RESEARCH ACTIVITIES 8

SWOV Institute for Road Safety Research

OCTOBER 1997

Sustainable solutions to improve road safety

The Dutch Government has set quantitative targets for road safety: a 25% reduction in the number of road deaths and injuries by the year 2000 (compared with 1985 levels) and a further reduction of 50% and 40% respectively by the year 2010 (compared with 1986 levels). Various indicators suggest that road safety in the Netherlands is not showing enough significant signs of improvement and it is no longer certain that the aforementioned targets will be met, even if the traditional policy continued to be followed.

New, innovative road safety policy is required and in 1990 the SWOV Institute for Road Safety Research was invited by the Dutch Government to develop a scientifically supported, long term concept of a considerably safer road traffic system. The general concept of sustainable development introduced by the UN Brundtland Commission also inspired the new vision for road safety: no longer do we want to hand over a road traffic system to the next generation in which we have to accept that road transport inevitably causes thousands of deaths and ten thousands of injuries, year after year in the Netherlands.

A sustainably safe road traffic system is one in which the road infrastructure has been adapted to the limitations of human capacity through proper road design, in which vehicles are technically equipped to simplify driving and to give all possible protection to vulnerable human beings, and in which road users have been properly educated, informed, and, where necessary, deterred from undesirable or dangerous behaviour. Man should be the reference standard and road safety problems should be tackled at its roots.

CONTENTS

Three safety principles

The key to arrive at a sustainably safe road system lies in the systematic and consistent application of three safety principles:

- *functional use of the road network by preventing unintended use of roads;*
- *homogeneous use by preventing large differences in vehicle speed, mass and direction;*
- *predictable use, thus preventing uncertainties amongst road users, by enhancing the predictability of the road's course and the behaviour of other road users.*

Monofunctional roads

These three safety principles require the specification of the intended function of each road and street. Roads are built with one major function in mind: to enable people and goods to travel, the so-called traffic function. Three options could be distinguished:

- *the flow function: enabling high speeds of long distance traffic and, many times, high volumes;*
- *the distributor function: serving districts and regions containing scattered destinations;*
- *the access function: enabling direct access to properties alongside a road or street.*

Besides a traffic function, streets and roads in built-up areas should allow people to stay in the vicinity of their house safely and comfortably. We call this function residential function and this function could well be combined with the access function. ▸

Common practice of today			Sustainably safe practice	
Existing types of roads	Traffic function		Traffic function	Sustainably safe types of roads
Motorway	↑	Increasing through and decreasing access	Through	Ia. Motorway
Motor road				Ib. Motor road
Main distributor			or	IIa. Distributor road (rural)
Local distributor			Distributor	IIb. Distributor road (semi-urban)
District artery	↓	Decreasing through and increasing access	or	IIIa. Access road (rural)
Neighbourhood artery			Access	
Residential street				IIIb. Access road (urban)
Woonerf				
	Residential function		Residential function	

Table 1. Common practice and sustainably safe practice of categorising roads and streets

The concept of sustainably safe road transport comes down to the removal of all function combinations by making the road monofunctional. Multi-functionality leads to contradictory design requirements and also to higher risks. The differences between the existing approach to categorise a road network and the sustainably safe approach are depicted in Table 1.

Based on our existing knowledge functional requirements for design criteria have been developed for a sustainably safe traffic system:

- *create residential areas as large as possible;*
- *every trip as long as possible over the safest type of roads;*
- *make trips as short as possible;*
- *combine short and safe;*
- *prevent search behaviour for destinations;*
- *make road types recognisable;*
- *reduce and uniform design characteristics;*
- *prevent conflicts between on-coming traffic;*
- *prevent conflicts between crossing traffic;*
- *separate different transport modes;*
- *reduce speed where conflicts could occur;*
- *prevent obstacles alongside a road.*

Recently, these functional requirements have been made operational in 'draft guidelines' by a C.R.O.W-working committee. An example of these guidelines for roads outside urban areas are presented in Table 2.

The policy on implementation of sustainable safety follows three lines: to develop the concept into more practical terms, to implement a so-called 'Start-up programme' and to carry out different demonstration projects.

Start-up programme on sustainable safety

The concept of sustainable safety cannot be handed over to just those who are interested in the concept and rely on their individual willingness to come to implementation and leaving those who are not interested aside. The concept requires an active participation of all road authorities and of the whole road safety community as well. The culture in Dutch public administration requires dialogue and consultation to meet this aim. A special Steering Committee, with representatives from the central, provincial and local government and from the water board, has been set up to guide this process. The Steering Committee made an integrated Start-up programme, covering the first phase of implementation of sustainable safety.

