkage for the total project was the "logo", an ever repeated sign on all posters, leaflets, advertisings, post cards and so on. There were two different ways to bring the message to the people. Fig. 1 shows the examples for the "bias-version", where often mentioned prejudices were taken and revealed by arguments. The second way was the "testimonial-version". The people shown at the examples of Fig. 2 are living in this area, are respected in the neighbourhood and represent each a special group (children, elder people, cardrivers, motor-cyclists). The total concept cannot be described, because it is a graphical one and must be looked at. The time-table for the different activities must be planned carefully because of the areaspecific and seasonal details; a lot of work had to be done during weekends and evenings, which some members of a "classical" administration are not used to.

For controlling the success of this experiment speed was measured at 13 points in the area and a questionnaire was done. The before-/after-study showed that the mean velocity decreased by 11 % (39.1 km/h -> 34.8 km/h). That is surely not enough, but it shows that the soft policy of public relations can be effective. This is proved too by a second fact; Tab. 3 shows the difference between the measurement values and the questionnaire results; it decreased from 39 % (before) to 12 % (after).

<table>
<thead>
<tr>
<th>Percentage of cardrivers with V ≤ 30 km/h (measurement - all points)</th>
<th>before</th>
<th>after</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 %</td>
<td>32 %</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>&quot;I don't drive quicker than 30 km/h&quot; (questionnaire)</th>
<th>before</th>
<th>after</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 %</td>
<td>44 %</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 3: Speedbehaviour of cardrivers

The public relations campaign did not only change the behaviour of cardrivers, but changed too the awareness of the public and political parties in Darmstadt. That is one reason for the decision to realize over 40 areas with 30 km/h - max. speed within the next 5 years. For further details look at BLANK et al., 1987 and MÜLLER et al., 1988.
Es ist immer das Gleiche -
alle wollen's
keiner macht's

Einer muß ja schließlich mal anfangen. Alas fangen wir an.
Mit Tempo 30. Damit unsere Straßen sicherer werden, der Verkehrslärm zurückgeht und die Umwelt weniger mit Abgasen belastet wird.

Deshalb

TEMPO
30

Da kann man ja gleich zu Fuß gehen

Tempo 30 ist gar nicht so langsam.
Beispiel: Der Weg von der „Brunnenbüh“ bis zur „runden Kirche“ ist 1,4 km lang. Bei Tempo 50 braucht man rund 200 Sekunden,
bei Tempo 30 230 Sekunden.
Das macht pro km nur 20 Sekunden.

Deshalb

TEMPO
30

Fig. 1: Examples for the "bias-version"
I'm a slow rider


Glänzende Lösung - Sofort dafür.

1988 the government of the state of Hessen decided to test the French "Minus 10 %"-idea as part of a new traffic safety policy: "Every particular road user should be activated to reduce the number of accidents with injuries by 10 % within one year." Two rural districts (Vogelsberg/Darmstadt-Dieburg) and the city of Darmstadt take part in this programme. Within the Federal Republic of Germany this is the first time that the French original is tested. The public relations campaign in Darmstadt started at October 1988 and was finished at September 1989. The earlier mentioned Road Safety Work Force is charged to initiate and coordinate the project. The Ministry for Economics and Technology (Hessen) supports the work with 90.000 DM; moreover there are numerous industrial sponsors financing f.e. the printing of posters or the engagement of top stars. This indicates the purpose to combine public and private efforts for the common aim of increasing traffic safety. This combination is done too at the local level with the "multiplier-sessions". The members of this group meet once a month and represent all social aspects (sport clubs, church congregations, trade unions, Technical University, gas and electricity suppliers, car driver associations, employer unions, teachers at schools and kindergarten, pupils and students connections, management and shop committees of big companies a.s.o.). At the beginning nearly 50 people took part in the meetings, unfortunately with a decreasing trend over the months.

Their job was to tell the people of their institutions about the aims and intentions of the "Minus 10 %"-project.

The Ministry of Economics and Technology analysed in a first step the risk patterns of all cities and rural districts in Hessen. The result did not please us, because the city of Darmstadt was recording to many criteria above the average value of the Hessian towns (Tab. 4/5).

<table>
<thead>
<tr>
<th>Town</th>
<th>Turning movements</th>
<th>Denying right of way</th>
<th>Injured cyclists</th>
<th>Injured drivers of mopeds/mofas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darmstadt</td>
<td>170</td>
<td>168</td>
<td>180</td>
<td>39</td>
</tr>
<tr>
<td>Frankfurt</td>
<td>48</td>
<td>108</td>
<td>104</td>
<td>19</td>
</tr>
<tr>
<td>Kassel</td>
<td>53</td>
<td>109</td>
<td>90</td>
<td>21</td>
</tr>
<tr>
<td>Offenbach</td>
<td>73</td>
<td>127</td>
<td>122</td>
<td>35</td>
</tr>
<tr>
<td>Hiesbaden</td>
<td>68</td>
<td>95</td>
<td>58</td>
<td>15</td>
</tr>
<tr>
<td>average</td>
<td>67</td>
<td>114</td>
<td>100</td>
<td>21</td>
</tr>
</tbody>
</table>

Tab. 4: Accident patterns in Hessian towns
(Accidents with injuries/100.000 inhabitants; 1988 - 89)
<table>
<thead>
<tr>
<th></th>
<th>Accidents with injuries / 1000 inhabitants</th>
<th>Percentage above Hessian average value</th>
</tr>
</thead>
<tbody>
<tr>
<td>injured drivers of mopeds/mofas</td>
<td>0.39</td>
<td>+ 86 %</td>
</tr>
<tr>
<td>injured cyclists</td>
<td>1.80</td>
<td>+ 80 %</td>
</tr>
<tr>
<td>accidents by turning movements</td>
<td>1.70</td>
<td>+ 154 %</td>
</tr>
<tr>
<td>accidents by overtaking</td>
<td>0.36</td>
<td>+ 44 %</td>
</tr>
<tr>
<td>accidents by denying right of way</td>
<td>1.68</td>
<td>+ 47 %</td>
</tr>
<tr>
<td>accidents by driving too fast</td>
<td>1.43</td>
<td>+ 29 %</td>
</tr>
<tr>
<td>accidents by alcohol abuse</td>
<td>0.73</td>
<td>+ 16 %</td>
</tr>
</tbody>
</table>

Tab. 5: Darmstadt accident patterns (1986 - 88)

Each crucial point of Tab. 5 is attached to a month of special actions, which got coloured attributes. We started e.g. with the "grey" month November referring to problems of light and visibility; the "blue" month December referred to the peak of accidents by alcohol abuse during this month. The "red" month March referred to the speed problem; May, the "green" month, was dedicated to cyclists and June, the "yellow" month, was dedicated to the turning movement- and right of way-problem. Each month starts with a big event on central places of the pedestrian zone featuring the problem by artists and other stars from sport, culture, television a.s.o. Adding the opening and final performances about 10,000 people visited the seven central events. Complementary there were a lot of articles and reports in public newspapers, company journals and regional television. Nearly 50,000 "logos" as sticky labels were spread (Fig. 3).

Two items have been done to evaluate the project:

A) Changes of accident patterns
Accidents with injuries decreased significantly by 10.6 % if an interval of 12 months is compared. In the state of Hessen and the town of Kassel, which is very suitable for a comparison and where not such campaigns had been made, the change was only about
Even if the before-interval is prolonged up to 3 years the reduction is still 8.3%. Details of the accident patterns are shown in Tab. 3.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents with injuries</td>
<td>1 152</td>
<td>1 030</td>
</tr>
<tr>
<td>All accidents</td>
<td>5 332</td>
<td>5 401</td>
</tr>
<tr>
<td>Pedestrians</td>
<td>137</td>
<td>143</td>
</tr>
<tr>
<td>Cyclists</td>
<td>377</td>
<td>267</td>
</tr>
<tr>
<td>Alcohol abuse</td>
<td>313</td>
<td>254</td>
</tr>
<tr>
<td>Slightly injured</td>
<td>1 270</td>
<td>1 198</td>
</tr>
<tr>
<td>Seriously + fatal injured</td>
<td>213</td>
<td>163</td>
</tr>
</tbody>
</table>

Tab. 3: Accident patterns

B) Questionnaire

During the last phase of the project (August 1989) an inquiry was done at four sites in the central business district. A great deal of people knew about the campaign (79%) by signs, posters and the "logo". 38% evaluate the campaign as "good/very good", 27% were sceptical and only 5% rejected the idea. It is well known that a modified opinion does not automatically mean changes in behaviour; in the inquiry yet 5% of the people told us that the campaign was the turning-point for their individual behaviour. More details are published by MEISSNER-ÖHL et al. (1989).

In the meantime the local authorities decided to continue the campaign in Darmstadt; the good results encouraged the government to offer such campaigns to all local authorities in Hessen; till the end of April 1990 15 of them accepted.

Altogether the two examples show that the "soft policies" are getting more and more important and they can be as effective as the French prototype (LEBRUN, 1989).
4. CONCLUSIONS

Public relations campaigns to increase traffic safety can change the behaviour of road users and the awareness of the society. It is essential to

- refer the campaigns to the local level,
- support them with public money,
- include professional agencies or experts for design and entertainment,
- install a Work Force and give all responsibilities to it,
- get sponsors from industry, business and commerce as part of the programme,
- interest volunteers and people from different social groups in joining the activities ("cumulative returns"),
- combine the educational and instructive approach with traffic-system-management,
- do the job in a fair, open, critical and confident manner not against one another but together.

Fig. 3: "Logo" of the campaign
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Öffentlichkeitsarbeit mit Tempo 30 - das Darmstädter Modell
Straßenverkehrstechnik (32), Heft 6, 1988
A Comedy on TV to Promote Traffic Safety

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Research & Marketing bv  
The Netherlands

and

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The Netherlands
A TV COMEDY FOR PROMOTING TRAFFIC SAFETY

(Contribution to the Internation Conference on Road Safety and traffic environment in Europe, to be held in Gothenburg, Sweden)

Since the end of 1987, a television-series has been promoting traffic safety in the Netherlands. This series, named 'The Oudenrijn-family' after a well-known traffic junction, is a comedy that treats important road safety themes in a casual and playful way.

The members of this tv family, and their neighbours and friends, represent various road user target groups, such as children, adolescents and elderly people. Some of the characters have a special relationship with road safety: the father and mother free-lance for VVN, the Dutch organisation for the production and distribution of road safety information. This manner of presentation is supposed to increase individual as well as institutional concern regarding traffic safety. Moreover, the series is intended to provide a rationale for behavioral traffic safety measures, such as information, education and enforcement. The series is also intended to stimulate public interest for regional road safety events, in which the Oudenrijn family plays an important role.

The SWOV evaluated the series and regional events. Viewer-ratings and penetration were compared with other television programs. In 1988 and 1989 the Dutch population was surveyed concerning general aspects of accident prevention as well as specific traffic behaviors such as speeding, seat belt use and drinking and driving. In addition, an evaluation was made of personal involvement with traffic safety, and attitudes concerning the presentation of road safety public information in general and the Oudenrijn family in particular. The results of these evaluation studies will be presented.

In 1990 the series will be broadcast for the third season. The environmental consequences of traffic will also be given special attention. A preliminary evaluation of this third season will also be presented.

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A COMEDY ON TV TO PROMOTE TRAFFIC SAFETY
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1. INTRODUCTION

A tv-series is used as a central instrument in the information policy on traffic safety in the Netherlands. The series is a family-comedy: "Familie Oudenrijn". The series attracts attention to traffic safety and shows that every road user is able to contribute to it. The conviction that others are to blame for safety problems has to be broken down. People should get 'mobilized' by information or by an example or event. However all these messages seem to be placed second to the daily adventures of the family characters in the series. As a comedy the series should attract viewers.

Now the characters in this series have become well-known to the public, traffic safety has been more and more interwoven into the events of the family. Father "Oudenrijn" designs playbills and cartoons on road traffic. Mother Oudenrijn takes photograph as illustrations to articles in newspapers. Grandfather plays a role as an inspired and energetic man, a volunteer to promote better traffic behaviour. The adults and children are sometimes shown as road users.

Ms. Ducker has an other important role. She comes to consult mr. and ms. Oudenrijn for new orders to produce road safety materials. The themes and the materials which are part of the series can be inserted into local promotional activities. By using them, the communication on traffic safety is integrated, easier recognizable and identifiable to road users.

Three series of 16 shows each have been broadcast since december 1987. VVN, the Dutch Road Safety Association, the organisation for the development and distribution of information materials, developed the plan. TROS, one of the broadcasting organisations, brings the series on tv.

2. DESIGN OF THE EVALUATION-STUDY

The Ministry of Transport subsidized the programme and asked SWOV to carry out a number of evaluation studies. In the first year of the evaluation SWOV invited the research department of "NOS" (Dutch Broadcasting Company) to collect data on viewing figures and marks of people aged 6 and beyond, and to interview a representative sample of the population aged 15 years and beyond. In the before-measurement in December 1987, 542 persons were interviewed, and in the after-measurement in February 1988 413 persons (see Hagenzieker & Wittink, 1988). In the second year "Intomart" collected and analyzed viewers' data. In February 1989, "r + m, Research &
Marketing" executed a survey of the Dutch people (N=542) (see r + m, 1989 a,b,c,d; Wittink & Hagenzieker, 1989). In 1990 "r + m, Research & Marketing" executed another survey. The results of this study are still being analyzed.

As a sequel of the tv-series, traffic shows were organized in eight cities. They consisted of demonstrations, games and information. The main characters of the series took part in the shows. The series was to have a radiating effect on the shows. "r + m Research & Marketing" held a survey about their experiences (N=817) among the visitors aged 12 and beyond. On top of that it was studied how regional newspapers reported on traffic safety during some months before and after the shows.

A theoretical study on the potentials of a television-series by "r + m, Research & Marketing", completed the set of evaluation-studies.

3. RESULTS

3.1. THE PROGRAMME ITSELF

1.1 million people, on average, aged 6 and beyond viewed a show of "Familie Oudenrijn" in 1989. This meant an increase of 20% compared to the year before. It seemed that a more "steady" public viewed more episodes of the series than in 1988. Children between 6 and 12 years old viewed most. The series is broadcast before eight o'clock in the evening. Probably the children invited others to view the series with them. The number of viewers in general are twice as high after eight o'clock.

The marks for the series are over 7 (out of 10). That is good in comparison to other TV-programmes. With respect to the first year the appreciation rose by 0.3. It is highest for children.

In the survey, more than half the people who viewed (N=237) the series found the programme "very worthwhile". Half of them think the programme is informative and important to traffic safety. The problems discussed are recognized. Although the series is a comedy, the majority of the viewers finds that the seriousness of the subject traffic safety gets enough attention.

We composed two image-profiles of the tv-series, on the basis of positive and negative formulated aspects. Table 1 shows that the series seems to be more attractive as a comedy than for the sake of traffic safety. This way it may have its function to keep the threshold to view low.

The positive appreciations score in general higher than the negative. One may expect this from people who view regularly, but there are also many others who view only one episode of a series.
TABLE 1

Image-profile Family Oudenrijn

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Original idea</th>
<th>Nice and easy</th>
<th>Amusing</th>
<th>Humorous</th>
<th>Informative</th>
<th>Relevant to traffic safety</th>
<th>Problems are recognizable</th>
<th>I watch because of traffic safety</th>
<th>Boring</th>
<th>There are enough of this kind</th>
<th>Stories are flat</th>
<th>Infantile</th>
<th>Quickly no more interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100%</td>
<td>1</td>
<td>5%</td>
<td>3%</td>
</tr>
</tbody>
</table>

3.2. TRAFFIC SAFETY AS A PROBLEM

The series is intended to contribute to positive attitudes to traffic safety. The survey serves as a monitor of the Dutch road users' attitudes and opinions. But by comparing opinions, attitudes, reported behaviour and so on from year to year, one sees that there are more things influencing people besides a tv-series. So the differences found can not be contributed to the series only. In fact, the effects of the tv-series are hidden. Where changes in opinions over time were found, it was not possible to discover differences between people who viewed "Familie Oudenrijn" and who did not. That is not in conflict with the idea behind the series. The series is supposed to have a promoting and stimulating effect on other informative activities, it supplies ideas and materials, it is only a starting point for behavioural change.

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So the data should be used for a diagnosis. We collected data on affinity with information on traffic safety, involvement with traffic safety, opinions on the cause of accidents, and attitudes and reported behaviour on seat belts, alcohol and speed limits.

3.2.1. AFFINITY

The influence of the tv-series may be highest on the affinity with traffic information. A comedy is quite different from almost all kinds of information on traffic safety. People were asked four questions with which they could review information about traffic safety. A small majority judged this information as engaging (a significant increase from 39% to 52% from 1988 to 1989), about one third judged it as pedantic, 7% judged it as useless and 6% was of the opinion that the media pay too much attention to traffic safety. A five-point scale was used. Giving the most positive answers a "5"-score and ranking the other answers from 4 to 1, all the persons in the survey could be given a score for affinity with traffic safety. 60% of them had a total score of 15 or more. These were decided to have a high affinity with information on traffic safety.

3.2.2. INVOLVEMENT

In 1989 "involvement" was added as a new item in the survey. We asked people if they wanted to be informed on traffic safety, if it steadily occupied them, and if they often discussed the problem. 21% of the interviewed persons answered "yes" on at least two of the questions. They were labelled "highly involved" in traffic safety. Compared to other issues, traffic safety scored in the middle between other problems of society. It scored higher than the problems of pushing back car use (13% highly involved) and below safeguarding nature and landscape (39%) or the fight of acid rain (33%). (In the second half of 1989, pushing back car use in favour of public transport and bicycles became a big issue in the Netherlands, so it is of interest to see how people will react in 1990).

3.2.3. CAUSES OF ACCIDENTS

In order to evaluate the objective to make people aware of their own contribution to traffic safety, nine questions were asked about causes of accidents (compare e.g. Mortag & Comrey, 1987). Many persons accuse others to be the cause of dangerous situations or accidents. But in comparison with a year before, this percentage decreased from 53% to 36%. More persons seem to recognize that they themselves as road users can contribute to safety. The number judging bad luck and circumstances to be the main causes of accidents decreased from 30% to 12%

Comparison of the data gave cause to interpretation
problems. The answers people gave to different questions often seemed contradictory. The best to conclude from these results is that people discriminate more in the number of contributing factors to safety problems than in the kind of contributing factors. People who point out more contributing factors were labelled as people with a high sense of danger. People who score low seem to feel more comfortable in traffic.

3.2.4. ATTITUDES AND BEHAVIOUR

Positive tendencies are also visible in reported behaviour. More people say to use seat belts (from 48% to 61%), more persons say to stick to the speed limit of 80 km/h on rural roads with mixed traffic (from 34% to 54%), to the speed limit of 50 km/h on urban roads (56% to 64%), and more persons say that they never drive after more than 3 alcoholic drinks (from 63% to 78%). All these changes were significant on a 5% reliability level. The attitudes to these aspects did not change significantly. It seems that attitudes and reported behaviour correspond better now.

3.2.5. TRAFFIC SHOWS

The traffic shows attracted ca. 10,000 visitors each. About 80% appreciated the shows as good or very good. This was caused by interests in traffic and in the design of the shows: demonstrations, games and so on. The visitors were far better informed on the tv-series "Familie Oudenrijn" than Dutch people in general. So the series had a mobilizing effect for the shows. Children greatly contributed to the number of visits.

An important goal of the shows was to stimulate a follow-up in the regions and to get traffic safety more on the agenda in newspapers. In this respect the shows did not succeed. They were too much organized from the central national level. Regional organisations could join, but they did not regard it as their own.

4. SECONDARY ANALYSES

In secondary analyses is was tried to figure out if it was possible to combine answers on different aspects, for example for 'involvement', 'affinity' and 'sense of danger'. Scales were used in the same manner as described above. The age of people and their mileage as car drivers were also taken into account.

'High involvement' seemed to be an interesting factor. As stated earlier 21% of the population has been ranked as highly involved in traffic safety. These persons are over-represented in the age category of 35 to 49 and in the category of car drivers with a high yearly mileage. In short: the more experienced drivers. They score less on a high sense of danger than persons who are less involved (32% compared with 46%); less of them report to use seat belts (75% compared with 87%); less of them stick to the 80 km/h limit (50% compared with 55%); the
percentages on urban roads did not differ); less of them reported not to drive after 3 alcoholic drinks (65% compared with 73%). The differences are only significant with respect to seat belts, but they all go in the same direction. Routine on the road seems to lower the 'standard', which is not surprising. It is also understandable that highly involved persons tend to have a greater affinity with information. More of them knew the programme "Familie Oudenrijn" and more of them viewed it.

5. SEGMENTATION OF TARGET GROUPS

What we did not expect was that persons with a high involvement also marked the tv-series higher and considered it more often valuable and successful, according to the goal to attract attention to traffic safety information in a playful way. They also regarded it more often as a programme in which traffic safety is treated seriously enough. The fact that these highly involved persons are over-represented in the category of routine drivers made us believe that their involvement is mainly of a rational character. Maybe they are not so much concerned with traffic safety in itself (they make more offences) but more interested in information because of their daily practical problems. This may be concluded from theories in mass communication science which claim that information to change behaviour will be processed 'central' when persons are highly involved with the subject (see e.g. Mc Quail, 1983; Nilssen 1988; Petty & Cacioppo 1981). Persons who are less involved tend to process information 'peripherally' and react more intuitively. The less involved persons mainly belong to the younger and older age groups, as a consequence of the over-representation of the highly involved persons in the middle-age group. Their sense of danger is higher, which will be connected with the fact that they mostly take part in traffic as pedestrians and cyclists, the ways of transport with a high vulnerability rate. As less involved persons, they take in information to a smaller extent. Because they take in the information more intuitively, the wrapping of the material (cues) is important. Only if it is attractive enough, there is a possibility that the information is taken up. The character of a comedy of the tv-series appears to be an effective approach. But it seems that a comedy does not uncouple the interests of highly involved persons. Although in information campaigns it is necessary to make segmentations of the target groups - and involvement should be one of the factors for segmentation - the tv-comedy seems to be able to attract quite different groups.

6. RELATION WITH OTHER STUDIES

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The positive changes in reported traffic behaviour in highly important aspects as seat belts and alcohol, has been confirmed by some behavioural field-studies. SWOV found in roughly the same period that in some provinces the percentages of car drivers with too high BAC fell sharply and the percentages of passengers using seat belts had increased (Mathijssen, M.P.M., 1989 resp. Varkevisser, G.A. & Arnoldus, J.G., 1989). These provinces had special programmes for police enforcement and publicity campaigns.

One may suppose that police enforcement gives the greatest possible immediate effects on behaviour, and information policy makes the soil fertile. But one may not exclude the possibility that information activities strengthen the effects of police enforcement by giving a motivation to cling to the behaviour that was provoked by the police.

More research is needed to measure changes in behaviour and its determining factors for short-term as well as long-term effects. For that purpose opportunities exist to compare different regions in the Netherlands. In the last few years, in each of the 12 provinces a regional body has been installed to stimulate and support activities (of for example municipalities) in the field of traffic safety. Each region formulates its own policy. We will further analyze the data from our evaluation study to compare the results of our data for different regions.

7. FOLLOW UP OF "OUDENRIJN"

It is already mentioned that the third series of "Familie Oudenrijn" is broadcast this year. Our survey is repeated and it will be interesting to analyze the longitudinal developments.

The addition of many questions to the survey makes it even more interesting. The theme of the tv-series is not only traffic safety any more, but it includes the policy to push back car use. Car use has grown dramatically in the last few years, with decades of kilometers traffic jams on motorways daily and rapidly growing problems of the environment. So car-pooling and the use of public transport and bicycles are promoted. Of course this should not have negative effects on traffic safety, since bicycle riders are a vulnerable group of road users in the Netherlands as well.

The new questions in the survey have already been put to a sample of our population in a before-measurement. Another study is of an explorative character. We will interview functionaries in different regions who are responsible for promoting activities in the field of traffic safety and transport and ask them how they think to help organize an integrated communication policy (national, regional and local level). It will also be interesting to find out in what way coordination takes place between traffic safety policy and transport policy.
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Road Safety as Business - Vision or Reality?

The Brazilian Example

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ROAD SAFETY AS BUSINESS - VISION OR REALITY? THE BRAZILIAN EXAMPLE

Brazil has today one of the worst accident rates in the world. With almost 150 million inhabitants and a fleet of about 16 million vehicles, Brazil witnesses annually 50,000 deaths and more than 350,000 injuries in over 1 million accidents.

In 1987, as a celebration of its 10th anniversary in the country, Volvo do Brazil launched a long-term road safety awareness program. The only goal was to investigate the government, press, private sector and community to seek answers for a single question: How to increase road safety and decrease the number and severity of the accidents?

The program comprises four permanent activities: a TECHNICAL PANEL whose membership is drawn both from government agencies and private sector, meets at regular intervals to assess road safety issues and formulates proposals; a ROAD SAFETY BULLETIN, published and circulated free of charge to all organizations and individuals that are active in this field; ROAD SAFETY SYMPOSIA, held several times a year in different parts of the country to provide information and encouragement at local or regional level; ROAD SAFETY AWARD, competed for once a year, in six categories; professional drivers, journalists, companies, state governments, municipal governments and the general public.

Many companies have since joined Volvo in sponsoring road safety awareness events: government and society reacted very positively and the media have been devoting much more attention to this issue than formerly. Due to this reaction, the Volvo Program proposed to the Government to decree 1989 as the Brazilian Road
Safety Year which was good but not good enough to spread out the awareness message all over the country in the appropriate way.

Motivated by part of the private sector to go ahead with the action, the Volvo Program proposed that the 90's should be considered as the Brazilian Road Safety Decade. Therefore, there will be time for government, private sector and communities to plan and develop long term plans. For example, the use of safety belts is compulsory on the highways only - there is a plan to set up a law for its use also in the city as of next year. The private sector is giving full support to that plan. There is need of improvements in all areas related to road safety in Brazil.

It is difficult to state some concrete results of this action, but there is no doubt that today the Brazilian society is more conscious of the scale of the problem that the country faces and that road safety is becoming a national issue.

Companies have now realised that it is in their own interest to conduct road safety campaigns. They gain from sustaining fewer losses (employees killed or injured, damages to vehicles and goods), they enhance their institutional image as community-minded companies and some of them find a new source of sales income in safety-related products.

This is a program we feel is particularly appropriate for underdeveloped or developing countries, since much can be achieved with a relatively modest investment.
Ladies and gentlemen,

The country I am going to talk about is certainly one of the most beautiful in the world. It is one of the most important in South America. It is a sunny country, with more than 5,000 km of coastline, more than 8 million square kms of land, which corresponds to the whole western Europe. Endless natural resources, nice people. The land of marvellous beaches, coffee, samba (now lambadas as well) carnival and, of course football (on spite of the recent "disaster" in Italy).

This is Brazil!

There is a saying there that God is Brazilian - which, of course, is true only up to a point. If God was Brazilian He would help the Brazilian population to learn faster some basic rules for living in greater safety.

You have probably seen this picture before. This is Christ the Redeemer on the peak of the Corcovado, a hill overlooking the city and the bay of Rio de Janeiro. From this height Christ seems to be surveying what happens in the town and in the country as a whole. He must be very disappointed with a lot of what He sees - particularly with the traffic. Some people say that Christ, with his arms spread wide, is actually shrugging his shoulders and saying: "I GIVE UP".

Brazil, ladies and gentlemen, has one of the worst traffic violence rates in the world. We kill in our traffic some 50 thousand people every year, leaving nearly another four hundred thousands maimed in more than one million accidents. Material losses amount to no less than US$ 2 billion a year, not counting another US$ 2 billion in social security payments to road accident victims and their families.

The available data are incomplete and unreliable but we can safely say that Brazil kills, in its traffic, one person every 13 minutes. This is a frightening statistic.

Why is our traffic so violent?
No traffic education, information, culture;
Outdated highway code;
Impunity
Corruption
Insufficient and poorly equipped law enforcement personnel
Inadequate traffic signals
Poorly maintained road surfaces
Irresponsible behaviour by road users in general
We can no longer tolerate the fatalistic approach that remains prevalent in Brazil, that it is God's will that all these thousands of people are being killed on our roads. Despite popular belief, it is not a matter of fate, ineluctable destiny or the stars. A deeply-rooted Brazilian belief is that our traffic will never improve. This passive acceptance means that the violence will go on and on—unless somebody starts doing something to stop it. This is the starting point from where Volvo began its campaign.

**Volvo Road Safety Program**

In 1987 Volvo do Brazil decided to launch a road safety awareness program aiming to arouse society to this unacceptable "war". Our program should be seen as a contribution to the community to combat the third main cause of deaths in Brazil. Due to the complexity of the problem, we took it for granted from the outset that we should not waste time discussing the problem but embark immediately on the search for solutions.

The program was based on four main activities: a Technical panel comprising government and private sector representatives; a Road safety bulletin circulated to experts, government officials and other interested parties; Road safety symposia held at intervals all over the country; and the Volvo road safety award, for professional drivers, journalists and members of the public. State and municipal governments and private-sector companies making outstanding contributions to the road safety cause are also awarded recognition.

Four years later, the program reports very positive results. Segments of society, the press, and many large companies (including multinationals) responded immediately. This reaction showed that there was a tremendous need in the country for such an action. This explains why our activities became the most important road safety program ever undertaken in Brazil.

Areas of public opinion, the press, parts of the private sector and even the government, specially in some states, were quite strongly motivated. But then we realized that we needed to correct the strategy in order to achieve concrete results. It became obvious that the Federal Government was powerless to change the situation. We realized, for instance that the traffic and safety issue was such a widespread problem, with so many ramifications, that we couldn't expect any significant improvement unless we enlisted the private sector in battle.

**Vision or Reality**

The realistic approach, in our judgement, was to start getting influential people to undertake concrete actions to reduce the appalling accident rate. Influential people, in this context, could mean only the business community.

But how were we to set about involving the Brazilian business community in this movement? That was essential but not easy.
Road safety is an arid, difficult, disagreeable subject that often puts people in an uncomfortable position. Brazilians like to do things their own way. This includes driving. They feel free to disregard traffic lights and speed limits. Only softies wear safety belts. Since this attitude is shared, too, by and large, by the law enforcement authorities, people are usually correct in assuming that doing things their own way is unlikely to entail any kind of punishment.

The vision, then, was to replace one set of values by another. The reality was that, by adopting the new set of values, people were acting in their own best interests. In particular, companies would be acting in their own best interest by requiring their employees to wear safety belts, to stop at the lights, and to keep within speed limits. This would mean less damage to their vehicles, and fewer man hours lost through injuries sustained in road accidents.

Thus, to attract the private sector to play together in order to increase road safety awareness became the name of the game. Appealing to their sense of social responsibility, asking them to set a good example was not enough. Road safety was a product that had to be marketed.

Our bottom line was the motto that "the best way to make money is to avoid losing it". In other words, safety is good business.

A company campaign aimed at reducing the risk to employees, to the company fleet, to products and, consequently, to the local community, is capable of yielding a positive financial return as well as excellent institutional PR.

This is probably true of most recently industrialized countries. Unlike the developed world, where a large investment would be required to yield a relatively small return, in the Third World a significant reduction in accident losses can be achieved from a relatively modest investment involving, say, the compulsory use of safety belts in company cars, a simple electronic "spy" to inhibit speeding, or defensive driving courses.

Small companies manufacturing safety equipment were stimulated to invest more in promotion. The structure of the Volvo Program was placed at their disposal. Safety is also a product and needs to be professionally marketed: during our symposia we have always made space available, free of charge, for safety products, private campaigns, public action, and community action groups.

Proof of the latent potential of this area were the 32 entries competing for the Volvo's company of the Year Award in 1989. All told, we estimate that some 60 large companies invested in aggregate US$ 100 million in road safety during 1989.

The Brazilian press has played a very important role in the development of this program. Till some years ago traffic accidents might provide sensational copy for the police pages, but were never regarded as a suitable subject for serious discussion.
Today, fortunately, we find the road safety issue appearing in several different sections of our newspapers; the economy, or education, or urban problems or even in science and behaviour. During 1989—designated Brazilian Road Safety Year by the federal government—we counted more than 500 pages in our newspapers dealing with the issue. This is a fantastic achievement when we consider that serious coverage was previously virtually nonexistent.

Of course, we do not dare to state that the road safety problem is now solved in Brazil but we can celebrate the great conquest that it is becoming a real national issue. Government, private sector, press, and society discuss it in search of solutions.

Brazilian Road Safety Year produced very good results but it was not enough to meet the expectation of many areas. That’s why Volvo Road Safety program proposed that informally we consider that 90’s as the Brazilian Road Safety Decade. There are many reasons for such an idea: no country in the world has solved its traffic safety problems in less than ten years. In Brazil, with a tremendous lack of money, of qualified people, of technological know-how in this area, even of appropriate laws, there is no way to expect any strong positive reaction in the short time.

This program seems to be applicable for a certain number of developing countries that face the same problems as Brazil. For those who are interested, we would emphasize action on the "Three E’s" (engineering, education and enforcement) with remarks on some points:

* Wake up the country to its losses due to the accident rate;
* Create pressure on governments, at all levels, to give priority to road safety;
* Stimulate traffic education at schools (which is still not the case in Brazil);
* Make it compulsory to wear safety belts;
* Carry permanent campaigns against drunken driving;
* Incentivate private sector companies to develop road safety programs;
* Create public awareness for emergency accident care;
* Support the creation of a national road safety institution to conduct research and projects for both private sector and government;

The work must be patient, the way must be carefully set up, people need to be prepared and—we must not forget—money must be found in a very creative way. Perhaps the 90’s will not be enough to solve the Brazilian road safety battle but there is no doubt that a good beginning has been made and that those who were involved in the process have every reason to feel that their efforts were not wasted.
A New Way of Broadcasts for Motorists

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NEW REGULATION OF "TRAFFICWARNSERVICE"

The European-broadcasting-organisation (UER), including the German ARD, is going to build a European wide traffic radio, a news spreading by Traffic-Message-Channel (TMC) and the using of Radio-Data-System (RDS).

A voting with the industrie, which has to produce such radios, is principally done.

The realisation would use time up to the year 1995. Up to that time, the "Trafficwarnservice" in West Germany must be new regulated. The hitherto existing of technical unwinding has to be replaced urgent by a modern technical data compound.

Information providing, working up and transmitting by road building authority, traffic authority and police are able to do so, therefore data transmitting from the base (technical seize of disturbing/information by police) up to the radio in each car can be done by an uniform technical proceed (RDS/TMC).

That starts with an automatical seize of disturbing on carways (Autobahnen), working up and code the message by computer, transmitting the informations to the police stations and country information centrals for "Trafficwarnservice", goes up to the broadcasting organisations and from there coded to each transmitting station and then also coded into the RDS-Radios.

The European-broadcasting-organisation has worked up guidelines for trafficsendings and a catalogue of events together with others (for example: ministery of traffic, federal institute of road affairs), which should be base for a compound.

This guidelines (UER/EBU guidelines) and the catalogue of events are projecting foundation for the coming going forward. The hitherto traffic warning system is not qualified to work up the informations under that requirement.

It is also apired to get an European compund at the National information centrals (that’s in West Germany the Federal informatin central at the Ministery of internality).

Therefore it is necessary to build an European information central. But therefore it is first necessary in a lot of European countrys to build national information centrals.
Under todayly knowledge West Germany has the best organisation of "Trafficwarnservice". That's the reason why representants of the German radio organisation ARD and the Ministry of traffic accentuated, that it is probably, if Nordrhein-Westfalen should be asked to shoulder also the function of an European information central with its federal information central. The reason therefore is, that there exist excellent experience about necessary coordination because of the federal system in West Germany. This needs consent by the country government of Nordrhein-Westfalen.

In this connection it would be specially negotiated about cost distribution. Todayly Nordrhein-Westfalen pays the costs for the federal information central alone. That needs for example nearly 400.000,- DM yearly only for telex-charge.

At an European compound also technical questions for an information compound system have to be detaily advised.

It is necessary that national data-working-up-systems are europeanwide compoundable. This should be attentioned at the new organisation of "Trafficwarnservice" the Federal Republic of Germany. On proposition from Nordrhein-Westfalen a working-group is set up by all Ministrys of Internal. This group should provide a concept for futurenal "Trafficwarnsystem" and it's tactical and operational requirement.

This working group consists of agents from the Federal ministery of traffic, the Ministry of international from Baden-Württemberg, Bayern, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz and Saarland and the business office from the technical commission of the working circle two (AK II) at the Polizeiführungsakademie in Münster-Hiltrup.

It has provided that concept and handed it to the technical commission of the AK II. There its technical realisation should be tested and its costs should be estimated. This should use time up to 1995. It's nearly the same time imagination as it has the EBU.

For realisation of the whole project "Neorganisation of Trafficwarnsystem" it is closly necassary after discussion in the AK II to get a resolution from the conference of all Minister of the Interior in West Germany. This is necassary, because that the police of each country has to work with at the whole concept and so the country supreme power is tangented.

Traffic referee at the Ministry of Internal from Nordrhein-Westfalen LPD Melchers.
A new way of broadcasts for motorists

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1. PRAEAMBLE

The following statement results from practical experiences in traffic information by radio broadcasting organizations in Europe, who since 1971 cooperate through the "European Broadcasting Union" EBU/UER not only under themselves in organized working structures but also with their essential partners in the common field, as f.i. road authorities, police, traffic organizations, automobile associations, radio receivers and car producing industry, road security organizations and others, not to mention technical institutes of their own organizations.

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2. GENERAL REMARKS on BROADCASTS for MOTORISTS
2.1 The radio organization's broadcast of traffic information is based on material (messages) given to them mainly by other institutions, but is put out over the antennas under their sole legal and editorial responsibility. In so far they permanently have to compromise the conflict situation that radio's public makes radio responsible for items of its programme(s) radio cannot be fully aware of.

2.2 The aim of traffic information by radio is to offer news (messages) to anybody being somewhere and with individual reactions to it, whereas radio has no real possibility to influence, to guide or even to govern this varying unknown audience towards their attitude to traffic. The intention of influencing traffic situations, anyhow, is in the responsibility of relevant authorities outside radio.

2.3 Considering the fact that radio and its partners in traffic information are bound to close cooperation in a field of eminent importance to the large public, there is a long-term gentleman agreement to respect each other's authority and not to interfere into the partner's responsibility, but to cooperate voluntarily and constructively.