This Start-up programme comprises a package of measures which forms essential conditions to fulfil firstly before investments in a sustainably safe road transport system could be made. Secondly, all measures in this start-up programme are relatively cost-effective and could be implemented in a rather short time (three year period) and got support from a wide majority of those who were consulted. It is to be expected that the programme will be realised in the period between 1998 and 2000. The total costs of implementation are estimated to be some 200 million dollars. The central

Design criteria	Through road	Distributor road	Access road
Speed limit	120/100 km/hour	80 km/hour	60 km/hour
Longitudinal marking	complete	partly	no
Cross section	2x1 (or more)	2x1 (or more)	1
Road surface	closed	closed	open
Access control	yes	yes	no
Carriageway separation	yes, physical	yes, visual, to be crossed over	no
Crossing between junctions	at grade	at grade	grade
Parking facilities	no	no	parking space or on the carriageway
Stops for public transport	no	outside the carriageway	on carriageway
Emergency facilities	emergency lane	in verge or on hard shoulder	no
Obstacle free zone	large	medium	small
Cyclists	separated	separated	depending
Mopeds	separated	separated	on carriageway
Slow motorised traffic	separated	separated	on carriageway
Speed reducing measures	no	appropriate measure	yes

Table 2. Design criteria for road sections outside built-up areas

government will provide half of the financial means required, and the other partners will contribute the other 100 million dollars.

The following measures are part of this Start-up programme:

- *road classification programme (for the complete Dutch road network of more than 100,000 km. road length), which enables the roads to fulfil their functions satisfactorily and forms a basis to solve the problems of contradictory design requirements;*
- *stimulate a low-cost introduction of 30 km/h-zones inside built-up areas (excl. roads with a flow function and with a distributor function); an extension is agreed upon of the number of 30 km/h-zones from 10% of the possible zones (as is the case now) up to 50% by the year 2000;*
- *introducing with simple means a concept of 60 km/h-zones for minor rural roads; some 3,000 km of road length is aimed for to be realised by the year 2000;*
- *if needed and possible infrastructural measures like cycle facilities, roundabouts, small-scale measures to support 30 km/h-zones and 60 km/h-zones;*
- *inside urban areas mopeds on the carriageway instead of on cycle tracks or cycle paths in 1999;*
- *indication of priority at every junction (outside the 30 km/h-zones); the same priority rules for cyclists and mopeds as for motorised traffic will be introduced;*
- *public information campaign to support the introduction of sustainable safety, a better police enforcement and education programmes;*
- *the introduction of a road safety audit in 1998.*

Based on the implementation of this Start-up programme further steps will be defined for the implementation of a sustainable safe road network in the Netherlands in the years to come.

Demonstration projects

Large-scale demonstration projects are implemented to gather practical experiences when applying the sustainable safety principles. Some of them are co-financed by the Dutch Ministry of Transport. Other plans are developed without such financial support. Two of these projects are introduced here.

West-Zeeuwsch-Vlaanderen

This project is carried out in the very south-west of the Netherlands, close to the Belgian border: the western part of Zeeuwsch-Vlaanderen. This area is a rather rural one with many visiting tourists during the summer season. The road network is without a clear hierarchy of mainly low volume roads. Enormous differences could be observed in usage of this network: a mix of different types of vehicles: fast moving passenger cars together with agricultural vehicles and biking school children using the same physical space.

The road safety record of this area is rather poor. The high number of severe accidents in the last few years created a strong support in this region for remedial actions.

The key elements of this project is the restructuring of the road network in the region according to the principles of sustainable safety. The road network will be divided into four categories and the total operation involves 1,000 km of roads, mainly the upgrading of roads. Intersections between the highest and lowest categories of roads will be eliminated and many intersections will be transformed into roundabouts. It is estimated that the chose alternative will result in a 60% reduction of the number of road accident casualties and the costs will amount 200 million Dutch guilders.

West-Friesland

West-Friesland is a region of 350 square kilometres, 180,000 inhabitants, in the Northwestern part of the country, with relatively high accident figures. About 50% of the population lives in villages of less than 5,000 inhabitants. The number of casualties in this region has been increased with 14% since 1986 and in the same period of time a reduction of casualties has been registered in the surrounding regions. A large proportion of the accidents occurs on rural roads on or in the direct vicinity of junctions.

Two major causes of accidents are reported: high driving speeds and road situations which are unclear for road users.

A road safety plan has been developed in the region based on the principles of sustainable safety. Implementation of this plan could

reduce the number of casualties with 60%, if all road authorities in the region cooperate, if the implementation will be prepared carefully and if the measures are taken quickly.

Two ideas are leading in this plan: to categorise functionally the road system and to design the different types of roads (flow, distributor, access) in order to meet the corresponding functional requirements as indicated before. This leads to roads with a flow function with access control, with separated carriageways and at-grade crossings. Design of distributor roads will depend on the traffic volumes: 6000 vehicles/day has been chosen a criterion. Large areas (1000 - 5000 ha.) will be considered as 60 km/h-zones, where through traffic will be prevented and the 60 km/h speed limit will be enforced.

These so-called 60-zones form the backbone of this plan. The costs of the implementation are estimated to be 240 million Dutch guilders and the time needed for implementation will be some 10-15 years.

Traffic calming

During the seventies the principle of total integration of different transport modes was developed for residential areas in the Netherlands. The concept has also become internationally known by the Dutch word 'woonerf'. Motorised traffic - excluding through traffic - is accepted but is subordinate to the other 'woonerf'-users. In a woonerf motorised traffic is permitted to drive at walking pace (5-8 km/h). Separate provisions for pedestrians (such as sidewalks) are absent. In 1976 the 'woonerf' achieved legal status.

The 'woonerf' led indeed to a substantial reduction in the number of injury accidents. In some projects some 70% reduction of injury accidents were reported. However, the application of the 'woonerf' often remained restricted to only a limited amount of and relatively small areas. As reasons for this the following was given: very strict legal design requirements, the high construction costs and the extra physical space needed for realisation.

We learned that two features were essential: reducing driving speeds and reducing through traffic. From accident studies it turned out that the collision speed should remain below 30 km/h, because then the probability of a serious injury will be minimal. Based on a recent survey it could be concluded that 300 out of 700 Dutch municipalities have realised one or more '30 km/h-zone'. Recently the effect on the number of injury accidents was studied and it was determined that the number of serious injury accidents had dropped by more than 30%. A rough estimate at this moment is that 10% of the network of roads in the built-up areas has the status of 30 km/h areas. Opinion is that within the built-up areas approximately 80% of the road network could be given the status of 30 km/h-streets.

Two recent developments also deserve attention. Firstly that due to the high costs streets which qualify for a 30 km/h status do not receive it and for the same reason those areas which have the 30 km/h status are relatively not extensive. It was therefore reason to investigate to what extent a more low-cost construction demand for 30 km/h-areas would lead to large-scale implementation and in addition to determine if a low-cost construction is equally effective and thus more efficient. SWOV has carried out this investigation.

Financing a sustainably safe road transport system

Estimates have been made to investigate what the introduction of a sustainably safe traffic system would cost. The first SWOV-estimations resulted in 60 billion Dutch guilders; a major proportion of this money should be invested in adapting the existing road infrastructure according to the principles of sustainable safety. Based on different recent and more detailed estimations, especially based on the demonstration project in West-Zeeuwsch-Vlaanderen, a more sober implementation would cost 30 billion Dutch guilders. SWOV has suggested to spread these investments over a period of 30 years in order to run these investments in parallel with the standard maintenance of the road infrastructure; a period of 30 years is a reasonable one for the Dutch circumstances.

The Dutch government annually spends about 6.8 billion guilders on the road infrastructure. Just over half of this is invested in (major and minor) maintenance work, while the rest represents investments, excluding the (no longer freely disposable) capital costs of earlier investments. In view of both the size of this sum and the number of kilometres of road annually renewed or newly constructed, this offers sufficient

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The location of our office and our telephone and telefax numbers have not been changed.

space to realise a sustainably safe system within a period of thirty years.

Estimations have to be made of the costs of road hazard and the reduction of these costs due to the investments to implement in a sustainably safe traffic system. The material costs of road hazard in 1993 amounted to 9.53 billion Dutch guilders a year. When the immaterial costs are also included in the calculation, the total costs come to 12.35 billion Dutch guilders a year.

If we invest 30 billion Dutch guilders over a period of 30 years, we estimate a reduction of 60% of the number of road accident casualties. Even if we use a conservative basis for cost-effectiveness estimations, SWOV concludes a cost-effectiveness of 9%, which is considerably higher than the customary government standard of a 4% return on investment for infrastructure projects.

Further innovations

To reach the Dutch targets for road safety, we cannot and will not rely only on existing knowledge and technologies. Innovation is, as ever, a necessity.

A wide range of Transport Telematics devices could possibly solve current transport problems and the road safety problems. But we have to be careful that new telematic devices, which are meant to support the driver, do not overload or underload the individual driver or will result in counterproductive adaptation.

From a road safety point of view perhaps three observations are of importance. First of all, the introduction of some means of speed management seems to be very significant to improve road safety. Secondly, telematics applications should specifically deal with protecting vulnerable road users (pedestrians, cyclists, the elderly and the young). Finally, a large proportion of our road safety problems exists on urban traffic arteries and on rural roads. It is to be recommended to put special emphasis to these types of roads when further developing transport telematics.

Concluding remarks

A new vision on how to improve road safety considerably, like the Dutch concept of sustainably safe road transport, will only get support from key stakeholders (politicians, government, road safety community) if a need for a new vision is broadly considered as inevitable.

Furthermore, such a new vision has to be seen as attractive by those stakeholders. In the Dutch situation members of parliament played a key role by expressing their support on a conceptual level at the right moment. The positive attitude of private organisations in the field of road safety turned out to be very valuable. The Dutch Ministry of Transport embraced the concept without many hesitations and their 'policy craftsmanship' resulted in support from the organisations of municipalities and provinces and the water-boards, although it has to be admitted that their support could be seen as somewhat hesitant.