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3. **EBU WORKING PRINCIPLES on BfM**

3.1 In order to establish rules and standards for radio traffic information, to find orders for cooperation between EBU radio organizations and their partners and to meet the needs of equal behaviour, the EBU Working Party on BfM (later called Group of Experts) since 1971 developed "EBU Guidelines on Broadcasts for Motorists". The guidelines have been officialized by the EBU Radio Programme Committee and consequently acknowledged by the EBU Administrative Council. They have been introduced to the partners, at least since the EUROTRAVEL Conference 1984 in Grado. These guidelines offer the basis for all information work in the traffic field, as f.i. conditions for cooperation, traffic message format, priorities, traffic density, road situations, urgent tourist calls and, at least, the vocabulary for all events to be regarded in radio's traffic information.

3.2 The EBU Guidelines on Broadcasts for Motorists are official rule within member organizations and, as free offer to the partners in traffic informations, in many European countries partly or totally have been accepted for official use by police and similar institutions with best effort.
3.3 The EBU Guidelines on Broadcasts for Motorists for the last times have been revised by the group of experts at the end of 1989 and reprinted as "Revised 1990" edition.

3.4 The most important recent EBU standard was the introduction of the "Traffiv Message Telegramme" concept, laid down as EBU Guideline No. 3 (replacing the old "Standard Message Format"). This, already for some time, is the rule of cooperation and forms the basis link to every single traffic message being exchanges between partners or broadcast by radio in what form ever. It also is devoted for automatic translations between seven European linguistic areas internally and externally.

3.5 Nevertheless, according to the nature of European Broadcasting Union, each radio station is free to realize the traffic information service in its programme(s) along her own programme policy and according to her individual responsibility.

3.6 The generalizing question "What does the driver want to hear?", posed by Castle Rock Consultants, is likely to find varying answers from country to country and radio station to radio station. Under the aspect of European cooperation represented by EBU experts on Broadcasts
for Motorists, the answer is laid down in EBU Guideline No. 2. An additional comment was given in this statement unter chapter B, paragraph 2. Yet, any final judgement must regard the fact that radio broadcasts of traffic messages are not expected by "drivers" including those who are accompanying the traffic under professional or private aspects.

* * *

4. RDS-TMC CONCEPT

4.1 Need of Improvement

From the viewpoint of radio broadcasters as well as their audience the introduction of RDC/TMC must offer reasonable improvements, compared with long-lasting difficulties, as f.i.

- better input to and output by radio
- quicker, better and more complex information
- passive and active attitudes of the listener
- selection possibilities in information (area, direction)
- selection possibilities in reception (speech, print, visual)
- selection possibilities in language
4.2 Traffic Message Telegramme

The Traffiv Message Telegramme (= EBU Guideline No. 3) forms, as mentioned above, the basic standard for all traffiv messages, incorporating the possibility of computerized data processing as well as automatic translation in different languages. As existing rule it should also be introduced to RDS-TMC concept, without amendment or correction, in order not to disturb the partive of radio and its partners.

4.3 Catalogue of Events

The EBU Catalogue of Events (= Guideline No. 5) was elaborated during the course of more than five years by the experts of 24 broadcasting organizations in 11 European countries, partly with the assistance of police, road authorities and industry in several countries. In some countries (Austria, Denmark, Germany, Italy) the first edition of the catalogue has already been by external partners.

From its purpose, the Catalogue of Events represents only supra-national characters. Any national/geographic particularities are only welcome if they are of inter-national relevance like f.i. special weather or road situations, sea links, etc.
The experts on BfM hold a different opinion to the statement that "the Catalogue of Event (falls) under the responsibility of traffic authorities", as expressed in EBU ad-hoc group meeting 8. - 10.11.1989 in Geneva (Report GT R/RDS-TMC 207). As a matter of communication, questions of language, speaking and listening reception undoubtedly fall into the genuine responsibility of radio. Radio, of course, welcomes any proposals of specific nature coming from police, road authorities and others.

4.4 Editorial Rights

According to the legal situation of radio organizations, the radio broadcasters, within the limits of their programme responsibility, cannot neglect their right to select the right information and to decide over its order, time and way (programme, frequencies, spoken or coded, etc.).

4.5 Content Mixture

The expects underline that the content of traffic information by radio consists, all together out of a mixture of various topics. That is not only traffic on roads, but also air, rail and sea, as well as not only of motorist's travel but also of pedestrians, bicyclists, nautic tou-
rists, etc. Furthermore, this information offer is devoted not only to users actively engaged in moving traffic, but also to listeners participating passively, like the feedback to police, private car runners and disponents of trucking firms, taxi organizations etc. Radio editors are responsible for adequate consideration and composition, also for the disposition regarding verbal or coded (RDC/TMC) output.

4.6 Traffic Information Characters

Radio staffs, responsible for traffic information in traditional form or coded for RDS/TMC, have to deal not only with traffic messages originated by local/regional/national police or road authorities but also with information characters from other resources like EBU cooperation, other radio stations and special informators. The staffs also have to regard, beyond traffic information in a narrower sense, also public warnings, individual emergency calls, urgent tourist calls, etc.

4.7 Information or Traffic Management?

The question "TMC - information system or traffic management system?" referred to by Mr Ove Joanson (Ad-hoc group R/RDS-TMC Brussels meeting
7.12.1989, is from a theoretical point of view no alternative to radio, but to its partners (road authorities, police, etc.). As already stated in chapter B, paragraphs 2 and 3, radio cannot and does not risk peculiar traffic management or traffic guiding activities, regardless of indirect effects of this kind whenever broadcasting any traffic information.

4.8 Tourist's and Touristic Information

The permanent question if and how traffic information by radio may include some sort of or be open for touristic information elements cannot become an item of EBU discussion or recommendation, even since private radio stations in a growing manner disregard this to be a problem. The answer must part of the individual programme policy of each radio organization, but as a common principle the traffic information (messages) and touristic information must be kept separate from each other (see also EBU Guideline chapter A, point 1.2.).

4.9 Concentration of Traffic Information

Any concentration of traffic information on selected sectors of the general traffic scene
(f.i. on congestion areas, towns, main routes), as brought into discussion by Castle Rock Consultants, is neither possible nor desirable with respect to the nature of radio broadcasting. The concentration may indeed be effected by the character of a radio station (f.i. a local radio or short-wave station) or it might be the result of traffic messages offered by partners (road authorities, police etc.) for broadcasting. If listeners seek concentrated information, they may make individual use of the RDS-TMC possibilities of selecting area, direction, etc.

4.10 Coding of Messages

The final coding of messages for broadcast in the RDS-TMC must be in the hand of radio staffs, not the least in order to better organize the computerized systems processing the traffic information, including interface with partners systems. Radio has also to define the follow-up of messages, correct or amend them. In a sense of saving time and gaining quality, the pre-coding of traffic telegrammes by others is welcome.

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5. RDS-TMC SPECIAL QUESTIONS

5.1 Codes Mixture

In order to keep the EBU Catalogue of Events as small as possible, the coding of several telegrams informing about durations, distances, etc., goes by mixing the elements of different relevant codes.

5.2 Message Geographic Relevance

Regarding the fact, that neither the importance of a single traffic message to the listeners nor the range of a radio's broadcast, be it local, regional, national or far reaching, is known beforehand, each traffic telegramme must be marked with a qualification of the degree of geographical relevance. According to EBU Guideline No. 2 section A, this definition has to be made primarily by the police or road authority.

5.3 Message Range (Priority)

In order to meet the needs of traffic, each traffic telegramme must be qualified in one of three categories of priority according to EBU Guideline No. 2, section B, called "Range".
5.4 Accessibility to Information

According to the importance of traffic messages and to the general nature of radio, everybody in the public must have free accessibility to the traffic information in either version, verbal or coded or even both, related to the receiver he has chosen or the place he wants to receive the programme.

5.5 Message Circulation

Message circulation primarily seems to be a matter of technical nature resp. a question of luxury with the receiver. But, under programme policy aspects it should be a good rule to keep "on air" through RDS-TMC permanently an offer of traffic messages already broadcast, consisting of all information put out.

5.6 Message Cancellation

The broadcasting radio organization must have the possibility to cancel messages already broadcast at any time by calling up the individual keynumber of the messages, not to mention in this context that cancellation of message principally should be initiated by the road authority having offered the relevant message for broadcasting.
5.7 Location and Area

As already now, the location of any event must be informed about. In future, especially via RDS-TMC, not only a more precise information about location but also about the area must be possible, not the least in a way to select relevant messages from others not actually interesting the listener.

5.8 Choice of Direction

As an important improvement, the RDS-TMC system must offer the possibility to select traffic telegrammes according to the driver's direction on road, eliminating all other information except urgent messages.

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6. REMARKS

European Traffic Message Exchange Network

The varying character of radio stations and their audience waiting for traffic information in ever more different situations, ranging from small lo-
cal stations via regional, national and international station until up to forthcoming European-wide satellite programmes, also more and more amplifies the selection responsibility of editors and minimizes same time possibilities of pre-selection by partners delivering traffic messages.

At the end, and this has shown to be needed already in some cases, the principal concept should be that every radio staff at any time or place in Europe should find easy, individual access to all traffic telegrams existing at a given period, she/she can select whatever is suitable for the traffic programme.

To bring this concept into reality, each European country must organize one national information centre which is connected with all other (inter) national centres in a network, watering the national and the international field with traffic messages. This has to be organized not by radio or EBU, but the need arises with them first. The EBU experts group on BfM took first steps in their EUROTRAVEL Conference 1988 in Copenhagen to make partners aware of this uprising problem and to stimulate their international cooperation towards solution.
Automatic Monitoring and Enforcement of Traffic Highway Violations

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Automatic Monitoring and Enforcement of Traffic Highway Violations

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ABSTRACT

New technologies are currently being sought to assist authorities in the enforcement of traffic laws which protect the highway infrastructure, improve road safety, and enhance the environment. For example, axle load screening has the potential to improve weight limit enforcement, the classification of vehicles according to their 'plated' weight allows for the automatic detection of potential lorry ban violations, and automatic vehicle detection and speed measurement can be employed in red light and speed limit enforcement.

This paper describes work undertaken by Castle Rock Consultants (CRC) to develop an automatic monitoring and enforcement system designed to monitor and photograph vehicles contravening traffic highway regulations. The techniques described in this paper should eventually allow more efficient and comprehensive enforcement procedures to be employed to the long-term benefit of us all.

An introductory section to the paper describes the background to the development effort. Subsequent sections deal with system design concept and the work undertaken to develop, install and commission a prototype enforcement system, together with the results of the commissioning trials. The particular application studied was the automatic enforcement of lorry bans. The conclusion reached from these results is that the system will allow effective monitoring of the extent of lorry ban violation problems and can also be used to identify potential violating vehicles. The cost-effectiveness of using the system would be significantly better than using conventional police enforcement methods.

The need for similar systems to be used in the detection and enforcement of weight limits, speed limits and red light violations is also identified and discussed in this paper. The SHERIFF law enforcement system developed to make the automatic lorry ban enforcement capability commercially available and to fulfill these additional functions is also described. The recently developed SHERIFF 4000 weight and classification system allows the enforcement camera to be triggered upon detection of a user-selected vehicle class, axle weight, gross weight or speed in excess of a user-selected threshold. Systems such as this could play an important role in assisting police authorities to monitor and enforce a range of traffic highway violations.
AUTOMATIC MONITORING AND ENFORCEMENT OF TRAFFIC HIGHWAY VIOLATIONS
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1. INTRODUCTION - CHAPTER 1

Enforcement of traffic highway violations has long been considered a difficult issue, as manual policing is expensive, potentially hazardous and can be ineffective as a deterrent. Some violations, such as speeding, have been given a high priority by police authorities with the result that automatic systems have been developed and routinely utilized to improve enforcement procedures. Enforcement of other violations has tended to be ad-hoc rather than part of any routine programmes, although this situation is beginning to change with the introduction of new technology.

This paper describes work undertaken by the authors in developing a system to provide automatic monitoring and enforcement capabilities for a number of traffic violations. The system was developed following research into piezoelectric sensor technology performed under contracts to the Transport and Road Research Laboratory (TRRL) and the Iowa and Minnesota Departments of Transportation.

The microprocessor-based system processes signals generated by vehicles passing over a piezoelectric sensor array in the highway, and identifies those vehicles violating user-selected limits. Parameters such as weight, class and speed of vehicles can be determined for monitoring and/or enforcement. Photographs of the offending vehicles, with violation information superimposed, are then taken by a camera subsystem to enable the vehicles to be identified from the licence plates. This evidence may be subsequently used for warning, prosecution or identification of frequent offenders.

Following this introduction, Chapter 2 describes the background to the system development. Research into piezoelectric sensors is outlined, together with the evaluation of a low-cost weighing and classification system and the assessment of a weigh-in-motion system as a pre-selection tool for enforcement weighing.

The third chapter details the development of a prototype system for the automatic enforcement of lorry bans. The feasibility study is described, followed by the prototype development and system evaluation.

Chapter 4 outlines the development of a production version of the system, called Sheriff, following the successful prototype demonstration. The current and future applications of the
system are discussed in Chapter 5, and the conclusions presented in Chapter 6.

2. BACKGROUND - CHAPTER 2

2.1 Introduction

The authors have been involved in the research and development of vehicle sensor technology and vehicle classification and weigh-in-motion methodologies for several years. This section briefly describes three particular projects that have been undertaken by the authors, which formed the technical base for the design and development of the monitoring and enforcement system. The projects concern the testing of piezoelectric axle load sensors for the UK Transport and Road Research Laboratory (TRRL), the development of a low-cost automatic weighing and classification system for the Iowa and Minnesota Departments of Transportation, and the evaluation of a WIM pre-selector system for enforcement weighing, also for TRRL.

2.2 Piezoelectric Axle Load Sensors

Extensive research and development was carried out during the early 1980s for the UK TRRL which resulted in the design of a highly robust, low-cost dynamic axle load sensor. The sensor utilized Vibracoax piezoelectric cable manufactured by Thermocoax in France. The 3 mm diameter coaxial cable consists of copper inner and outer conductors, with a piezo-electric powder dielectric. The dielectric is polarized during manufacture by an electric field so that when a radial pressure on the cable is applied a voltage is generated between the conductors.

Tests were carried out initially on the unmounted cable to establish its behavioural characteristics and, subsequently, on different mounting designs. The tests covered both laboratory and field tests. The laboratory tests involved the use of a hydraulic loading ram to apply sinusoidal and steady-state loads to the sensor and a moving wheel rig to simulate slow speed wheel passage.

The mounting design, which is now the subject of a licence agreement, was developed to effectively eliminate the problems that had been associated with the use of the piezoelectric cable since its commercial availability in the early 1970s. The two main problems were:

* large variation in output signal with lateral position; and
large signal variation due to longitudinal bending of the sensing element.

The design consists of an aluminium channel with the Vibracoax cable encapsulated in a proprietary rubber compound. The sensors are easily installed in slots cut into the road surface and provide a robust method of axle load sensing.

Investigation of the sensor outputs, fed through a suitable charge amplifier, revealed that for effective load estimation the magnitude of the signal was not sufficient. More complex processing, in the form of signal integration, was shown to be necessary. Microprocessor technology was used to convert the sensor outputs to load estimations and allow weighing algorithms to be developed.

2.3 Automatic Weighing and Classification System

In 1986, the authors undertook a project to demonstrate a low-cost automatic weighing and classification system (AWACS) for the Iowa and Minnesota Departments of Transportation, in association with the U.S. Federal Highway Administration. The project involved the development and evaluation of two generations of AWACS and concluded with the preparation of a procurement specification. This specification was subsequently used as the basis for the low-cost weigh-in-motion element of the Heavy Vehicle Electronic License Plate (HELP) programme.

The first generation AWACS was capable of monitoring up to six piezoelectric cables and one inductive loop located in a single traffic lane. The system used the sensor designs and signal processing techniques described above. The facilities provided by this system included the measurement of tyre contact widths and lengths.

A quantitative scheme was developed to help consistent selection of the AWACS sites. Engineering factors of prime importance such as pavement rigidity, profile, surface condition and maintenance schedules were incorporated in the scheme. Other factors considered for economic and administrative reasons included availability of services, equipment housing, and proximity to a static weighbridge. On the basis of the scheme, two different sites were selected for the initial demonstration, one in Iowa and one in Minnesota.

Data were collected over a period of time using both random and test vehicles. The data were analyzed and the results used to develop the second generation AWACS equipment. The second generation system included additional features such as automated tyre length and width measurement, diagnostic checks and self-calibration. The self-calibration algorithms relied on the principle that the loads on certain axles of specific HGV classes show relatively little variation, regardless of the
loading conditions of the truck. If the mean weight of these axles is continuously calculated, the system calibration factor can be adjusted to force the mean weight to agree with a known long-term population mean.

The inductive loops were removed from the second generation system as the use of these in addition to the piezo sensors produced lower classification accuracies. The use of two axle weight sensors represented an optimum in the tradeoff between system cost and performance. The second generation system included a diagonal sensor for tyre width measurement and a short off-scale sensor positioned in the wheel track to allow identification of vehicles not passing wholly over the weighing sensors.

2.4 Piezo WIM Sorter

Further work on piezoelectric weigh-in-motion systems performed by the authors concerned the evaluation of a pre-selector system for enforcement weighing. Working under contract to the Transport and Road Research Laboratory, the aims of the project were to assess the accuracy and effectiveness of the system, under different operating strategies, for improving the efficiency of the selection process.

A WIM system was installed half a mile upstream of a weighbridge site in Wiltshire. After some preliminary testing the final configuration of sensors in the two lanes was two full-length piezo sensors, a short sensor and an inductive loop in each traffic lane.

Charge amplifiers and other electronics for signal processing were housed in a roadside cabinet next to the sensors. Processed signals were transmitted to a control unit located at the weighbridge, where they were displayed on a control unit and also sent to a microcomputer. The microcomputer ran a TRRL-developed program which further processed the WIM outputs by applying calibration adjustments and compiled summaries of axle weights, road wear factors and overloaded vehicles and axles. Summary data were stored on disk for subsequent analysis.

As a vehicle crossed the sensor array, the axle weights were displayed on the microcomputer monitor a few thousandths of a second later. When all axles of a vehicle had crossed the sensor, the gross vehicle weight was calculated by summing the individual axle weights. For each axle and gross vehicle weight, the TRRL program checked whether they were overloaded by comparing the respective weight with the maximum allowable weight. Where an axle or vehicle overload was identified, the weight value was shown in red on the monitor and an audible warning was also given to the operator.

In order to assess the sorter's effectiveness, four different
operating strategies were employed by the enforcement officers from the Department of Transport and the Wiltshire Trading Standards Department. These were as follows:

1. WIM sorter output monitored by an enforcement officer at the weighbridge with radio link to the police located at the roadside;

2. WIM sorter output monitored by the enforcement officer at the weighbridge along with output from a video camera located next to the sensors;

3. WIM sorter remote output and control unit used to allow the enforcement officer to be positioned at the vehicle stopping point or close to the sensors; and

4. No WIM sorter used. (This was a control strategy which employed existing manual methods for the vehicle selection.)

Each strategy was implemented on at least four occasions over a twelve-month period. Data were collected to establish the effectiveness of the system. This included recording the number of overweight vehicles, the total number of vehicles selected and the number of potentially overweight vehicles not stopped. The latter was determined by asking the enforcement officer, for each vehicle, what action would have been taken if the WIM equipment had not been used. This provided further information on the system's effectiveness. Without this extra information, accurate assessment could not be made since the number of overweight vehicles as a proportion of the total number of vehicles selected could be maximized simply by selecting only those trucks which appeared to be grossly overweight.