Nevertheless, it looks like that a very positive point will be reached when the just signed letter of intent will result in a formal agreement on the so-called Start-up programme. This ambitious approach would not have been possible without using the Dutch model of creating awareness, support and commitment of all key stakeholders in the Netherlands.

It is without doubt that in the period between launching the concept (1991) and 1997 sustainable safety induced new energy in the road safety community. Many stakeholders and road safety professionals asked themselves which contribution could be made to elaborate the concept and to contribute to implementation. The debate, which is still going on, on sustainable safety has enriched and improved the concept.

Sustainable solutions to improve road safety in the Netherlands

A polder model for a considerably safer road traffic system

Fred Wegman (SWOV) & Peter Elsenaar (Ministry of Transport). D-97-8. 28 pp. Dfl. 17,50. (In English)

Other recent projects carried out by SWOV to achieve a sustainably safe traffic system are mentioned below. For more information please ask for the complete list of SWOV research on a sustainably safe traffic system.

Uniforming the right of way regulations

Research into the safety of major/minor junctions and exit constructions

J. van Minnen & J.W.D. Catshoek. R-97-24. 48 pp. Dfl. 22,50. (In Dutch)

Conditions for introducing 30 km/hour inside built-up areas

A study into the minimum conditions to which areas have to apply in order to be appointed as a 30 km/hour area

J. van Minnen. R-97-21. 45 pp. Dfl.22,50. (In Dutch)

Testing the sustainably safe character of the road network in West Zeeuwsch Vlaanderen

A. Dijkstra, P.C. Noordzij & C.M. Gundy. R-97-29. 83 pp. Dfl. 35,-. (In Dutch)

A sustainably safe traffic system: from concept to implementation

Final report

R. Roszbach, R.D. Wittink & F.C.M. Wegman. R-96-34. 108 pp. Dfl. 35,-. (In Dutch)

Financing a sustainably safe road traffic system

Existing expenses and return on investments in road safety

F. Poppe & L. Mulzelaar. R-96-49. 52 pp. Dfl. 25,-. (In Dutch)

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Drink-driving in the Netherlands slightly decreased

Between September and December 1996, SWOV, in collaboration with 73 police control teams, conducted a roadside survey in order to establish the alcohol consumption of motorists in all twelve provinces of the Netherlands. The study, which was carried out on Friday and Saturday nights between 10 p.m. and 4 a.m., represents a continuation of the nationwide studies into drink-driving habits. These were carried out between 1970 and 1995, to determine the trend in alcohol consumption.
In the roadside surveys, motorists are stopped at random, and all are subjected to a breath test. The 1996 sample contained 22,905 motorists.

René Mathijssen, 48 years old was working as an editor for a publisher from 1973 till 1975. Since 1975 he has been employed by SWOV, at first as an scientific editor, later on as a researcher.

His main topics are epidemiology of drinking and driving, effects of police enforcement on road user behaviour, and analyses for road safety policy.

In order to gain an impression of the development in random breath testing in the Netherlands, SWOV interviewed the police co-ordinators of the roadside surveys. In 1996, 56% reported that the enforcement level had increased, while 15% reported a decrease; the remaining 29% reported no noticeable change.

Development of drink-driving

The 1996 study showed that the number of motorists with a BAC over the legal limit of 0.5‰ had slightly decreased: from 4.7% in 1995 to 4.4% in 1996. The 1996 figure is not significantly different from the 1995 figure, but it is from the 1994 figure. In the latter year, 4.9% of motorists had a BAC over the legal limit.

In 1996, the *highest* percentages of drink-driving were found:

- *Saturday and Sunday morning between 2 and 4 a.m. (10.7% and 7.1% offenders, respectively);*
- *amongst male drivers aged 35-49 years (6.8% offenders);*
- *in municipalities with more than 50,000 inhabitants (5.1% offenders);*
- *in the western provinces of the Netherlands: 5.7% offenders in North-Holland; 5.2% in South-Holland; and 5.0% in Utrecht.*

Relatively *low* percentages of drink-driving were found:

- *amongst female drivers of all ages (1.8% offenders);*
- *amongst male drivers aged 18-24 years (3.1% offenders);*
- *in the northern provinces of Drenthe (1.5% offenders) and Groningen (2.0% offenders).*

Development of alcohol-related accidents

The 1996 decrease of drink-driving was not reflected by official accident statistics. According to these statistics, alcohol-related road fatalities and severe injuries increased in 1996, both in absolute numbers and as a percentage of the total road toll. This, however, is probably a result of more systematic testing of drivers involved in road accidents, due to new guidelines which became effective in most police regions in 1996.