The results of the study (Sommerville and Tarry, 1990) show that the use of the WIM equipment during enforcement sessions at the site increased the selection efficiency (ratio of the number of actually overloaded vehicles to the total number of vehicles sent for check-weighing). On average, fewer vehicles needed to be stopped when the WIM equipment was used than during normal enforcement sessions, and a higher proportion of vehicles which were directed for weighing on the enforcement scale were found to be overloaded. The highest selection efficiency was achieved when a closed-circuit camera system was used in conjunction with the WIM equipment.

3. DEVELOPMENT OF PROTOTYPE LORRY BANS SYSTEM - CHAPTER 3

3.1 Introduction

This section describes a study undertaken into the feasibility of developing an automatic lorry ban enforcement system, under
contract to the Vehicles and Environment Division of TRRL. The study results led to a further project being awarded to develop a prototype enforcement system. The equipment was installed for development tests at a site in Hertfordshire in cooperation with Hertfordshire County Council and Hertfordshire Constabulary, whose role in the project is gratefully acknowledged. This project was included as a case study in the Lorry Management Study, jointly undertaken by the Department of Transport, Civic Trust and County Surveyor's Society.

Lorry bans or vehicle weight limits are one of the most common types of vehicle restriction found in the U.K. Current policy is encouraging standardization on gross vehicle weight limits and the completion of metrication of controls within the next seven years. Gross weight limits of 7.5 tonnes or greater are therefore becoming increasingly common.

Enforcement of these bans currently relies on police observation, with possible violators being stopped to give details of their plated vehicle weight, or followed to establish whether the vehicle is in the restricted area for legitimate access or loading purposes. Given that this approach is time consuming, and that preservation of amenity may not be a high priority for the police service, the general level of enforcement is low. The initial phase of the project therefore took the form of a study to examine the feasibility of improving compliance levels through use of an automated system.

3.2 Feasibility Study

One of the main considerations in the feasibility study was the problems generated by the exemptions associated with nearly all bans. Generally there are two types of exemption to orders preventing the use of a road: "except for access" and "except for loading." The first is the less restrictive, allowing the carriage of persons or goods to premises on or adjacent to the road. "Except for loading" allows only the carriage of goods. In addition to this, there are normally exceptions for emergency vehicles.

In order to address these problems, three lorry ban application scenarios were developed, each illustrating the different types of scheme commonly encountered. The first application scenario concerned lorry bans which cover a single length of road with one entry and one exit for each direction of travel. Numerous bans of this type exist, often having been imposed in response to an isolated problem. The second application scenario involved a lorry ban covering a local network of roads with up to six or seven access points to the ban area. The third application scenario concerned wide-area lorry ban schemes. These are generally implemented in urban areas, covering city centres or environmentally sensitive districts where alternative routes using ring roads or bypasses are available. Lorry bans
of this type have a large number of access points.

The main conclusions from the feasibility study were that a system for automatic enforcement of lorry bans was technically feasible, and it would allow resources to be directed towards other activities. The system could assist with enforcement by deterring potential ban violators, even with relatively short periods of enforcement, provided it was given appropriate publicity, and by helping to apprehend those not deterred.

The recommended design for an effective, yet relatively low-cost, automated enforcement system comprised a vehicle detection system incorporating axle sensors and a camera system to photograph vehicles (see Figure 1). It was believed this could be used for effective enforcement of small to medium scale lorry bans.

A further conclusion drawn indirectly from the study was that the conceptual design for the automatic lorry ban enforcement system allowed for the future development of enforcement technologies which could assist the police in the monitoring and enforcement of a wide range of traffic highway violations.

3.3 Development of Prototype System

Following on from the feasibility study, a demonstration project was initiated in February 1988 to develop a prototype short-term automatic enforcement system (Tarry, 1990). The project was performed in association with members of the Vehicles and Environment Division and Photographic Section of TRRL, who were responsible for the installation, operation and maintenance of the camera subsystem, and aspects of the evaluation and commissioning. The trial site chosen for the prototype system was in Welham Green in Hertfordshire. Hertfordshire County Council and Hertfordshire Police were actively involved in the project, identifying a suitable site and providing general assistance. Without this assistance, which is gratefully acknowledged, the trial would not have been possible.

The main project objective was to develop, install and commission a prototype system that would record the numbers of lorries falling into three separate gross vehicle weight (GVW) bands (Mode 1), and photograph lorries entering and leaving the ban site with GVWs in excess of 3.5, 7.5 and 16.5 tonne limits (Mode 2).

The gross vehicle weight refers to the maximum or "plated" gross weight at which a vehicle can operate under UK legislation.

A secondary objective was to develop a modular design for the lorry ban system which would facilitate the future development of a wide range of automatic monitoring and enforcement technologies.
3.4 System Design

A preferred system design was developed suitable for demonstration and implementation in the short to medium term. This was based on currently-available technology, and assumed that low capital cost and portability would be desirable features for the initial system applications.

The prototype system included vehicle detection and camera system elements. The vehicle detection system was designed to identify heavy goods vehicles by classifying vehicles from parameters collected by piezoelectric axle sensors. The camera system consisted of standard 35 mm equipment with accessories allowing a timebase to be superimposed on each photograph. The camera was triggered automatically by the detection system when potential ban violators were identified.

Data retrieval involved a person periodically visiting the enforcement sites to collect the films for development. Processing of the photographs taken involved manually matching number plates and calculating journey times to determine whether vehicles had stopped for access to premises within the ban area.

The vehicle detection system was designed to calculate the number of axles, their spacings and speeds from the signals generated by two piezoelectric sensors permanently installed in each lane. Using this information the vehicle could be classified into specified GVW bands using suitable look-up tables. These tables were initially developed from data collected by TRRL during routine axle weight surveys (Shane and Newton, 1988) and were adjusted through the course of the project to obtain improved system performance.

Piezo sensors were chosen for their clean axle detection signals. The axle load information also available from these sensors was not required in this application as a high correlation between plated Gross Vehicle Weight and wheel base measurements had been demonstrated previously.

The camera system component of the automatic lorry ban system was based on professional quality 35 mm cameras fitted with 250 exposure magazine backs, post-mounted in protective weatherproof cases by the roadside at the lorry ban entry and exit. These were provided, installed, and subsequently operated by the TRRL Photographic Section. The camera was activated by a signal transmitted via a cable link from the vehicle detection system, whenever a suspected ban violator was identified with the system operating in Mode 2.

The end-view photographs, taken a fixed distance from the sensors, allowed number plates to be read. A date and time base was superimposed on the photograph by a data unit. This information allowed journey times of suspected violators through
the ban area to be manually calculated, since the times were synchronized on the cameras at each end of the ban zone. Comparison of the journey times with a predetermined threshold was then used to identify those vehicles which passed through the ban area without stopping.

As there was an overlap in vehicle dimensions between classes, the camera was occasionally triggered by vehicles which were not actually ban violators. These had to be identified and sifted out through examination of the photographs produced and comparison with vehicle registration data stored on computer at the UK Driver and Vehicle Licensing Centre. Equally, a few ban violators with unusually small wheelbase dimensions were probably missed by the system.

In order to overcome this problem, two alternative submodes were provided within operating Mode 2. In "photographic" submode, the system classified vehicles according to the same look-up table as for operating Mode 1. However, in "film-saving" submode, a modified look-up table was used which reduced the number of photographs taken, and increased the percentage of photographed vehicles that were true ban violators.

3.5 Evaluation of Prototype

A prototype system was installed at the trial site in April 1988. It was commissioned, refined and evaluated between June 1988 and December 1988. In order to assess the system performance data were collected manually and compared with data collected for the same vehicles by the automatic monitoring system. Two main types of statistics were calculated, absolute and compensated accuracies.

Absolute accuracy was of most interest in the photographic modes since it is a measure of how well the system classifies each individual vehicle. Compensated accuracy was more applicable to the traffic monitoring mode. It is a measure of how well the system classifies a number of vehicles as a group. It is a comparison between system category totals and true category totals for a group of vehicles.

Surveys conducted in November and December of 1988, each consisting of approximately 800 vehicles, gave overall accuracy figures of 98% and 99% for absolute and compensated accuracies, respectively (Tarry, 1990). In order to establish the extent of false camera triggering that might be expected over an extended period, the system was set to photograph all suspected ban violators at one of the zone entry points. "Film saving" submode was not used and 146 photographs were taken. Approximately two out of three of these photographs were of vehicles of interest in enforcing the lorry ban. It was estimated that if the film saving mode had been invoked the ratio would have risen to three out of every four.
The final aspect evaluated was that of the feasibility of discriminating between ban violators and vehicles entering the area for legitimate access or loading purposes. A survey of lorry journey times through the ban area gave times of between 33 and 65 seconds for non-stopping vehicles and between 88 and 335 seconds for vehicles making a brief stop. From these results, a threshold of 60-70 seconds was deemed appropriate for identifying ban violators.

4. **THE SHERIFF LAW ENFORCEMENT SYSTEM - CHAPTER 4**

The results of the prototype development project and the impeding law changes in the UK encouraged the authors to develop a production version of the lorry monitoring and enforcement system. Called Sheriff, this production system is now available commercially and can be used to assist police and highway authorities in the monitoring and enforcement of traffic highway violations.

The production system is largely based on the automatic lorry ban enforcement system installed and tested at Welham Green. However, in addition to lorry ban enforcement, it offers continuous automatic monitoring of weight limit compliance and enforcement of speed restrictions.

The recently developed production system can be configured so the camera is triggered upon detection of a user-selected vehicle class, axle weight, gross weight or speed in excess of a user-selected threshold. When triggered by the electronics sub-system, the camera system will produce a photograph of the vehicle, identified according to the selected parameter, of sufficient quality to allow unobscured licence plates to be read during normal daylight hours.

A more sophisticated camera system has been designed, still based around a 35 mm professional camera but utilizing a unique display and overlay mechanism to superimpose time, date and also measured vehicle parameters onto the photograph. The camera system is housed in a purpose-designed, robust box ready for mounting on a roadside pole. The camera has a 250-frame back to allow it to operate in an unattended enforcement mode for a significant time period and includes a heating element for use at sites with mains power.

The custom-designed electronic control system interfaces to a PC-compatible computer, via an RS232C port, to allow internal parameters to be configured. In this way the user can select mode of operation, input data relating to the particular site, carry out simple diagnostic routines and retrieve collected traffic data files.
The previous sections have described how several interrelated strands of research, development and evaluation have been brought together to produce an automatic traffic enforcement system. This section briefly describes some of the current applications and practical installations of the system. Brief descriptions are also given of possible future applications and scenarios in which systems of this type could provide a valuable contribution to improving enforcement, safety and economic aspects of the highway.

The system has been installed at several sites in the U.S. for the Virginia Department of Transportation (VDOT). Three sensor installations were made at two dual carriageway sites and one single carriageway site. Two microprocessor control systems were provided and one camera system for use on a rotational basis at these sites.

The sites chosen included Strategic Highway Research Program (SHRP) monitoring sites, combined with sites where there are known traffic problems or weight limits. The SHRP sites form part of a national highway monitoring programme which aims to provide information for input to traffic planning and long-term pavement performance (LTPP) related programmes. At the sites of known traffic problems, the systems will provide detailed information on the extent of the problem and will also provide a proving ground for the photographic technology prior to any constitutional issues being addressed.

The systems supplied to VDOT are full specification weighing and classification systems, capable of providing all the enforcement monitoring facilities described in the previous chapter. These include the following, which can be independently selected and combined without restriction:

- recording individual vehicle speeds, class, axle spacings and axle weights;
- recording of periodic summary data;
- photographing of vehicles travelling at speeds greater than a user-selectable limit;
- photographing of vehicles whose classification falls into a user-selectable prohibited band; and
- photographing of vehicles who exceed axle, gross or FHWA bridge formulae user-selected weight limits.

The system could be readily used as a WIM sorter system. Utilizing the real time output capabilities of the system,
enforcement officers could identify suspect overweight vehicles and direct them to a weighing facility where enforcement measurements could be made and the appropriate action taken. When the site is unmanned suspect or violating vehicles could be monitored so that enforcement activities could be targeted on those periods of the day when the violation rate is highest.

With a number of minor modifications the system could be easily used for several other applications. Interest has been shown in the monitoring and enforcement of bus lane violations. Equally the system could be utilized to identify and photograph vehicles not stopping at traffic signals showing a red aspect, or exceeding speed limits.

6. CONCLUSIONS - CHAPTER 6

This paper has described some of the work undertaken by the authors that has led to the development of a production version of a traffic monitoring and enforcement system. The early work on piezo-electric sensor mountings and weigh-in-motion systems has been described. Particular emphasis has been placed on the techniques and knowledge used to develop the prototype lorry bans system which subsequently formed the basis for the production enforcement system.

The results obtained during commissioning trials of the prototype automatic system used for the enforcement of lorry bans indicated that the system performed satisfactorily, in accordance with the objectives of the project. The demonstrated classification accuracy of the system was generally good, with overall accuracies between 98% and 99%. In trials with the system operating in photographic mode, the majority of the photographs obtained were of heavy goods vehicles that were potential ban violators. The proportion of photographs which were of potential ban violators could be further increased by operating the system in "film-saving" sub-mode.

The conclusion reached from these results is that the system will allow effective monitoring of the extent of violation problems and can also be used to identify violating vehicles. The cost-effectiveness of using the system would be significantly better than using conventional police enforcement methods. Enforcement costs could be much less than that associated with effective conventional policing methods and detection rates could be increased many times over.

Systems such as Sheriff that provide photographic evidence of violating vehicles are gaining acceptance throughout the world. They are being increasingly recognized as an effective method of improving safety on our heavily trafficked roads. Tangible benefits have already been seen to result from the widespread
use of enforcement technology. This type of system is likely to play an important role in assisting police authorities to monitor and enforce a range of traffic highway violations.

7. REFERENCES


8. ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance and cooperation of the Vehicles and Environment Division of TRRL, Hertfordshire Constabulary, Hertfordshire County Council, Wiltshire Constabulary, Wiltshire Trading Standards, the Department of Transport Traffic Examiners and Iowa and Minnesota Departments of Transportation. The views expressed in this paper are those of the authors and not necessarily those of the aforementioned parties.
Figure 1 Lorry Ban Enforcement System
Can Road Traffic Law Enforcement Permanently Reduce the Number of Accidents?

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ABSTRACT

CAN PERMANENT REDUCTION IN THE NUMBER OF ROAD ACCIDENTS BE ATTAINED BY MEANS OF TRAFFIC LAW ENFORCEMENT?

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In this paper it is argued that conventional analyses of road user adaptation to traffic law enforcement, based on parametric rational choice theory, are flawed. Such analyses only consider road user actions as a response to enforcement level and penalty size, and do not simultaneously consider enforcement as a response to road user behaviour.

If both parties are considered as rational agents who adapts to the other's behaviour, the proper way to analyze the outcomes is by the way of game theory.

A game theoretic model is presented and the main implications are: (1) most attempts at enforcing road traffic legislation will not have any lasting effects; neither on road user behaviour, nor accidents; (2) imposing stricter penalties (in the form of higher fines or longer prison sentences) will not affect road user behaviour; (3) imposing stricter penalties will reduce the level of enforcement; (4) implementing automatic traffic surveillance techniques and/or allocating enforcement resources according to a chance mechanism, and not according to police estimates of violation probability, can make enforcement effects last, but both alternatives are difficult to implement.

Relevant empirical studies are reviewed, and they seem to support the conclusions arrived at by the game-theoretic model.
CAN ROAD TRAFFIC LAW ENFORCEMENT PERMANENTLY REDUCE THE NUMBER OF ACCIDENTS? *)
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1. INTRODUCTION

Road user behaviour is of paramount importance to road safety. Drunken driving, speeding, driving against red lights and not wearing seat belts are examples of road user behaviour which increases the risk of accident. If these road traffic law violations were eliminated, the number of injury accidents in Norway could be reduced by about 20-25 per cent, according to estimates made at the Institute of Transport Economics (Ingebrigtsen, 1988; Vaa & Elvik, 1988; Assum & Ingebrigtsen 1990). In order to prevent roadusers from committing these and numerous other violations, laws are enforced by means of police control.

According to standard rational choice theory, road users will abide by the law if the expected utility of law-abiding actions is greater than the expected utility of violations. The expected utility of an action is defined as the probability-weighted sum of utilities from all possible outcomes of the action.

A driver's utility from speeding is, very simplified, the sum of the following products: (Probability of detection by police x Disutility of detection) + (Probability of not being detected by the police x Utility of driving at desired speed).

The probability of having an accident is not included in the above calculation of drivers' utility from speeding. The reason is that we assume, following Nätänen and Summala (1976; Summala, 1988), that drivers consider the probability of accidents to be practically zero.

Thus, according to standard rational choice theory, drivers can be deterred from speeding by increasing the probability of detection or the disutility of detection (the size of the penalty) (see e.g. Palmer, 1977).

In this paper it will be argued that such conventional analyses of road user adaptation to road traffic law enforcement are likely to be misleading. It will further be argued that the most fruitful approach to

*) This paper draws heavily on Tsebelis (1989). The Royal Norwegian Council for Scientific Industrial Research has cofinanced this paper.
analysis of the relationship between police enforcement and road user behaviour is to apply game theory. A game theoretic enforcement model will be proposed, and the implications of the model stated. It will be shown that some of these implications are highly counterintuitive.

Relevant empirical studies will be reviewed and the results interpreted in light of the model. Finally a number of practical implications of the results will be discussed.

2. PARAMETRIC RATIONAL CHOICE THEORY

Traditional rational choice theory or decision theory is parametric, i.e. the probabilities of different outcomes are exogenous and not dependent on the decision chosen.

A car driver’s decision whether to violate the speed limit or not, can be analysed in the following way, based on parametric rational choice theory.

Table 1. Payoffs to Car Driver of Speeding and Not Speeding dependent on the presence or absence of Police.

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Police</th>
<th>No police</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>$a_1$</td>
<td>$b_1$</td>
</tr>
<tr>
<td>Not speed</td>
<td>$c_1$</td>
<td>$d_1$</td>
</tr>
</tbody>
</table>

We make the following assumptions: A1: Car driver prefers to speed if there is no police around ($b_1 > d_1$); A2: Car driver prefers not to speed if the police are out in force ($c_1 > a_1$).

In order to arrive at a decision, car driver must have some idea of the probability that the police are out in force. It seems reasonable to assume that an estimate of this probability ($p$) is obtained from experience. Conventional decision theory predicts that car driver will choose to speed if expected utility from speeding is greater than expected utility from not speeding. In formal terms car driver should speed if:

$$[a_1 \times p + b_1 \times (1-p)] - [c_1 \times p + d_1 \times (1-p)] > 0$$

On the other hand, if the expression is less than zero, car driver will observe the speed limit.
From the expression it is easily seen that the driver's
decision can be influenced in two ways; either by ma-
nipulating the size of p or by manipulating the payoffs
a_1/b_1/c_1/d_1. The probability p can be changed simply by
increasing, or decreasing the level of enforcement. It
is perhaps more difficult to change a car driver's pay-
offs, but a_1 can easily be manipulated by changing the
size of the fine. It is more difficult to change the
driver's payoffs of speeding and not speeding when
there is no police. This involves changing attitudes
etc. and is, of course, a harder task.

To analyze a car driver's decision problem in these
terms might, at first glance, seem very plausible. The
problem is that one commits the Robinson Crusoe
fallacy, to use an expression from Tsebelis (1989).