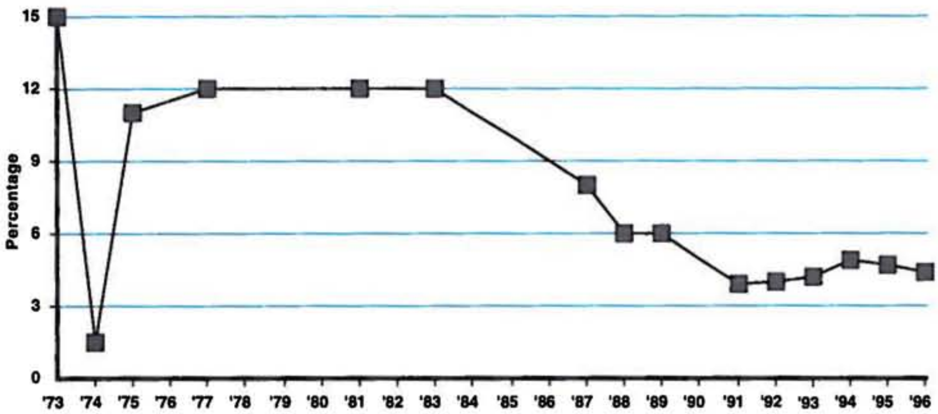
In 1996, the official number of alcohol-related fatalities in the Netherlands was 97 (versus 87 in 1995), the number of serious injuries 1,200 (versus 1,123 in 1995). The real numbers, however, are considerably higher, since even in 1996 the registration rate of alcohol-intoxicated drivers involved in accidents was still rather low. Only one third of the police co-ordinators of the 1996 SWOV roadside survey reported systematic testing of accident-involved drivers in their research area.

A rough estimate for 1996, based on a comparison with German data, gives 235 fatalities and 2,000 serious injuries as a result of alcohol-related accidents in Dutch traffic. The associated economic damage is estimated at a sum of almost two thousand million guilders.

Young men and weekend nights

The relatively greatest share in alcohol-related fatalities and serious injuries have young men aged 18 to 24, namely 24% while forming only 5% of the Dutch population overall. The explanation for their marked

Percentage motorists with a BAC > 0,5 promille during weekend nights



over-representation is that, after alcohol consumption, the accident risk increases stronger for young drivers than for older ones.

Serious alcohol-related accidents in the Netherlands are strongly concentrated on Friday and Saturday nights (10 p.m. - 4 a.m.). In 1996, no less than 28% of all alcohol-related fatalities and hospital admissions occurred during these two periods, representing only 7% of the week as a whole.

Recommendations

In order to combat driving under the influence, SWOV recommends a mixture of countermeasures, consisting of legal regulations, education and information campaigns, police enforcement and associated publicity. These countermeasures should be aimed particularly at young drivers (lower legal BAC limit or stricter enforcement of the present limit; education and information campaigns), at visitors of public drinking places (information and a certain amount of social control by barkeepers), and at days and times of the day where higher alcohol consumption is known to occur (police enforcement and associated publicity).

Drink driving in the Netherlands, 1995-1996

Development of alcohol use of motorists in weekend nights

M.P.M. Mathijssen.
R-97-20. 67 pp. Dfl. 25,-.
(In Dutch)

Opinions of *Dutch motorist* compared with those of the average European

SARTRE, a large-scale survey studying Social Attitudes to Road Traffic Risk in Europe, was carried out for the second time in 1996. This survey questioned a random sample of approximately one thousand people with passenger car driving licences in regard to their opinions about measures and speed limits, causes of traffic accidents, their own behaviour in traffic and that of others, their perception of danger in traffic, and their experiences involving police enforcement. The countries participating in 1996 were: Austria, Belgium, the Czech Republic, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and Switzerland.

This report describes the Dutch data from the second SARTRE study. The results are also compared with those from the first survey done in 1991 in order to trace shifts in opinions, attitudes, perceptions of risk and/or self reported behaviours. It is also described how the opinions of Dutch and foreign possessors of passenger car driving licences compare in regard to measures, behaviours and risks. The research was financed by the Dutch Ministry of Transport and by the European Union.

Differences between 1996 and 1991

The opinions of Dutch motorists in regard to various subjects appear to have changed little if at all. Both in 1991 and in 1996 there was ample majority support for many of the road safety measures. The two greatest shifts in opinion are as follows:

- *to an increasing extent, behaviour factors are thought to be playing a dominant role in regard to (causes of) road accidents;*
- *acceptance of the introduction of a third brake light in Europe has increased greatly in 1996 and is receiving the support of a generous majority.*

Differences between the Dutch and the average Europeans

Compared with the 'average' European motorist, the Dutch motorist in 1996 shows:

- *less concern about air pollution, road accidents and unemployment;*
- *less perceived risk regarding walking, cycling and motorcycling;*
- *less perceived risk for vehicle or road defects as causes of accidents;*
- *greater perceived risk for the daily drinking of great amounts of alcohol;*
- *greater disapproval of the freedom to drive while intoxicated;*
- *a greater frequency in the pattern of alcohol consumption, while at the same time, a lesser frequency in the pattern of driving a car following alcohol consumption;*
- *a more positive attitude in regard to car pooling as a way of reducing air pollution;*
- *a less positive attitude to the use of public transport as a way of reducing air pollution;*
- *a stronger impression that he/she is driving at speeds equal to or a bit faster than average.*

What do European motorists think

Road safety measures
According to European drivers, the national government should first of all devote more attention to improving the standards of roads, and should in second place improve the driver training. The support of European drivers for government stimulation of more enforcement of traffic laws, more testing of vehicles and more road safety campaigns is somewhat less, but still considerable. Drivers in countries with a high quality of road infrastructure tend not to be so strongly in favour of their government devoting more attention to the standards of roads, whereas drivers in countries with less developed or maintained road infrastructure tend to very strongly favour an active government role in this respect.

Penalties, car advertisements and public transport
A large majority of all European drivers (strongly) agrees with the need for better public transport; more than half of the drivers (strongly) agrees with the necessity of more severe traffic penalties; slightly less than half of the respondents (strongly) agrees with a restriction on the freedom of car manufacturers to use the appeal of speed in car advertisements.

Drink driving
There is large variation in the tolerance of European drivers towards the freedom in drinking and driving. In all of the survey-countries, there is only minor support for the statement that people should be free to decide for themselves how much they want to drink before driving. The general opinion is that drivers should not be free to decide for themselves how much they want to drink before driving. But whereas seven or eight out of every ten drivers in the Northern countries like Finland, Sweden, the Netherlands and the UK strongly disagree with any freedom in drinking and driving, only three or four out of every ten drivers in the Southern countries like Greece, Italy, France, Spain and Portugal strongly disagrees.

European introduction of measures
In 1996, there is ample a major support for the European introduction of regular technical checkups for safety purposes, a penalty points system, a zero alcohol limit for new drivers, and the installation of a third braking light. An European introduction of a requirement that car manufacturers restrict the maximum speed of cars meets a mixed response among European drivers. Surprisingly, Italian and Grecian drivers who tend to be somewhat less strict in regard to the freedom in drinking and driving, are very supportive of the introduction of a zero alcohol limit for new beginning drivers.

Telematics
Telematics is the combination of telecommunication, electronics and information sciences. The applications in this field for a better and safer traffic system seem numerous. The future role of telematics in national and international traffic partly depends on how road users think about these new technological applications. The respondents were asked how useful they would find it for themselves to have new technological appliances in their car. Their opinion was asked on the usefulness of the following devices: a route guidance system, a device that helps not to exceed the speed limit,

a distance control device, an alcohol-metre and a mobile telephone.

The most appreciated telematics application in Europe is a distance control system. Two third of the European drivers would find it very or fairly useful to have a distance control system in their cars. More than half of the European drivers find it very or fairly useful to have a device that helps them to respect the speed limit or to have a device that guides them to their place of destination. The mobile telephone and the alcohol metre come first and second as regards to judgments of non usefulness. Slightly over 50% of the European drivers do not see any or much usefulness for themselves in having these devices in their car.

Unique positions

Some national groups of drivers have a rather unique position on certain subjects.

Belgium is unique in its low approval for the European introduction of a penalty points system. *France* is unique in its strong support for restricting the freedom for car manufacturers in using speed in car advertisement and in obliging car manufacturers to restrict the maximum speed of their cars.

Italian and Grecian drivers may have what we call a double norm towards drinking and driving: very strict when thinking about drinking and driving as a problem of specific target groups or as a cause of accidents, but less strict when thinking about general freedom in drinking and driving.

The *Swiss* are rather unique in their meagre enthusiasm for measures on an European scale and in their decreasing support for a number of road safety measures.

The *Netherlands* have a relatively unique position in their opinion on drinking and driving: very strict regarding the freedom in drinking and driving, but at the same time Dutch drivers do not see much easefulness in an alcohol-metre in their car.

Portugal is unique in its decreasing support for a number of measures.

Among *Italian* drivers there is increased support for a number of measures, but there is no increase in the strictness concerning penalties for traffic offenses and drinking and driving.

Austrians are relatively unique in their reservations towards in car devices.

SARTRE 2: the Dutch report

Results of the second survey 'Social Attitudes to Road Traffic Risk in Europe' (SARTRE) held in 1996, compared with the Dutch results from 1991, and also compared with results from other European countries

Dr. Ch. Goldenbeld. R-97-26. 102 pp. Dfl. 35,-. (in Dutch)

Black box study shows a reduction in the number of accidents

Human behaviour is a determining factor in road safety. For this reason, it is of crucial importance to encourage people to behave safely in traffic. It is known that people aware of being observed tend to modify their behaviour. By observing and recording the behaviours of drivers, it might then be possible to confront them with their behaviour. This could mean that drivers who realise that this can happen will adjust their behaviour ahead of time. They can also react this way as a result of an actual confrontation. For this form of behaviour influence to prove effective, it would ultimately have to result in fewer road traffic accidents.