The Robinson Crusoe fallacy is to behave as if the
environment is not influenced by one's own action, when
in fact it consists of other rational actors whose
actions are influenced by one's own actions. The car
driver in our example behaves as if the level of en-
forcement is independent of whether or not he (and
other drivers) abide(s) by the law. If our car driver
is the only one who ignores the speed limit, a para-
metric analysis might be sufficient i.e. the level of
enforcement will not be influenced by a single
violer.

But if our car driver is representative, his estimate
of the probability of police control will be fairly the
same as other drivers' estimates, and thus if our
driver gets a larger expected utility from speeding
than not speeding, so will other drivers. And because
the level of enforcement is not fixed, but chosen by a
rational agent, the level of speed violations will
probably influence the level of enforcement.

While nature can reasonably be approximated by a proba-
bility distribution, rational players cannot. In our
example, we cannot replace the action of the police by
a probability distribution independent of the acts
chosen by the drivers.

3. A GAME THEORETIC MODEL OF ROAD USER BEHAVIOUR AND
ENFORCEMENT CHOICES.

A game theoretic model takes account of the dependency
between two or more actors who jointly influence the
outcomes and thereby each other's payoff. This is such
a situation, both parties influence the outcome i.e.
the level of speed violations and enforcement. A game
theoretic model is the proper way to model simul-
taneously the authorities' decision of enforcing or
not, contingent upon the drivers' combined choices, and the drivers choices contingent upon the choice made by the enforcer.

The use of a game-theoretic model might be seen as an elaboration of the argument put forward by the various "risk-compensation theories" (OECD 1989). The crux of their argument is the same as here; road users are not passive (parametric) receivers of safety measures. They are strategic actors who take advantage of whatever measure available to attain their goals, which is not always to maximize traffic safety. Compensation theorists have duly pointed to the fact that viewing road users as parametric entities or "nature", is a fatal mistake which might result in no safety effect of potential safety measures.

But, compensation theorists have not simultaneously considered the actions chosen by enforcer as a response to road user behaviour. In that sense one might argue that the use of a game theoretic model is a further development of the line of thought compensation theorists have launched.

In our example of a parametric model, the level of speeding is determined both by the payoffs car drivers get from different alternatives, and from the level of enforcement. To complete the model, we must also include the payoffs to enforcer of the different outcomes. The payoffs to the car drivers and the enforcer are shown in table 2.

Table 2. The Enforcement Game. Payoffs to Car Drivers and Enforcer of different combinations of enforcement an speed violations

<table>
<thead>
<tr>
<th></th>
<th>Enforcer</th>
<th>Drivers</th>
<th>Enforce</th>
<th>Not Enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td></td>
<td>a₁</td>
<td>a₂</td>
<td>b₁ b₂</td>
</tr>
<tr>
<td>Not speed</td>
<td></td>
<td>c₁</td>
<td>c₂</td>
<td>d₁ d₂</td>
</tr>
</tbody>
</table>

a₁ - d₁ are car drivers payoffs of the different outcomes and a₂ - d₂ are the corresponding payoffs to the enforcer.

We will now argue that just as the level of speeding depends on the level of enforcement, the level of enforcement depends on the level of speeding. We make the following assumptions; A3: If car drivers choose to speed, Enforcer will choose to enforce (a₂ > b₂); A4: If car drivers do not speed, Enforcer will prefer not to enforce (d₂ > c₂).
Assumptions A1 to A4 imply that the car drivers will drive above the speed limit if there is no police enforcement. This, in turn, will lead to enforcement, which will cause car drivers to abide by the speed limit. When car drivers observe the speed limits, enforcer will stop enforcement, which again will cause car drivers to violate the speed limit.

In this game there is no equilibrium point based on the actors' so-called pure strategies. An equilibrium point is an outcome where none of the actors can improve his outcome by unilaterally changing his choice. Thus, an equilibrium point is generally a stable outcome. In all the above mentioned outcomes, either the car driver or the enforcer is motivated to alter his choice, and the situation is highly unstable.

According to standard game theory, there exists a unique equilibrium point in such a game if both parties adopt a mixed strategy. A mixed strategy is simply to choose one of the pure strategies with probability p, and the other one with probability 1-p.

Each of the parties can achieve a so-called security level by the use of a mixed strategy. In this example enforcer can choose to enforce with probability q and not enforce with probability 1-q so that car drivers are unable to reach a payoff above value V no matter what they do. The same goes for car drivers, they can also maintain a security level which limits the payoff to the enforcer to a specific value. According to game theory, the best way to maximize one's expected utility in a noncooperative game with antagonistic preferences and no pure strategy equilibrium, is to choose this specific mixed strategy, which is called the minimax strategy in the language of game theory. Here it will be called the equilibrium strategy.

For enforcer the equilibrium strategy consists of selecting "enforce" and "not enforce" in such a fashion that the car drivers' expected utility of speeding will equal the expected utility of not speeding. This can be calculated as follows:

\[
EU(\text{speed}) = q(a_1) + (1-q)(b_1) \quad (1) \\
EU(\text{not speed}) = q(c_1) + (1-q)(d_1) \quad (2) \\
EU(\text{speed}) = EU(\text{not speed}) \text{ when:} \\
q(a_1) + (1-q)(b_1) = q(c_1) + (1-q)(d_1) \quad (3)
\]

Solving this for q yields:
By choosing "enforce" with probability $q$ and "not enforce" with probability $1-q$, enforcer can limit the car drivers' expected utility to maximally $V$. $V$ can be calculated using this expression for $q$ in either equation (1) or (2):

$$V = \frac{(b_1c_1 - a_1d_1)}{(b_1 - d_1 + c_1 - a_1)}$$ (5)

One might argue that enforcer's aim is not to maximize expected utility but to increase road safety. It might be argued that enforcer can choose to enforce with a probability which is slightly larger than $q$ (Hamburger 1979). Thus, for the drivers the expected utility from abiding by the speed limit will be larger than the expected utility from violating the speed limit, and thus, car drivers will choose the former.

It might seem very tempting, perhaps also rational, for enforcer to choose a probability of enforcement which is just sufficient to deter the drivers. But, given our assumptions, this can not be a stable solution because enforcer will reduce the level of enforcement when car drivers abide by the law.

In our opinion, this seems very likely. Although enforcer do not have utility maximization as a goal, the authorities have to make priorities, and it is easy to argue that police efforts ought to be channeled to other areas when there is no, or almost no speed violation. In fact, such an argument was recently used by the minister of justice in Norway when it was decided that the mobile police force (UP) would not get the funding they had expected.

A possible problem in the model presented above, is, as Hamburger (1979) correctly states, that the two parties in this game are not equal. Enforcer might reasonably be viewed as one rational agent, but there are of course many drivers, and the level of speed violations is the sum of their individual choices. Therefore, it might seem a bit odd to calculate a corresponding equilibrium strategy for the drivers. However, we may interpret the proportion of drivers who violate, and the proportion of drivers who abide as an expression of the probability of violating vs not violating. If the level of enforcement is increased, it follows from our assumption A1 that the proportion of car drivers who violate will be reduced. Likewise, if the level of enforcement is reduced, the proportion of car drivers who violate will increase. From this kind of reasoning, it might be very interesting to calculate the car drivers' equilibrium strategy, i.e. which level of speed viola-
tion that will make enforcer indifferent between "enforce" and "not enforce".

This can be calculated in a similar fashion as above, i.e. we examine when enforcer's expected utility of enforcing equals the expected utility of not enforcing.

\[
EU(\text{enforce}) = p(a_2) + (1-p)(c_2) \\
EU(\text{not enforce}) = p(b_2) + (1-p)(d_2) \\
EU(\text{enforce}) = EU(\text{not enforce}) \text{ when:}
\]

\[
p(a_2) + (1-p)(c_2) = p(b_2) + (1-p)(d_2)
\]

Solving this for \( p \) yields:

\[
p = \frac{(d_2 - c_2)}{(a_2 - b_2 + d_2 - c_2)}
\]

Just as enforcer can make drivers indifferent between observing and violating the speed limit, the drivers can jointly make enforcer indifferent between enforcing and not enforcing. Now, the only stable equilibrium point in this game emerges when both parties play their equilibrium strategies.

This is illustrated in the diagram below where the vertical axis represents the probability of enforcement, and the horizontal axis represent the probability of speed violations. The equilibrium strategies \( q \) (for enforcer) and \( p \) (for the drivers) are shown, and the intersection between \( q \) and \( p \) indicates the equilibrium point.

Any movement away from the equilibrium point will be selfcorrecting, and there will be a counter movement towards equilibrium. This is indicated with the arrows in the different areas of the diagram. For instance, if the probability of enforcement is above \( q \), and the probability of speed violations is below \( p \), i.e. we are in the north-west area of the diagram, there will be a tendency towards reduced enforcement and thus increased level of speed violation.

In the north-east area, where enforcement is above \( q \) and violations are above \( p \), there will be a movement towards reduced level of speed violation, and accordingly reduced level of enforcement.

In the south-west area, where enforcement is below \( q \), and speed violations are below \( p \), there will be a tendency towards increased violation, and thus, increased enforcement.

In the south-east area, the level of speed violation is above \( p \) and the level of enforcement is below \( q \). Here, there will be a tendency towards increased enforcement, and accordingly reduced level of speed violation.

3.1 An example with payoffs in monetary values

If we use monetary values to illustrate the payoffs to enforcer and to drivers, the line of argument will perhaps be clarified.

We assume that the cost of one police control is 10 000 norwegian kroner (nkr). We assume further that a police control on average saves public accident costs for 20 000 nkr. We assume that car drivers must pay a fine of 300 nkr, if they are caught violating the speed limit, and if not caught, we assume the time saved on average amounts to 50 nkr. If the drivers choose to observe the speed limit, we assume an equal time loss of 50 nkr. Thus, the car drivers will gain a total of 100 nkr from violating the speed limit, if not caught by the police. These payoffs give the following model:
Table 3. The Enforcement game with numerical payoffs.

<table>
<thead>
<tr>
<th>Enforcer</th>
<th>Not enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enforce</td>
<td>- 10 000</td>
</tr>
<tr>
<td>Not</td>
<td>- 300</td>
</tr>
</tbody>
</table>

The payoff to the enforcer is indicated by the number in the upper right corner in each cell, the payoff to the drivers is indicated by the lower left number in each cell.

By submitting the relevant payoffs, the equilibrium strategy to enforcer is calculated by the use of (4):

\[ q = \frac{(50 - (-50))}{(50 - (-50) + (-50) - (-300)} \]
\[ q = \frac{100}{350} = 0.2857 \]

If enforcer enforce with a probability of 0.2857 the expected utility to car drivers of violate vs observe the speed limit is equal. The value \( V \) to the car drivers is calculated by the use of (5):

\[ V = \frac{(50 * -50) - (-300 * -50)}{350} = -\frac{2500}{350} = -\frac{50}{1} \]

The maximal value to car drivers can also be calculated by substituting 0.2857 for \( q \) and 0.7143 for \( 1-q \) in (1) and (2) respectively:

\[ EU(\text{violate}) = 0.2857 * (-300) + 0.7143 * 50 = -50 \]
\[ EU(\text{observe}) = 0.2857 * (-50) + 0.7143 * (-50) = -50 \]

The car drivers equilibrium strategy can likewise be calculated by the use of (9):

\[ p = \frac{(0 - (-10 000))}{(-10 000 - (-20 000) + 0 - (-10 000)} \]
\[ p = \frac{10 000}{20 000} = 0.5 \]

The car drivers' equilibrium strategy is to violate with a probability of 0.5 and to observe with a probability of 0.5. As earlier mentioned, it might seem strange to speak of an equilibrium strategy to the car drivers on the whole. We may phrase this somewhat differently; if 50 per cent of the car drivers observe the speed limit, and 50 per cent violate, the expected
utility of enforcing equals the expected utility of not enforcing:

$$EU(\text{enforce}) = 0.5 \times (-10000) + 0.5 \times (-10000) = -10000$$

$$EU(\text{not enforce}) = 0.5 \times (-20000) + 0.5 \times 0 = -10000$$

4. IMPLICATIONS FROM THE MODEL

This model has some very important implications regarding the possibility of influencing road user behaviour by way of increasing enforcement, increasing penalties or both.

4.1. Any attempts at enforcing road traffic legislation will be at best halfhearted.

This implication follows from the assumptions A1-A4, and the equilibrium strategy of enforcer. If enforcer enforces more than the equilibrium strategy prescribes, more drivers will observe the speed limit and thus, according to assumption A4, in turn the level of enforcement will be reduced.

This also follows from the model, in the sense that the expected utility of enforcing more than, or less than the equilibrium strategy, will be less than the expected utility of using the equilibrium strategy.

If enforcer enforces with a probability of 0.3, this will change the expected utility to car drivers of violate vs observe:

$$EU(\text{violate}) = 0.3 \times (-300) + 0.7 \times 50 = -55$$

$$EU(\text{observe}) = 0.3 \times (-50) + 0.7 \times (-50) = -50$$

This will gradually reduce the number of drivers who violate, and thus yield diminishing returns to enforcer. When the proportion of drivers who violate is reduced from 0.5 to 0.49, the expected utility of enforcing is unchanged, but the expected utility of not enforcing has increased from -10000 nkr to -9800 nkr, i.e. not enforce has become the better strategy, and will be increasingly better, the more the drivers observe with the speed limit. When all car drivers observe, the expected utility for enforcer is $$(-10000 \times 0.3) = -3000$$ of enforcing, and $$(0 \times 0.7) = 0$$ of not enforcing.

Based on this line of argument, it is reasonable to expect that enforcer will reduce the level of enforcement the less drivers violate the law. Given this consequence, it follows that no lasting reduction in the number of accidents can be obtained by means of traditional police enforcement.
4.2. **Imposing stricter penalties will not affect road user behaviour.**

As Tsebelis (1989) has shown, it follows directly from the model that changing the size of penalties will not affect road user behaviour. The size of the penalty only affects the equilibrium strategy of enforcer and **not** the equilibrium strategy of the drivers.

The equilibrium strategy of the drivers was calculated from equation 4, and it is only the payoffs to enforcer which influence the equilibrium strategy of the drivers. Likewise, it is only the payoffs of the different alternatives to the drivers which are used to calculate the equilibrium strategy of the authorities. This is easily seen; it is only numbers with footprint 2 in table 2 which are included in the calculation of the equilibrium strategy of the car drivers, and only numbers with footprint 1 which are included in the calculation of the equilibrium strategy of enforcer.

This result is perhaps surprising, and a numerical example might be helpful. Let us assume that the fine for violating the speed limit is increased from 300 nkr to 1000 nkr. This gives the following model:

**Table 4. The Enforcement game with revised payoffs.**

<table>
<thead>
<tr>
<th>Enforcer</th>
<th>Not enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enforce Violate the speed limit</td>
<td>10 000</td>
</tr>
<tr>
<td>- 1000</td>
<td>50</td>
</tr>
<tr>
<td>Car drivers Observe the speed limit</td>
<td>- 10 000</td>
</tr>
<tr>
<td>- 50</td>
<td>- 50</td>
</tr>
</tbody>
</table>

We may now calculate the equilibrium strategy for enforcer by the use of (4), and for the drivers by the use of (9).

For enforcer:

\[
q = \frac{(50 - (-50))}{(50 - (-50) + (-50) - (-1000)} = \frac{100}{1050} = 0.0952
\]
For car drivers:

\[ p = \frac{0 - (-10000)}{-10000 - (-20000) + 0 - (-10000)} \]
\[ p = \frac{10000}{20000} = 0.5 \]

An increase in the fine for speeding only influences the equilibrium strategy of the enforcer, and not the equilibrium strategy of the drivers. If the fine is increased from 300 nkr to 1000 nkr, enforcer should reduce the probability of enforcement from 0.2857 to 0.0952, in order to maximize expected utility.

If the authorities maintain enforcement at the former level, more and more car drivers will quit violating because the expected utility of violating will now be (-1000 * 0.2857) + (50 * 0.7143) = -250. Expected utility of observing the speed limit will be as before = -50. According to our assumption traditional police enforcement will not be maintained at that level. Automatic traffic surveillance may, however, be used to keep enforcement level just above the equilibrium strategy and thereby accomplish a lasting reduction, and according to the model, elimination of speed violations.

5. AN EMPIRICAL EVALUATION OF THE GAME THEORETIC MODEL

We have not found any study of the effects of police enforcement on violation rates and accident rates which relies directly on the game theoretic model presented above. It is therefore correct to say that this model has, so far, not been tested empirically.

This does not mean, however, that the implications of the model have no bearing on the interpretation of results of studies based on different models. In the following sections we will review evidence from empirical studies in light of the game theoretic model. Most of the reviewed studies were collected as part of a systematic literature survey, which was conducted as part of the revision of the Norwegian Road Safety Handbook. The revised edition of this book was published in November 1989 (Elvik, Vaa & Østvik, 1989). In the review presented below, we have added a few studies which have appeared after publication of the revised Road Safety Handbook.

5.1 Responses of road users to variation in the amount of enforcement

A number of studies, most of them referring to speed enforcement, show that violation rates decline when enforcement is increased. Table 5 gives the main findings of these studies.
Column one identifies each study by author reference. Column two gives information on the amount by which enforcement was increased. This is indicated by a factor, e.g. 6-8, which indicates that the amount of enforcement was increased by a factor of between six and eight from the initial level. Column three shows the percentage decline in violation rates associated with the increase in enforcement. The initial violation rate served as the basis of these percentages. Thus, a decline in the violation rate from 30 percent to 15 percent amounts to a 50 percent decline in violation rates, not a 15 percent decline. Column four shows the change in accident rates associated with increased enforcement. Different ways of estimating this accounts for the fact the estimated change is presented as an interval in some cases.


For two of the studies (Amick & Marshall, 1983; Sali, 1983) a simplified estimate of the change in the violation rate has been made on the basis of information given on the increase in manpower. Thus, if, say 10,000 violations were detected annually at the initial level of enforcement, and manpower devoted to enforcement is increased by a factor of four, we would expect 40,000 violations to be detected if the increased enforcement did not affect the violation rate and if the effectiveness of enforcement units in detecting violations was unchanged. If, say, only 25,000 violations were detected, we estimate that the violation rate has dropped to 25,000/40,000 = 62.5 percent of its previous level. This corresponds to a 37.5 percent decline in violation rate. Such an estimate is very crude, but hopefully indicates the order of magnitude of the change in violation rate.

The general picture emerging from Table 5 conforms to the implications of the game theoretic model. Increased enforcement leads to fewer violations; the more so the larger the increase in enforcement is.

We would not, however, expect every increase in enforcement to lead to fewer violations. Changes in violation rates are only to be expected if road users notice that the risk of detection has increased. The risk of detection is often very low in absolute terms, perhaps in the order of 1:1,000 or even 1:10,000. This means that the increase in the objective risk of detection must be substantial for road users to notice it.
### TABLE 5: CHANGES IN VIOLATION RATES AND ACCIDENT RATES ASSOCIATED WITH INCREASES IN THE AMOUNT OF ENFORCEMENT.

<table>
<thead>
<tr>
<th>Reference of study</th>
<th>Increase in enforcement</th>
<th>Change in violation rate</th>
<th>Change in accident rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Munden (1966)</td>
<td>6-8</td>
<td>-35%</td>
<td>-25-28%</td>
</tr>
<tr>
<td>Ekström, Kritz &amp; Strömgren (1966)</td>
<td>Ca 3</td>
<td>-13%¹</td>
<td>-21-37%</td>
</tr>
<tr>
<td>Lund &amp; Jørgensen (1974)</td>
<td>Ca 3</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Lund, Brodersen &amp; Jørgensen (1977)</td>
<td>Ca 5.5</td>
<td>-37-45%¹</td>
<td>Not given</td>
</tr>
<tr>
<td>Roop &amp; Brackett (1980)</td>
<td>4-8</td>
<td>-15%</td>
<td>-6-18%</td>
</tr>
<tr>
<td>Engdahl &amp; Nilsson (1983)</td>
<td>0.5-1.0</td>
<td>No overall change, but rate of very high speeds was reduced</td>
<td>Ca +11% Ca -11% Ca -12% Ca -19%</td>
</tr>
<tr>
<td>Åberg (1983)</td>
<td>2-3</td>
<td>5-8</td>
<td></td>
</tr>
<tr>
<td>Ross (1982)</td>
<td>Ca 9</td>
<td>Ca -70%</td>
<td>-30-40%²</td>
</tr>
<tr>
<td>Cheshire blitz</td>
<td>Ca 9</td>
<td>Ca -70%</td>
<td>-30-40%²</td>
</tr>
<tr>
<td>Amick &amp; Marshall (1983)</td>
<td>3-6³</td>
<td>-50-75%⁴</td>
<td>Ca -40%²</td>
</tr>
<tr>
<td>Sali (1983)</td>
<td>3-4³</td>
<td>-20-40%⁴</td>
<td>Ca -17%</td>
</tr>
<tr>
<td>Salusjärvi &amp; Mäkinen (1988)</td>
<td>60 km/h: 2.5-3.0 80 km/h:</td>
<td>-7% -25% + 2-11%</td>
<td></td>
</tr>
</tbody>
</table>

**Notes to Table 5:**

1. The figure refers to speed limit compliance only. Enforcement was directed at all types of offences.
2. Nighttime accidents only, presumed to be more closely related to drunken driving that daytime accidents.
3. The figure refers to increase in manpower resources devoted to enforcement.
4. Estimated change, based on increase in manpower devoted to enforcement.

This point is clearly illustrated by the experiences gained in the two Danish experiments referenced in Table 5. In the first experiment (Lund & Jørgensen, 1974) enforcement was increased by a factor of about three. No effects on violation rates or accident rates.
could be detected. Interviews with road users confirmed that few had noticed the increase in the level of enforcement. In a later experiment (Lund, Brodersen & Jørgensen, 1977), enforcement was increased by a factor of about five. This time, road users did notice the change. There was also a drop in violation rates, especially the rate of speed violations.

5.2 The minimal nature of road user adaptation to enforcement

A number of studies show that the effects of police enforcement are transient and local in nature. This conforms to what we would expect if the game theoretic model is true. The model implies that road users adapt to changes in the perceived probability of encountering enforcement. If enforcement is encountered, violation rates drop momentarily, but return to their previous level once the site of enforcement has been passed or as time passes since the last enforcement was encountered.

A Finnish study detected an effect on speed level of a parked, uniformed police car up to 1.9 kilometres from the car (Syvānen, 1976).

A Canadian study (Hauer, Ahlin & Bowser, 1982) concluded that the effect of a parked, uniformed police car on speed level was halved each 0.9 kilometres passing cars were removed from the car. No effect on speed level could be detected beyond about 2.4 kilometres from the police car. The effect of one enforcement period lasted for about three days. Repeated enforcement extended this to about six days. Repeated enforcement did not seem to affect drivers who passed the site daily more than those who passed the site occasionally.

An American study (Hool, Maghsoodloo, Veren & Brown, 1983) found that the effect on speed level of a stationary, marked police vehicle lasted up to about 8 kilometres downstream from the vehicle. Upstream, the effect could be detected about one kilometre from the parked vehicle.

In another American study, a uniformed police car was moved from site to site in a random fashion, in order to give an impression of massive enforcement (Brackett & Edwards, 1977). This pattern of enforcement extended the effects up to about 20 kilometres from each site where the vehicle was parked.

A Norwegian study (Østvik, 1989A) found an effect on speed level of a stationary radar up to about 2.0-2.5 kilometres from the radar site. No effect on speed level could be detected once the radar was removed.
A Swedish study (Engdahl & Nilsson, 1983B) tried to find out how long the effects of enforcement last. Several techniques of enforcement were compared. It was concluded that drivers who pass an enforcement site reduce their speed when passing the same site for a period of about 14 days. The effects did not last any longer among drivers who had passed two, three or four enforcement sites. Enforcement conducted by means of unmarked ("civilian") cars did not produce any lasting effects.

Ross (1982) gives several examples of the transient effects of legislation and enforcement introduced to reduce drunken driving.

In the United States, seat belt enforcement campaigns have only given a temporary rise in wearing rates (see e.g Transportation Research Board, 1989).

We have not found any studies which show that traditional police enforcement alone produces permanent effects on violation rates. The changes in violation rates given in Table 5 were all measured shortly after enforcement was increased. The changes in accident rates given in Table 5 in most cases refer to the first year after enforcement was increased.

5.3 Police priorities in planning enforcement

Most of the studies which have been reported on the effects of police enforcement concentrate on road user adaptation to changes in enforcement. There are hardly any studies of how enforcement agencies adapt their priorities to prevailing violation rates in the manner predicted by the game theoretic model.

There is little doubt, however, that enforcement agencies to a large extent set their priorities according to changes in violation rates and perceived seriousness of offences. Recently, the chief of the Norwegian mobile police force expressed his concern at the declining rate of seat belt wearing in Norway. He said that the mobile police force would step up its enforcement of seat belt wearing legislation in order to reverse the trend towards less use (Aftenposten, May 8, 1990).

It has also been documented that vehicle inspectors, who conduct roadside vehicle inspections, select vehicles which, on the basis of previous inspections, frequently have turned out to have technical defects for inspection more frequently than other vehicles (Elvik, Vaa, Østvik, 1989). A recent example of this was provided by a roadside inspection of motor cycles in
Norway (Aftenposten, May 19, 1990). In one county, a third of the inspected vehicles was prohibited from driving.

Police try to catch those who drive fastest before catching those who drive slower. A Swedish study (Andersson, 1989) found that the risk of apprehension was higher the more severe the speed violation was.

5.4 Successful enforcement brings about its own demise

One of the basic mechanisms operating in the game theoretic model is that once enforcement brings down violation rates, enforcement agencies will tend to bring down the level of enforcement.

Unfortunately, we have not found any study which documents the reduction of successful enforcement, because of its success. This vital element in the game theoretic model has so far not been documented.

5.5 The effects of stricter penalties

A number of studies show that the imposition of stricter penalties for road traffic law violations does not bring down violation rates. This does not imply that all penalties can be removed, just that their severity is less important for their deterrent effect than their existence.

In 1982 the standard fines for speeding were doubled in Sweden. No changes in speeding behaviour could be detected as a result of the new fines (Nilsson & Åberg, 1986; Åberg, 1989).

In 1987 the standard fines were once again raised. Once again, no changes in speeding behaviour could be detected (Andersson, 1989).

Not even the introduction of jail sentences in stead of fines will necessarily reduce violation rates. In the state of Tennessee, a mandatory jail sentence of two days was imposed for drunken driving. A before-and-after study, in which the states of Alabama and Kentucky formed the control group, concluded that no lasting effect on the amount of drunken driving or the number of accidents could be detected. There was an instantaneous drop of 11 percent in the recidivism rate. Within one year, this effect had disappeared (Jones, Joksch, Lacey & Schmidt, 1988).

The existence of some sort of sanction for violations is essential for assuring a high observance rate. In Norway, the wearing of seat belts became compulsory for
drivers and front seat passengers of passenger cars in 1975. No sanctions were imposed against violators until 1979. Upon the introduction of sanctions, wearing rates increased from 63 percent to 83 percent. A subsequent change in the standard fine from 200 kroner to 300 kroner in 1987 did not lead to any change in seat belt wearing rates (Fosser, 1989).

5.6 Permanent surveillance can ensure permanently low violation rates

So far, there are few experiences with automatic surveillance techniques. Probably the best known example comes from Germany. On a dangerous section of a German Autobahn, speed limits were introduced in 1972. In 1973 automatic surveillance of speed by means of radar detector and cameras was introduced. A long term follow-up study showed that this ensured an almost perfect and lasting compliance with speed limits (Lamm & Kloeckner, 1984).

A recent Norwegian study indicates that automatic speed cameras are very effective in bringing down the violation rate (Østvik 1989B). The long term effects are not known, as the cameras have only been operating for a short period.

6. CONCLUSIONS AND PRACTICAL IMPLICATIONS

The studies reviewed show that our assumptions regarding road user adaptation to enforcement are fairly well supported. It is hardly surprising that road users tend to abide by the law if the police is recognized, and violate if there is no police around. To many it is perhaps also quite obvious that police priorities generally follow the assumptions stated. There are good reasons to reduce enforcement when road users abide by the law, and vice versa. The assumptions regarding the priorities of the police are not well documented, but the findings point in the expected direction.

Given the support for the assumptions A1 to A4, we will conclude that the use of a game theoretic model gives a better understanding of the relationship between road user behaviour and police enforcement than ordinary (parametric) rational choice theory.

In our opinion, this also shows the importance of the development and application of theory in road safety research. Compensation theorists have brought road safety research a big step forward. We believe that game theory might be considered as an elaboration of the line of thought compensation theorists have launched, and that the application of game theory might bring road safety research even further.
Although in our example, the game theoretic approach may give a pessimistic impression of the possibility of reducing road accidents by means of enforcement, we would like to stress that according to our model violations and road accidents can be permanently reduced if enforcement is not reduced once it is successful.

The most obvious way to maintain the level of enforcement at a sufficient high level to deter drivers is by means of automatic traffic surveillance. And the experience gained so far shows that automatic surveillance has a great potential for improving road safety. There are, however, at least two problems connected with it. First, the use of automatic surveillance may be a quite unpopular measure, and thus difficult to implement. Recent debates in the Danish Parliament on automatic speed surveillance, or "photo-traps", may illustrate this point. The Danish minister of justice announced that it was not the business of the state to watch over the public (Aftenposten 3.5.90).

Second, many violations cannot be enforced by means of automatic surveillance techniques. Drunken driving, gap acceptance, dangerous overtaking etc. are examples of violations which necessitate manual enforcement, and thus will be subject to the mechanisms proposed by the model. A possible solution even with manual enforcement is to allocate enforcement efforts according to a chance mechanism, and not according to police estimates of violation probability. By the use of a chance mechanism, and an enforcement level just above the equilibrium strategy, road users can be deterred all together. This seems, we suspect, quite counterintuitive to both political authorities and police and hence, such allocation of enforcement resources is not very realistic today.

We must, therefore, conclude that it is hard to find a foolproof way out of the problems stated by the model. It is, as we have argued, not impossible to overcome these problems, but that demands a very different view on how enforcement should be allocated, a view that we suspect the authorities are not yet prepared to adopt.

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SALI, G. J.:

SALUSJÄRVI, M. & MÄKINEN, T.:

SUMMALA, H.:

SYVÄNEN, M.:
TRANSPORTATION RESEARCH BOARD:

TSEBELIS G.:

VAA, T. & ELVIK, R.:

ZADOR, P. L., LUND, A. K., FIELDS, M. & WEINBERG, K.:

ØSTVIK, E.:

ØSTVIK, E.:

ÅBERG, L.:

ÅBERG, L., ENGDAHL, S. & NILSSON, E.:
A Vehicle Accident Data Recorder

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ABSTRACT.

Current methods for the reconstruction of the sequence of events associated with a road accident are based largely on measurements taken during the static phase of the accident. This is when the vehicle(s) involved have come to rest. The use of observations made by casual observers is notoriously unreliable. DRACO will provide data on the movements of the vehicle and the status of the vehicle systems immediately prior to, during and after impact thus allowing a greatly reduced potential for ambiguity in the reconstruction of all phases of the accident. DRACO data will still be supported by the usual observations made currently by the police and accident investigators.

The paper surveys the likely interests in DRACO data by a variety of end users. The need to protect the interests of the driver with regard to privacy issues is explained. The political and social implications of a DRACO device are discussed. Additionally, ideas to make the recorder data and any down-loaded data tamper-proof, free from misuse by unauthorised agencies and be acceptable to lawyers for use in a court-of-law are described.

The information structure of DRACO is described with attention being paid to what is the most crucial component in the system viz. the accident detection algorithm. This is the decision making process which synchronises the recording action to the accident event. The structure of ADA is highly dependent on the physics of accidents for which there are an infinity of possible scenarios.

The cost of DRACO must be set at a level which is realistically affordable to the vehicle owner, including the connection and installation costs, and must satisfy many of the features associated with a quality instrument. A long life, maintenance-free, calibration-free system which could offer data of a 'guaranteed' accuracy to the end-user would be the 'ideal' system.
A Vehicle Accident Data Recorder
Dr. Bill Fincham
Electrical Engineer
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1. INTRODUCTION.

DRACO is the acronym for DRiver and Accident Coordinating Observer and has the connotation of being an on-vehicle device which will record data associated with any accident in which the particular vehicle is involved. It is a project within the subset of European Communities DRIVE projects which relate directly to road safety. In this group the underlying theme aims at the greater understanding of the accident process and thereby a reduction of accidents by new intervention measures. The global objective is to examine all facets of the specification, development, production, use and application of a vehicle data recorder primarily intended for the provision of data to analyse and, and ultimately reduce accidents. Additionally there is the need to research the acceptability of such a "Draconian" device where what is essentially a driver monitoring aspect of the Road-Vehicle-Driver system will undoubtedly introduce problems of both a technical and psychological nature. Secondary objectives are to highlight potential commercially orientated end-users of DRACO and the potential benefits to them.

The first version of DRACO will function purely to obtain data appropriate to the process of detailed accident reconstruction. With such a tool it is hoped that there will be a considerable reduction in the ambiguity and vagueness associated with current methods of reconstruction because, for the first time, there will be available a means to 'observe' an accident while it is actually in progress. The potential statistical uses of DRACO data are as manifold as the many ways in which accident data has been used in the past but the additional benefit will be that the data could be accurately collected in a consistent format, wherever and whenever an accident occurs. This clear concise view of accident causation and frequency as a result of standardised on-vehicle data collection is the primary benefit of DRACO.

2. WHAT IS AN ACCIDENT?

We shall not attempt a formal definition of an accident but say simply that it is a "sudden event which involves a road user and leads to bodily injury and/or property damage". Of course, this is a very narrow view but the in-quotes wording is taken from the International Organization for Standardization paper ISO/22/12/WG7 of November 1989. An alternative statement, and somewhat more useful view, is that a traffic accident is "a disturbance of the foreseen path of movement of the vehicle".

An accident is seen to result from a multifaceted failure within the Integrated Road Transport Environment (IRTE) which is composed of the three parts:-
i) the roadside infrastructure  
ii) the driver  
and iii) the vehicle.

To exemplify this road-driver-vehicle classification, we consider an arbitrary accident remembering that accidents occur at specific geographical locations and involve one or more vehicles. A possible scenario is that of a tyre exploding on a vehicle travelling at 100 mph, causing it to veer off the road, at a bend with adverse camber, and hit a lamp standard. Here we might surmise that the 'blame' for the accident should be summarised as follows:

i) the infrastructure was at fault for siting the lamp standard so close to a road having poor features  
ii) the driver was at fault for travelling too fast  
iii) a vehicle component was at fault (the tyre)

DRACO cannot apportion blame. In this particular scenario it should provide factual evidence regarding the actual speed of the vehicle. Other DRACO data would hopefully show, perhaps directly, whether the tyre had burst before or after impact with the lamp standard. In this way the court would not have to speculate on certain important issues pertaining to the accident because DRACO data would be used to eliminate the necessity for related arguments.

Post analysis of a specific accident may show that 'something went wrong' in one or more of these parts. Incidentally, this three part view can be represented in several analogous ways, each with headings chosen to suit the needs of the end user, e.g. government (road)-individual (driver)-commercial (vehicle manufacturer). It should be noted that the data recording unit of DRACO resides in the vehicle and is NOT directly connected to the driver. This is an important comment regarding privacy issues which are mentioned in Section 7.

The above discussion follows the 'classical' approach to accident analysis when events are viewed retrospectively. With the availability of DRACO data we can update the approach by taking advantage of data gathered while the accident was in progress. What is presumed is that the accident can be typified by some impact type event (see section 4) which is detected by signal processing, within DRACO and is used to freeze data relating to a period of time around the impact such that

\[
\text{TOTAL ACCIDENT} = \text{PRE-IMPACT} + \text{IMPACT} + \text{POST-IMPACT DATA} 
\]

We see that the accident is considered to consist of three phases which might have nominal durations of 100, 15 and 60 seconds respectively i.e. two to three minutes in all.
3. THE DRACO CONCEPT

Figure 1 shows that the basic information structure of the DRACO system is split into two distinctive parts:

<table>
<thead>
<tr>
<th>DRACO Component parts</th>
<th>ON-VEHICLE</th>
<th>OFF-VEHICLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>type of data stored</td>
<td>raw coded data</td>
<td>decoded and validated data</td>
</tr>
</tbody>
</table>
| Direction of data flow| --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> --> 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time instants in the running of, say, the two DRACO clocks in each of the two vehicles involved in the accident.

DRACO will be asked to output information data (blocks A+B) following the specific event of an accident, and only then if there is good reason for this action. This is the only way it will interface with the IRTE.

Figure 2 Basic scheme for DRACO data storage

```
<table>
<thead>
<tr>
<th>data in</th>
<th>TEMPORARY STORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>data movement in store</td>
</tr>
<tr>
<td></td>
<td>&quot;...data block A...&quot;</td>
</tr>
<tr>
<td></td>
<td>&lt;this data block is analysed to detect an accident. ONLY IF an accident is detected, transfer block A to PERMANENT STORE and continue to record post-accident block B.</td>
</tr>
<tr>
<td>i.e.:--</td>
<td></td>
</tr>
<tr>
<td>&gt;&gt;&gt;&gt;&gt;&gt;</td>
<td>situation after a further time period T----&gt;</td>
</tr>
<tr>
<td>data in</td>
<td>TEMPORARY STORE</td>
</tr>
<tr>
<td></td>
<td>&quot;...data block B...&quot; &quot;...data block A...&quot;</td>
</tr>
<tr>
<td>Data block transfer A+B</td>
<td>PERMANENT STORE</td>
</tr>
<tr>
<td></td>
<td>post-</td>
</tr>
<tr>
<td></td>
<td>pre-</td>
</tr>
<tr>
<td></td>
<td>......relative position of data block to accident</td>
</tr>
</tbody>
</table>
```

DRACO does not directly inform the driver of its activity whereas it could easily connect, via say a radio link and an information centre, to emergency and policing services to alert them in the event of an accident.

4. ACCIDENT DETECTION USING ADA

The development of an Accident Detection Algorithm, code named ADA, is crucial to the success of this project. The primary function of ADA is to generate a reliable version of the trigger signal indicated to occur at the point X in Figure 2. The approach being adopted is to continuously characterise data from...
the transducer set (block A) and test if its statistical parameters satisfy the prescribed algebraic-Boolean thresholds imposed by ADA. If the consequence is a 'YES' then the data freeze trigger is generated. This must even work for gentle accidents because they can be high cost events.

An acceptable ADA formulation will have the following features:

1) It will not miss gentle accidents.
2) It will not produce spurious triggers.