Peter Wouters, 56 years old, studied Mathematics and Physics at the University of Amsterdam. He is a senior researcher employed by SWOV since 1969.

His main fields of interest are: manual control, man-machine systems, human factors engineering and system theory, integrated traffic safety management, specific (i.c. elderly and young) traffic participants, the safety of freight transport, and advanced telematics in transport.

Within this context, then, the goal of the study was to investigate if road safety could actually be increased by creating the possibility of confronting drivers when necessary with objective data about their own driving behaviour being recorded by telematic monitoring devices mounted inside their vehicles. For this purpose, a study would monitor whether using this feedback mechanism would result in fewer and/or less severe road traffic accidents in actual everyday experience.

The first phase of this study was carried out within the framework of SAMOVAR, a project within the European Union Commission's research programme known as 'DRIVE 2'. Implementing the follow-up phase was made possible by the cooperation of the Association of Dutch Insurers.

Field trial

To be able to establish the effect on the number and severity of road traffic accidents, it was decided to implement a quasi-experimental field trial, the general design of which was a pre-test and post-test applied to both the experimental and control groups.

The design's specific implementation construction formed an independent subject within the study. Partially due to the time period over which a study of this nature had to

extend, one of the assessments done beforehand was the number of vehicles that would be fitted with monitoring devices as well as the number of other vehicles.

The theoretical design was then modified to fit the actual research conditions, because these were ultimately determined partly by the fact that various fleet owners were included in the study (on a volunteer basis and at their own expense). As a result, it turned out that the vehicles available for the study displayed a great degree of variety in character and use.

Ultimately, 840 vehicles were involved in the study, 270 of which were fitted with monitoring devices already available on the market, the majority being 'accident reconstruction recorders', whilst some could generally be described as 'trip recorders' or 'journey recorders'.

The numbers of vehicles involved a diversity of fleets and for this reason created a non-homogeneous sample. Seven experimental groups of vehicles were equipped with recorders, for which twelve matched control groups could be selected. The advantage of this diversity, however, was that some insight could be gained into the distribution among such fleets as to the effect on accident occurrence.

The accident records of the vehicles involved in the study were recorded for a period of at least one year previous to the date on which the recorder was built into the vehicle as well as during at least one year following installation.
Also recorded for these time periods were use, exposure and accident damage, with a separate data collection format being developed for this objective.

Results

This study established a statistically significant reduction in the number of accidents for several fleets in which the behaviour of the drivers was monitored in such a way that the drivers could also be confronted with their behaviour. As yet, these positive results can be given only within rather wide confidence intervals, this being due chiefly to the relatively small sample size.

When viewing the total group of fleets involved in the study, it is possible to estimate an accident reduction of some 20%.

In the case of the only fleet for which the costs of its own accident damage were known, there was also a favourable development in terms of accident cost reduction. In this respect, accident damage can also be considered a measure for the severity of the accidents outcomes.

It can be concluded that the methodology developed in the study is more generally applicable, especially when investigating the safety effects of virtually any in-car system that may influence driving behaviour.

Recommendations

In view of the results obtained, applying behaviour influence by driver monitoring is recommended. Further research is worthwhile, in particular in order to optimise its effects. This research might focus on subjects like the implementation of the feedback and its most effective use, improved equipment, and ways to sustain lasting effectiveness of the measure.

The impact of driver monitoring with vehicle data recorders on accident occurrence

Methodology and results of a field trial in Belgium and the Netherlands

P.I.J. Wouters & J.M.J. Bos.
R-97-8. 64 pp. Dfl. 25,-
(in English)

SWOV REPORTS IN BRIEF

The Bicycle Master Plan and road safety

P.C. Noordzij & A. Blokpoel.
R-97-16. 72 pp. Dfl. 25,-.

In 1990 The Bicycle Master Plan was launched by the Ministry of Transport and Public Works. In 1996 the plan was concluded. The plan contained a lot of measures in order to make traffic safer for bicyclists. To mark the conclusion of the plan, a study was carried out to assess developments in road safety for cyclists. An overview of future measures was also compiled.
Since 1950, there have been three broad periods:

- *1950-1975: an increase in the number of deaths, mainly among young and old cyclists, coinciding with a sharp increase in car use;*

Fred Wegman: best guest lecturer of IHE course

Fred Wegman, SWOV's research director has been awarded as best guest lecturer 1997 of the International Institute for Infrastructural, Hydraulic and Environmental Engineering IHE in Delft, the Netherlands. IHE is one of the leading institutes for international education, enjoying a worldwide reputation for its achievements in post graduate education in civil and environmental engineering. Fred Wegman is one of the guest lecturers in the TREND course.
In this Masters programme 'Transportation and Road Engineering for Development', Fred Wegman teaches the subject road safety.