In general, this is a difficult problem to resolve. If an accident is a violent event then there is likely to be little problem in detecting such an event. The 'level of violence' of a collision could be assessed in terms of the rate-of-change of momentum of each of the vehicles involved in an accident. We can consider the five classes of vehicles listed in figure 3 to be characterised qualitatively, in a momentum context, by their mass-speed product ranges.

Figure 3 Vehicle classification

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MASS M</th>
<th>SPEED v</th>
<th>momentum m</th>
</tr>
</thead>
<tbody>
<tr>
<td>commercial</td>
<td>heavy</td>
<td>fast</td>
<td>very high</td>
</tr>
<tr>
<td>private</td>
<td>medium</td>
<td>fast</td>
<td>high</td>
</tr>
<tr>
<td>motor cycle</td>
<td>medium</td>
<td>fast</td>
<td>high</td>
</tr>
<tr>
<td>bicycle</td>
<td>light</td>
<td>medium</td>
<td>low</td>
</tr>
<tr>
<td>pedestrian</td>
<td>light</td>
<td>slow</td>
<td>very low</td>
</tr>
</tbody>
</table>

momentum m = Mv

The rate of change of momentum for a vehicle of constant mass is proportional to its acceleration. A key term in ADA is the rate of change of acceleration. Bearing in mind the fact that differentiation exaggerates the noise component of a signal and that vehicle acceleration during a typical trip is inherently a noisy variable, we cannot reasonably expect a simple algorithm to prove a very successful trigger generator. If some type of running average value of acceleration is used then is the problem of deciding the averaging time window. The impact phase of an accident might typically vary between 2 to 300 milliseconds which means that there is little time to make a convincing trigger decision. Simulation studies are in-hand which have the objective of describing an acceptable ADA formulation.

We have found it useful to consider the events pertaining to a number of stylized and somewhat artificial accidents out of the vast set of widely differing accident scenarios which are possible. Figure 4 shows some of the possibilities.
In case 4a we see two similar lorries meeting almost head-on. Each will be subjected to high momentum changes making life easy for the ADAs. In case 4b we recognize the problem confronting the ADA which sits in a heavy goods juggernaut J when it impacts with a cyclist C unless special low mass impact sensors are fitted, say, to its bumpers. An ADA aboard the cycle would have little problem in diagnosing that an accident had occurred because it would experience acceleration change. Case 4c shows the scenario of a car leaving the road without having impacted with another vehicle. The suggestion here is that a multidimensional view of its gyrations will be required by the ADA if some deviant condition is to be detected. This case fits the 'alternative' definition of an accident given in Section 2.

In order not to miss recording the more gentle accidents the trigger threshold must be set low to be sensitive to quite small changes in vehicle movements. This will certainly lead to spurious triggering. However, ADA continues to process data incoming after the trigger has been generated. The data shown in the post-accident block B of Figure 2 is then used to substantiate the trigger decision. If this cannot be done then the composite data block (A+B) is not transferred or kept in the permanent store.

It is, of course, possible to generate the trigger manually. There may be some instances where the driver wishes to ensure that certain events are recorded so that he could protect his interests. The merits of this proposal are still under
investigation because the time window for him to make such a decision before the data is overwritten is quite short.

5. ACCIDENT RECONSTRUCTION

A survey of current accident reconstruction methods and models has shown that it would be desirable for DRACO to register 100 parameters connected with the accident. Essentially these models attempt to reconstruct the trajectory of the vehicle which is reasonable since this reflects all the influences acting on the vehicle i.e. the road environment-driver-vehicle systems triumvirate. DRACO therefore needs to provide data which would allow the computation of x, y and z coordinates of the vehicle at any point in time around the accident. Vehicle rotation is also required.

Ideally the input parameter groups which are perceived relate to:
....the vehicle movements 'during' the accident
....the condition of the vehicle system
....the vehicle environment due to weather conditions
....the configuration of the road
....the unusual proximity of other objects
....the condition of the driver.

Mainly on the grounds of cost effectiveness, a first version of DRACO will only consider the first two in detail and it should therefore record (directly or indirectly) the nine parameters:—
....speed, x,y and z accelerations and yaw,
....activation of the brakes, indicator and key lights,
....time of accident.

Comment: Vehicle speed is considered important because this is the variable much favoured and understood by the Courts. An event type signal is required to assess whether it had been the intention of the driver to operate the relevant devices at the time of the accident.

6. WHO WANTS/DOES NOT WANT DRACO?

End user interests have been of paramount importance to the research of this project. These fall into the two classes of those who see benefits in the use of DRACO and those who only can see disadvantages. In order that the results of this project impact easily on the requirements of the IRTE, especially in the context of road safety, the technical approach has been formulated by the need to attract end-users on as wide a front as possible to overcome the objections that may arise within the context of "restricting civil liberties" or from motor manufacturers not wanting to risk charges under consumer protection acts. In today's commercially orientated society we also have worked to identify sources of revenue which can be realised as a result of the use of a DRACO system. Quite obviously the first step was to assess the needs of this user society and this, in turn, has required in-depth discussions with the end-users. Thus the technical approach has included identifying the beneficiaries which in turn led to
the identification of the end-users. The former is really the
community at large and thus definition of the requirements could
only be identified by in-depth discussions with the end-users who
will be the intermediaries for the community at large. The class
list of influential end-users includes the following:

- Police authorities and all the related emergency service
  organisations
- Traffic Managers and all related authorities responsible
  for the road infrastructure
- Private motorists whose interests are mainly addressed
  through the motoring organisations and insurance houses
- Fleet vehicle operators and associated commercial interests
- CEC roadside accident infrastructure and Euro-data base

It is of interest to further breakdown these end-users and see a
partial list of those organisations and persons who were consulted
with regard to their attitude to a, then, somewhat ill-defined
DRACO.

those having a national influence:

a) in The Netherlands:

- TBBS (Technical Bureau of Dutch Association of Automobile
  Insurers)
- ANWB (Dutch Royal Automobile Club)
- KNVTO (Dutch Royal Association of Transport Companies),
  Dutch Ministry of Transport, Department of Public Transport
  Ministry of Social Affairs
  Ministry of Justice

b) in the United Kingdom:

- ABI (Association of British Insurers)
- CA (Consumer Association)
- TGWU (Transport and General Workers Union)
  British Ministry of Transport,
  FTA (Freight Transport Association),
  RHA (Road Haulage Association),
  National Association of Risk Managers

those having an international influence—mainly European

- DG VII Transport
- IRTU (International Road Transport Union).
- EOCU (European Consumer Union)
- IDBRA (International Driver Behaviour Research Association)
  Comite European des Assurances—interview via IDBRA
  European Commission
- FIEA (Federation Internationale des Expertes en Automobile)

There is little doubt that legislation will need to be introduced
before the full benefits of DRACO can be enjoyed. Some writers
have referred to DRACO as a "blame box" in the sense that its output would inevitably be used to penalise the driver.

A sentiment strong in many texts written by lawyers is that accidents can only be stopped by stopping bad drivers and that payment of compensation to the victims of the accident does not stop the bad drivers. They see bad driving as synonymous with an antisocial and criminal activity. Thus, if drivers could be made to see that DRACO based data would only be used to confirm that an act of bad driving had taken place, they should then see this as a strong factor in making the roads a safer place for everybody including themselves.

7. RELATED ISSUES

In this section we discuss the implications of a DRACO type device to a number of different issues which relate to its design and potential usage.

7.1 Privacy and Civil Rights Issues

For the past few years there has been considerable activity with attempts to protect the rights of the individual. Whether such developments will proceed in the direction of giving the Euro-citizen greater freedom remains to be seen. A previously conducted interview with the UK based Consumer Association effectively concluded that they did not see DRACO as being too intrusive if the duration of the data recorded was not more than two minutes. One turns naturally to consider the possible consequences of Data Protection Acts with regard to DRACO data.

For the UK Act of 1984 the guiding motivation is to:-

i) protect the individual against unauthorised usage of his personal data by persons who had procured the data and required it for purposes other than those for which it was originally intended.

ii) protect the individual against use of his data which had been 'updated' incorrectly or amended illegally.

The data referred to here is that stored electronically and so is not immediately visible in print for check purposes and data which can be easily transferred and incorporated in other data banks at low cost. Further, the data is of a personal nature and its misuse is an intrusion on the privacy of the individual. The problem of proving that driver A was driving vehicle B at a specific time will not be easy unless details of the driver's identity are included in the DRACO data via, say, the use of a 'smart card'. There is, however, apparently fairly strong opposition to any such proposal and we need to await the outcome of the DRIVE/SECFO survey on Privacy Attitudes, effort on which commenced April 1990.

Let us now turn to DRACO data. The recorder has in its memory information about the last two or three minutes of the vehicle's trajectory. It is difficult to conceive of a realistic example
where this data might be used by the police to trace the driver’s movements and used in some criminal prosecution totally unconnected with an accident. If it did happen, would this be seen as a violation of his civil rights? Cases are known where the much longer duration tachograph records have been used to provide forensic evidence which later resulted in a conviction which was not related to a traffic offence. We should, however, expect various groups to use this very emotive issue as a weapon against the introduction of a DRACO type device on the grounds of some loss of privacy by the driver. Without doubt, DRACO data is inherently of a very different nature to the very personal data covered by the Data Protection Act. DRACO data is only very indirectly 'personal' and is basically 'physical facts' about the vehicle.

7.2 Warranty

Automotive electronics systems are of ever increasing complexity with recent features such as ABS, traction control systems, suspension control, power steering and 4 wheel drive. Most of these items can be considered as safety improvements. Additionally, we have engine management systems also superimposed, transmission control and a host of items associated with driver comfort. DRIVE is now seriously considering an Intelligent Cruise Control concept. With DRACO observing appropriate output signals from these systems it may be possible to determine which failure modes contributed to an accident situation and so aid the post-event analysis process. Perhaps we even need to consider the consequences of incorrect and endangering information presented to the driver by his navigation system? We submit that this evolution although resulting in superb performance and reliability can present a total inability to unravel the course of events and the cause of a catastrophic crash.

In general terms, the resolution of arguments between contending parties (in the case of DRACO these might include the vehicle user, vehicle and system manufacturers and perhaps even operation or maintenance managers) may take place in court or in private. If the latter course can be pursued to the satisfaction of all parties, and with no objections being raised by the law, then the total costs to reach a settlement should be significantly less than if the courts were involved. There is also the merit that such discussions might become less public, a course of action which may be of considerable value to a motor or component manufacturer wishing to avoid adverse publicity. This is a very speculative remark because just the opposite situation could arise if the press got nose of a cover-up operation and felt so inclined to write in their typical exposé style.

We are here thinking of actions of the type in which the vehicle owner is, for some reason, dissatisfied with his vehicle and believes that recompense is due from the manufacturer under the conditions of the warranty. DRACO may well record certain aspects about the condition of the vehicle when an accident has occurred. An often quoted example is the situation where the car becomes a write-off because it did not stop as intended by the driver. The driver states that he operated the brakes but there was no
reaction. The manufacturer or garage servicing department says that the braking system is well designed and well maintained according to documented procedures. Who is telling the truth? DRAKO could be designed to indicate whether the driver made any attempt to apply the brakes which would resolve one issue.

The wording of the above paragraph hints at another contentious area viz. that of product liability. Almost everyday, vehicle owners are in conflict with the vehicle manufacturers on the extent of liability and retribution arising out of the dissatisfaction of the owner with regard to his newly delivered vehicle. Here we need to consider the specific problem of data ownership. Unless the data belongs to the Community, when there would then be a sole owner, we may have to resolve the problem of dual ownership of data. The contenders for ownership might be the vehicle owner versus the vehicle driver or the vehicle manufacturer versus the vehicle operator. Although only two alternatives are given one can conceive that the full eight combinations of cross-case litigations might arise.

We can already see that there will be the need to define an interface via which the vehicle manufacturer must connect his own equipment especially if DRAKO is to observe aspects of vehicle (mal)function which are not driver dependent. Such an interface will require standards to be set in terms of, for example, connector types and signalling levels. At present we see it as being the responsibility of the manufacturer to supply such an interface with its output matching a DRAKO specification.

7.3 Legal

We have already said that legislation will be required to introduce DRAKO into the European IRTE. The histories of the introduction of legislation covering the tachograph, radar based speed measurement, breath testing for alcohol, urine testing and seat belt usage will probably provide useful experience of the attitudes and difficulties likely to be encountered with new DRAKO legislation. All five can be seen as intrusions of privacy, the first four requiring the use of instruments of specific accuracy. These conditions are true for DRAKO.

DRAKO will satisfy the Courts if:-
-----its data is accurate, reliable and meaningful
-----its data has been only issued to and used by approved agencies without violation of any rights the driver may have, if any, to the ownership of the data.

Figure 5 lists some of the safeguards and reasons for these requirements.
Figure 5 Data safeguards

<table>
<thead>
<tr>
<th>SAFEGUARD</th>
<th>PRIME LEGAL REASON</th>
</tr>
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<tbody>
<tr>
<td>accurate data values</td>
<td>to permit accurate</td>
</tr>
<tr>
<td>isolation from electronic interference</td>
<td>accident reconstruction</td>
</tr>
<tr>
<td>good packaging</td>
<td>to prevent data loss in the</td>
</tr>
<tr>
<td></td>
<td>event of severe vehicle damage</td>
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<tr>
<td>secure packaging</td>
<td>to prevent device tampering</td>
</tr>
<tr>
<td>secure data storage off the vehicle</td>
<td>to prevent data tampering</td>
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<td></td>
<td>to prevent unauthorised access</td>
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<tr>
<td></td>
<td>to observe requirements of any</td>
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<tr>
<td></td>
<td>Data Protection Act/Civil Rights Act</td>
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<tr>
<td>keep log of all accesses to data</td>
<td>to ensure fairness of data usage</td>
</tr>
<tr>
<td></td>
<td>to be accountable for the</td>
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<td></td>
<td>issuing of data</td>
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7.4 Data Security

Enforceable provisions need to be built into the handling of DRACO data if it is to satisfy the factors outlined in Sections 7.1 and 7.3. We see the sequence of events for DRACO data handling following an accident, or other event to which the police are called and for which there good reasons which demand collection of DRACO data, to be:-

1 The DRACO box and its contents must be untamperable and as indestructible as reasonably practical. Preferably its outer, fire-resistant, container would be sealed with a durable seal that cannot easily be imitated or re-joined once broken.

2 The policeman at the scene should have the power and the duty to remove the box from the vehicle, following any accident or moving traffic offence. The unopened box should then be labelled and sent to the independent lab for inspection, calibration and report.

3 The read-out would then be independently assessed and reported to the party or parties concerned on payment of a fee.

The alternative situation of where the data capacity of the DRACO box is reached (see Section 3) after a hit-and-run type incident has not been resolved. It is envisaged that sufficient data capacity will be provided to record data relating to, say, five ADA triggerings. The possibilities which could arise are:-

i) the vehicle is immobilised when the DRACO memory is full
   ii) the oldest data is over written
iii) it is a criminal offence for the vehicle to be further used without DRACO being 'reset' by an approved agency which would extract existing data and archive this for a defined period of time.

The first of these is not considered to be a realistic alternative. After the DRACO box has been lodged with an approved agency and the data removed, the internal transducers will be calibrated and the data values converted to engineering units.

It is assumed that processed DRACO data will be accessed by accident reconstructors, police officers, accident statistics databases, infrastructure providers, the legal profession, the driver and/or the vehicle operator or owner. Each group of end-users will require the data in a form suitable for his particular role in society. Initially to allow early progress into the project, it is planned that the output data from DRACO should be conditioned to suit the appropriate application of the particular end-user by some software programming device. All such issuings of copies of the data will be formally recorded.

8. SAFEGUARDING THE DRIVER’S INTERESTS

DRACO should not be confused with the tachograph because its function is quite different. DRACO will not provide data which can be examined on-the-spot by the police where they, for example, believed the driver had just exceeded the speed limit but no accident had occurred. In any case, if there was no accident and so no ADA trigger had been generated, no data would have been retained by DRACO (Figure 2). Measurement of speed from within the vehicle is a notoriously inaccurate if it is to be achieved at low cost. Speed will be recorded, the main reason being that this the one vehicle parameter which is easily understood by the Courts. For purposes of accident reconstruction, acceleration will be integrated to find speed. Simulation studies have shown that, with low cost accelerometers, accurate reconstruction of vehicle trajectory (double integration required) can only be achieved retrospectively over approximately a 15 second interval, but at least for 10 seconds, and this action requires the vehicle to have come to rest at a known point to satisfy the need for two initial conditions values. 'Hit and Runs' do not satisfy these conditions. However, if speed is recorded then it is theoretically possible to achieve an approximate reconstruction.

Thus the driver’s interests are protected by ensuring that the data is:-

i) accurate
ii) of short duration
iii) unpersonalised i.e. the data relates to vehicle movements

Inevitably the vehicle owner will have to pay for his vehicle and its operation. With DRACO there will be both a capital and an operational cost, the latter being incurred only if the vehicle is involved in an accident, but this is dependent on how the
associated infrastructure is set up to handle DRACO data. Naturally the capital cost of DRACO will be kept as low as possible and one might argue, that in round numbers, 100 ECU's should be a target price. There is hope of achieving this by the use of ASIC (Application Specific Integrated Circuit) technology. The necessity to have a system with battery backup is under investigation, as are the availability and cost implications of emerging sensor technology.

Routine servicing of the box should be unnecessary, but it should be checked, say on the occasion of the annual or biannual vehicle test, to see if it is still sealed and has not been tampered with.

We recognise the real problem of being able to attribute a particular set of DRACO data to a specific driver. This is a problem which could easily arise where a company operates a pool of vehicles any of which may be taken out at short notice. If data cannot be reliably attributed then it is worthless with regard to assigning blame.

9. CONCLUSIONS

The DRACO System will allow the vehicle trajectory during an accident to be reconstructed. The use of this information will be complementary to that which is currently used by the Courts, e.g. eye-witness accounts, police reports etc. As time progresses and DRACO proves that it is a reliable and trusted tool, the evidence it offers should then supplement other evidence and opinion, and perhaps supersede them. This paper has not considered the very feasible 'by-product' usages for the DRACO system such as the provision of more detailed data for a European aggregated database or for the automatic alerting of emergency services in the case of a serious accident. This would only be realistic if DRACO were interfaced to vehicle information systems which communicate with the roadside infrastructure. Because of the relatively high cost of making connections to systems outside of DRACO, an extended version will only become feasible when European vehicles adopt a standardised bus system for interconnecting their internal systems and components.

Future detailed work is needed to obtain a specific result in terms of what is likely to be the attitude of individual European Courts to the DRACO System and the mechanism for the introduction of new and necessary European legislation post 1992 if its use is to become widespread.
10. ACKNOWLEDGEMENTS

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**West Germany**
MAN Technologie GmbH, University of Bremen (IMRS) and Mannesmann Kienzle

**Netherlands**
Institute for Social Science Research (IVA)

**Italy**
Industrie per lo Spazio e le Comunicazioni (LABEN)

The balance is three industrial concerns, a motoring and a research organisation and three academic institutions.
The Scope of Automatic Detection and Enforcement Systems

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Enforcement: The Scope for Automotive Detection and Information Systems

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On the basis of a review of traffic law enforcement experiments the following conclusions can be drawn:

(a) traffic law enforcement involving a combination of visible surveillance and unobtrusive detection strategies is superior to other forms of enforcement activities;
(b) a change in subjective probability of detection is necessary to achieve behavioural change;
(c) the intensity of the enforcement activities needs to exceed a certain threshold to have an observable effect; and
(d) combination of enforcement with other activities such as posted feedback or mass media information campaigns increases the effect of the enforcement activities. It is also concluded that lasting behavioural change can only be achieved if the attitudes and norms regarding the behaviour is changed, and that this can only be achieved in long-term strategies involving both mass media and enforcement activities. The lack of perception of the relative seriousness of various traffic law violations is identified as a major problem. On the basis of dutch experiences regarding the change in speed limits it is argued that in practice the necessary requirements for effective law enforcement usually are not fulfilled. For this reason, new ways of enforcement need to be developed. It is argued that these only can be achieved by employing automatic enforcement systems, and that an essential element of these enforcement systems consists of providing feedback to the driver when he is about to commit a traffic offence. A conceptual framework and an outline of the possible technical realisation of these automatic policing and enforcement systems will be presented.
The scope of automatic detection and enforcement systems

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Introduction
The efficiency and safety of the road transportation system depend to a considerable extent on the road users' compliance to traffic rules and regulations. Unfortunately, in most countries road users tend to violate these rules and regulations on a rather massive scale, which results in unnecessary congestion, fuel consumption and accident occurrence. Due to the lack of necessary empirical data, this effect has never been quantified on an aggregate level, but examples drawn from isolated studies provide a clear indication that the accumulated effects must be tremendous.

One of the most extensively studied violations is non-compliance to speed limits. Depending on situation, type of road, country and level of police enforcement, between 20 and 80% of the drivers exceed the indicated limits. It has been estimated that an estimated 30-50% reduction in traffic casualty accidents could be achieved if speed limits could be realistically enforced. A similar picture emerges from studies investigating seat belt use, compliance to traffic signals, violation of priority rules, drinking-driving, and compliance to the regulations for professional drivers with respect to driving, working and resting hours and with respect to maximum vehicle load. Until recently, the focus of the studies has been mainly on the effects of non-compliance on accident occurrence, but there is increasing concern about the effects in terms of energy consumption and congestion. The effects of speeding on energy consumption have been demonstrated both experimentally and in field studies, as for example in the recent change in speed limits on motorways in the Netherlands. It has also been calculated that speed, and in particular speed distributions, affect road capacity, and thus, the occurrence of congestion. A second example is found in situations which require traffic flows to merge, where road capacity is influenced by the willingness of individual motorists to adapt speed and weave with the merging traffic flow. Finally, parking behaviour in cities can also be used as an example for road user behaviour that directly has an effect on congestion.

The willingness of road users to comply to traffic rules and regulation is also of great concern in the introduction of road transport informatics. Many systems that are in development, in particular navigation, traffic control and parking systems, assume that the road user will voluntarily comply with the
instruction and indications presented to him. Given the high levels of non-compliance at this moment, it is very doubtful whether motorists are willing to comply, even if it may seem to be to their own advantage to do so. At present, there is no reason to assume that road users will react in a rational and coherent manner to RTI innovations. Another issue, that will aggravate the situation is that many RTI innovations will be mostly beneficial to the road traffic system per se, and not necessarily to the individual road users. In those cases, experience from social-psychological studies and experience related to safety issues (collective risk, but individual safety) warrants the hypothesis that road users will not comply to newly introduced RTI systems unless they are either demonstrably deriving personal benefit, or are forced to comply by means of external manipulation.

Enforcement plays a crucial role in the efficient and safe usage of the road transport system and its role is more likely to increase rather than diminish with the introduction of RTI innovations. Unfortunately, at present the police forces are unable to maintain necessary levels of enforcement. There are a number of factors that contribute to this situation.

(a) The intensity of motorised traffic has increased rapidly in the last decade, without similar increases in police force manpower.

(b) In the assignment of the available manpower traffic surveillance has to compete with other societal issues -- increase in violence, criminality, environmental problems -- that also demand the attention of police forces.

(c) The enforcement strategies and techniques that are used are not particularly efficient and are mostly based on common sense notions rather than empirical evidence.

(d) Public opinion and politics are not generally in favour of intensive surveillance and enforcement.

(e) Legal requirements and procedures often seriously jeopardize efficient traffic law enforcement.

Automatic policing information systems can contribute to the effectiveness of the efforts of police law enforcement in several ways. Firstly, automatic detection systems can increase the probability of detection of violations being committed without requiring substantial increases in police manpower. In theory, the detection probability can be equalled to one. Secondly, automatic information systems can increase the amount and relevance of information or feedback provided to the road user, and thus, can result in a decrease in the likelihood of an offence being committed. Thirdly automatic systems can increase the 'fairness' and objectivity of enforcement. The assessment of the question whether an offence is being committed will not depend on the subjective judgement of the police officer. Moreover, automatic systems are in many cases able to produce definite proof of the offence being committed. The increase in 'fairness' and objectivity will not only simplify court procedures, or even make these superfluous, they are also likely to increase
public acceptance of traffic law enforcement. In fact, automatic policing is in the end conceptually not very different from automatic debiting and road pricing.

Only very few experimental and rudimentary attempts at automating police enforcement have been made. Most of these concern stand-alone detection systems monitoring speed or red light compliance combined with photographic registration equipment and/or feedback signposting. For this reason it has been necessary to develop a conceptual framework exploring all theoretical possibilities of automatic policing information systems.

**Functional aspects**

Enforcement can be considered as a step-wise process. The first step is legislation. Most countries have a set of laws that specify the requirements road users have to fulfil. In some countries this can be a set of rather general rules, such as the highway code; in some others traffic law deals with very specific behaviour required in specified situations. The degree of specificity of traffic law has large consequences for the possibilities of automation. The step of appropriate legislation is therefore crucial. The second step involves police surveillance to ensure that the general conduct on the road is in accordance with the legislation. Where discrepancies are found the police can take a number of alternative actions depending on the severity of the violations. They may stop and warn the driver without formal registration, stop and fine him, or may apply some on-the-spot sanctions varying from a compulsory one hour delay to confiscation of the vehicle or detention. Depending on the provisions made in law they may also register the action and the licence plate without attempting to stop the driver. The third step in the enforcement process involves the legal action that will result from police registration of an offence. Again, a wide variety of actions may ensue. In some countries offences such as parking and speeding are dealt with on an administrative level using a system of fixed penalties. Other countries use demerit point systems in those cases. More serious offences will result in a court case, often preceded by an offer of the prosecutor to settle out of court. If the offence results in a court case, a wide variety of appeal procedures are open to both the offender and the prosecutor. As these court cases are very often extremely time-consuming both for the prosecutor office and the police officers involved, the prosecutor may in some cases decide to file the case, in particular when it proves difficult to produce hard evidence. Such considerations, in their turn, also affect the police officer's decision to issue a warning only.

The description of the law enforcement process demonstrates that enforcement is much more than police surveillance alone, and that the effectiveness of law enforcement is dependent on many other factors than police surveillance alone. For this reason, all steps of the law enforcement process have to be taken into consideration when developing automatic
policing information systems.

Police surveillance is generally thought to have two main functions: deterrence and detection. The deterrent function is based on the assumption that road user behaviour will be affected by the awareness of the road user that his behaviour is monitored and that violations may result in a fine or conviction. At present, it is not fully clear how this mechanism works, as it has been repeatedly demonstrated that the mere presence of police does not necessarily influence road user behaviour. On the other hand it has also been demonstrated that certain measures (such as posted feedback) can affect road user behaviour without police enforcement being present. Implied threat and subjective probability of detection have been put forward as explanatory mechanisms for these findings, but these have as yet not been sufficiently substantiated.

The detection function is based on the assumption that road users will alter their behaviour if violations can result in receiving a fine or other more drastic punishments such as driver licence withdrawal or imprisonment. Again, empirical evidence is not fully unambiguous, which is probably due to the fact that in operational circumstances police enforcement, and consequently detection, does not reach a sufficiently high level to have an impact on road user behaviour. The objective probability of detection remains below the threshold necessary for influencing the subjective probability of detection. If the subjective probability of detection is raised, for example through publicity campaigns, changes in road user behaviour may be achieved with relatively low levels of objective detection probability.

On the basis of the evidence so far, it is reasonable to assume that automatic policing information systems have to assist police enforcement both in its deterrence and in its detection function. In other words, simple detection and registration systems as such are not sufficient. The systems will also have to act as a deterrent by providing information to the driver about the fact that he is committing a violation and that this will result in a fine or similar punishment.

In addition to the above functions, automatic policing information systems may also assist in the further steps in the enforcement process. Firstly, automated systems may be used to procure hard evidence. Semi-automated systems are already used for this purpose in many countries. This may involve radar speed registration, photographic registration of traffic light violations, licence plate registration for road tax purposes, and electronic breathalyzers used for the unambiguous registration of drinking-driving offences. Secondly, in-car electronic devices are used when a driver is stopped by the police to retrieve information about his record, for example, concerning his previous offences. Thirdly, office automation coupled to existing data bases, such as the driving licence and licence plate
registrations, is increasingly used for the administrative processing of
offences. In principle, licence plate number and type of offence provide
sufficient information to process all administrative offences and out-of-court
settlements. If such systems, which are already operative in some countries,
are coupled to automatic detection and registration systems, it will be
possible to process the majority of offences without any burden to the
manpower of either the police force or the prosecutor's office.

In summary, the possibilities of automatic policing information systems can
be divided into three categories: on-site registration and information systems;
in-car information systems, and registration processing systems.

On-site registration and information systems
Most semi-automated policing systems that are used at present are on-site
registration or information systems. These systems can fulfil the following
functions:
(a) on-site detection of an offence being committed,
(b) on-site registration of an offence,
(c) providing information to the driver about the fact that (i) he is
committing an offence and (ii) that this offence has been registered
(d) feeding the recorded information into an automated offence
processing system

On-site detection of an offence being committed
Detection of offences is at present limited to in particular speeding and
traffic light violations based on induction-loop systems. The induction-loop
system can also be used for a variety of other offences, as for example in
lane-keeping in motorways. In considering the potential of induction-loop
systems it should be realised that it is to be expected that these systems will
be installed in a wide variety of applications for the purpose of other RTI
system (in particular, traffic control) and these systems will be increasingly
supplied with 'intelligence', which, in principle, makes it feasible to use such
systems for the detection of offences such as violation of priority rules.

On-site registration of an offence
Registration of offences at present takes place through photographic means.
This has the disadvantage that licence plates have to be read by human
operators. Automatic licence identification can be achieved in two ways. The
first involves replacing the photographic camera with a video-camera which
produces an image that can be processed automatically. It seems realistic to
assume that this approach can be operational in the near future. The
alternative would be the use of electronic licence plate identification. In that
case, the electronic licence plate would transmit a code that can be used by
on-site registration systems to identify the vehicle. This requires that an
electronic licence plate becomes mandatory for all vehicles and that on-site
registration is equipped with a system that can receive the licence plate code
specific for the vehicle committing an offence.

Providing on-site information to the driver

One of the major reasons why the present traffic law enforcement system does not work is that the delay between committing an offence and, if this is recorded at all, receiving feedback is much too long. Immediacy has been pinpointed in both laboratory and field experiments as a crucial factor in behavioural change. In present day law enforcement it can take several months before the driver receive a notification of the fact that he has been recorded for committing an offence. Even if, and this is by no means always the case, it will lead eventually to some sort of punishment, the delay between the offence and the punishment will be so long that it is unreasonable to assume that any form of learning will result. For this reason, the provision of feedback to the driver is an important aspect of automatic policing information systems. The simplest way to achieve this is by placing message signs at the locations where recording is taking place. However, this can only be applied when the progression of the vehicle over time can be logically inferred, as is for example the case in motorway driving. Even then, it will be difficult to ensure that the feedback is given to the offending driver and not to other non-offending drivers. In many other situations, such as at intersections, the course of the driver cannot be ascertained. A final consideration is that on-site message signs cannot be installed in a density that would be desirable from a policing point of view. Reliance on a system with low density feedback would simply mean that drivers will adapt their behaviour in a site-specific manner instead of adapting their behaviour strategically. Just how many site-specific feedback message signs are required to achieve a generalisation of behavioural adaptation is unknown, but this probably requires such a massive effort that it is unlikely to be viable. One of the main disadvantages of this approach is that the mere presence of a alerting device would act as discriminative stimulus, that is to say, would be used by the driver as an indication that he is at present in an area where violations are registered. Consequently, he would infer that this is not the case when no message signs are present, response generalisation is for that reason not likely to occur.

The above disadvantages are not relevant in the case that specific behavioural adaptations are required. An example of such an application would be in situations requiring temporary or site-specific behaviour, for example, during road works. In this case the objective is to ensure that road users adapt their behaviour to the specific circumstances and hence generalisation is not an issue. In some aspects the situation is the same for variable message signs, where road users are only required to adapt their behaviour when the variable message sign is in function. In that case, it would very well be feasible to link the variable message sign system to a detection system that registers car drivers ignoring the specific message. Since it is likely, that variable message signs are only in function when this required in critical safety or traffic flow situations, this type of application
of automatic policing systems is likely to be cost-effective.

**In-car information systems**

An alternative way of providing feedback information to the driver would involve transferring the message to the in-vehicle information system. This would require all vehicles to be equipped with a receiver that can process the information transmitted by the on-site registration system. In principle, a simple device being able to translate the transmitted code into a verbal or visual warning message would be sufficient. In principle such a device could operate on stand-alone basis or could be integrated in general driver support systems, provided such systems would give sufficient priority to the feedback message to be displayed. The advantage of this approach is that it gives the driver no visible cues when his behaviour is being monitored, and for this reason, response generalisation is more likely to take place than in systems using on-site feedback. In simple operant conditioning terms, the road user would adapt his behaviour in such a way that negative feedback, indicating an offence being registered, would be avoided. Avoidance conditioning based on conditioned stimuli (in this case the feedback) has proved to be a very powerful tool in suppressing undesirable behaviour (in this case infringement of traffic law) in a wide variety of situations, provided that the feedback is given contingent upon the behaviour, and a sufficient high ratio of behaviour - feedback can be reached. In the above providing feedback is equal to providing a (conditioned) negative reinforcement, because it only occurs after the offence has taken place and consequently will lead to some sort of legal action. In principle, the same principle can also be used for providing antecedent information. In that case, the road user would be informed that he is committing an offence, or about to commit an offence, and that this offence will be registered if he persists in his behaviour. In operant conditioning terms, the information will act as a discriminative stimulus rather than feedback, because the road user is given the possibility to adapt his behaviour such that he will avoid being registered as having committed an offence. Such a system would be very similar to driver support systems that provide drivers information on manoeuvring aspects of the driving task. A message generated by an automatic policing system instructing the driver to slow down because he is about to exceed the legal limit would be very similar in nature to a message generated by a driver support system instructing the driver to slow down because he is approaching a curve. In both cases the message contain behavioural instructions that will help him avoid situations that might result negative consequences. The only difference is that in the first case the negative consequence concerns possible legal action and in the second case it concerns increased risk of an accident. As antecedent information implies an instruction to the driver, it is essentially dissimilar to feedback information. It can be regarded as a part of the task domain of the driver, while feedback is in fact informing the driver about the outcome (or consequence) of his task performance. For this reason, providing antecedent information cannot be regarded as separate from
providing other types of information that assist the driver in adequate task performance and it should therefore be integrated in other driver support systems that the driver may have at his disposal. In fact, it can be argued that if traffic law would be sufficiently specific, antecedent information from automatic policing systems is all the driver needs for adequate task performance.

Providing antecedent information poses additional requirements to automatic policing systems because it necessitates at least two consecutive measurements. In the case of speeding for example, one measurement would be needed to provide the driver with antecedent information (that he is exceeding or about to exceed the speed limit) and another measurement to check whether he has adapted his behaviour (i.e. reduced his speed), and if that is not the case, to register his speed, and possibly, to provide him with the feedback that his offence has been registered. Consequently, antecedent information systems would require much more sophisticated registration systems than simple offence recording or feedback systems.

An alternative way of providing in-car information to the driver would be based on directly assessing vehicle parameters or a combination of vehicle and on-site registration. An alerting device based on vehicle parameters alone is feasible for those behaviours that are illegal irrespective of the situation in which they are displayed. Examples of such behaviours are: exceeding the absolute maximum speed limit (assuming that speed limits will be harmonized in Europe), making a 900 turn without signalling, driving during dark without lights and exceeding the maximum driving hours allowed for commercial drivers. However, many behaviours are only illegal in certain circumstances. In those cases, it will be necessary to provide the in-car device with information about the environment and the legal constraints that are in operation in that environment. For example, if the in-car system would receive information from on-site beacons wherever the speed limit is altered, the in-car system would be able to provide the driver a warning whenever he is exceeding the speed limit that is operation in the situation he is driving in, i.e. 30 km/h in residential areas, 50 km/h in built-up areas and so on.

In-car registration of violations
Two systems can be thought of. The first system would entail an active component that transmit relevant information (e.g. licence registration and type of offence) to on-site registration beacons for further processing. The second system would basically involve the electronic equivalent of a tachograph. However, unlike a tachograph such a system could be used for the registration of many different types of violations. Storage of the registered violations could be an integral part of the vehicle and in that case retrieval could take place during periodic vehicle inspection. Alternatively, if smart card systems would be developed to replace convention licences, the
violation history could be stored on such smart cards and checked during licence renewal or tax payments. It would in theory even be feasible to develop an electronic demerit point system, which would render the smart card useless if the collected demerit points exceed a preset maximum.

**Automated offence Processing Systems**

A major problem in law enforcement is the processing of recorded offences. Both for recording and processing purposes it is essential that automatic registration is implemented, whether by video image analysis or by electronic car identification, and that automatic registration is admissible in legal procedures. In many countries this would require substantial adaptation of law and this is essential for traffic law enforcement to proceed in an efficient manner. If prosecution on the basis of electronic evidence alone is permissible, large number of offences could be processed without requiring any increase in manpower. At present, some countries already use automatic systems that retrieve the driver's identification and address from databases containing the information of all licence plate holders and determine the fine on the basis of preset criteria. Even though appeal, and hence costly court procedures are still possible, in practice only a very small proportion of offenders decide to refuse the possibility to settle out of court, and hence the system offers substantial benefits to the court system.

The realisation of a fully automated processing systems for on-site registration systems requires the following components to be implemented: (a) electronic registration of the offence and the identification of the offender (b) transmission of the information from the registration site to a central processing system (c) retrieval of information from licence plate registration data base and (d) production and dispatch of the documents required. In some European countries (c) and (d) are already partly or fully automized. A major problem to be addressed in automatic offence processing is the transmission of the on-site information to a central processing unit. Both line transmission and radio transmission can be considered. However, even though, because of the low density of information, relatively simple systems can be used, the cost of high density networks is likely to be prohibitive. Alternatively, semi-automated systems can be considered, that require manual retrieval of the information stored on-site.

In-vehicle information can be transmitted to on-site beacons whenever two-way communication is required, for example, at sites for automatic toll collection. Alternatively, the information can be retrieved during vehicle inspection or revalidation of smart card driver id's.

**Conclusions**

At present non-compliance to traffic laws and regulations already is severely impeding the safety and efficiency of the road traffic system. It is likely that the functioning of many of the RTI systems under development (e.g. traffic
control and route guidance systems) will be highly sensitive to non-compliance. In theory, many possibilities for automatic enforcement exist, but the feasibility of such systems is at present unclear. Cost, fraud and public and political resistance will severely limit the possibilities of implementing such systems. For this reason the different components of the systems (on-site vs in-vehicle and detection, feedback, registration and processing) have to be considered quite separately.