- *1975-1990: a decline in the number of deaths among cyclists per distance cycled, coinciding with increased bicycle-use; the absolute number of deaths among cyclists either rises or falls depending on age, gender and extent of injuries;*
- *1990-1995: the number of injured cyclists remains stable, with one exception; the number of deaths per distance cycled falls more slowly than before; bicycle-use remains more or less constant.*

Since 1994 new information is available concerning road victims who are getting treatment on the first aid stations of hospitals. These figures show that more than 60,000 cyclists are injured and require First Aid each year; 6,500 of these are admitted to hospital and over 250 succumb to their injuries. Serious injuries to cyclists are often caused by collision with another road-user; in the case of minor injuries there is often no other party

involved. It is not yet known whether the incidence of minor injuries to cyclists is rising or falling; nor is much known about the measures needed to reduce the number of such injuries.

The ratio of deaths among cyclists to distance cycled contains a very high proportion of older people, since the effects of an accident for such individuals are far more serious.

Measures to prevent serious injury as a result of collisions between bicycles and cars focus mainly on changes to the road system, such as those included in the recent proposals for a sustainably safe traffic system. This should in the long term result in a substantial decline in the number of seriously injured cyclists. However, these proposals do not contain enough detailed plans to prevent collisions between bicycles and cars at busy intersections and roads, even though it is here that most deaths and serious injuries occur.

Even a sustainably safe road system must be backed up by a code of behaviour and supplementary measures in the form of education, instruction and public information campaigns designed to improve road-use among drivers, cyclists and pedestrians.

A wide range of other measures could also be used, such as measures to improve observational skills, cycling skills and protection from injury.

The number of road deaths among young adults undertaking short, daily journeys in built-up areas is lower among bicycle-users than among car-users. Bicycle-use could thereby compare favourably with other types of transport in more situations, certainly if conditions were made safer for cyclists.

A safety checklist for ATT devices

A summary of the results so far of the project 'Automation of the Driving Task'
T. Heijer.
R-97-19. 13 pp. Dfl. 15,-.
(in English)

This project is aimed at investigating the effects on road safety of various applications of telematics intended to support the driver. During the first stage of this project the safety effects of single ATT systems have been investigated in both a number of theoretical studies and a series of experiments. The overall aim of this research is to provide policy makers with a well-based tool to assess the safety effects of existing and new telematic systems in road vehicles. The project must result in a set of guidelines and methods to identify potential safety hazards that single or multiple applications of these ATT systems may produce.

The general set-up of this project contains four stages:

- *First, a checklist is defined that summarises available knowledge on known safety effects and diagnoses which part or function of a given ATT device may prove unsafe or doubtful.*
- *The second step is the definition of standard procedures for laboratory testing to produce a verdict on the ATT device or parts of the device for which the checklist was inconclusive.*
- *The third step determines if and what modifications of the ATT application will be necessary.*

Finally, a last step should contain a cost/benefit consideration, aimed at determining whether safety benefits (if any) of the application outweigh the possible problems and costs to user and society (the problem of how to conduct such a comparison has not been addressed by this project).

However, the overall results of the project so far show that existing knowledge still only provides fragmented knowledge and not a clear, comprehensive picture. Therefore, as long as this situation remains, the second step of the scheme (laboratory testing) should be complemented by another possible testing method: full field testing.

The checklist constructed on the basis of results so far is predominantly based upon criteria related to overload. Criteria to gauge underload are significantly fewer and especially criteria to rate the effects of counterproductive behavioural adaptation are very incomplete.

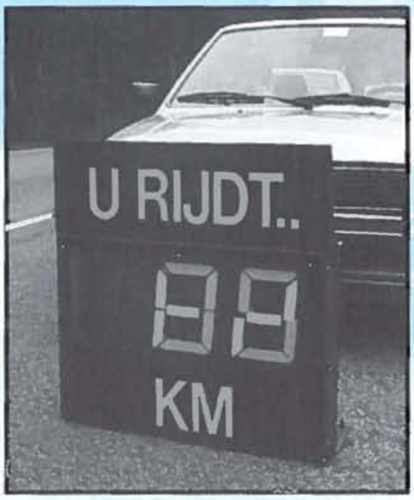
To produce a more balanced result, the last phase of the current project should be aimed at obtaining more firm criteria for underload and possibly a separate checklist for counterproductive behavioural adaptation.

The problem with the latter aspect is, that the theoretical basis for criteria is not very well developed: the risk homeostasis theory is an obvious candidate for a basis, but this theory is not uncontested.
Handholds may also be found in the concepts of 'situation awareness'; a theoretical framework that has so far mostly been applied to complex tasks of air traffic controllers or controllers of nuclear plants.
Also theories concerning the human propensity to optimise task load against performance may be applicable, in which case we can e.g. analyse the nature of criteria functions that have been used in successful optimal control models for human control tasks.

As long as the safety checklist is incomplete and the standardised laboratory tests are not completely developed, field testing, either with instrumented vehicles in real traffic or with driving simulators, will be necessary. In order to provide a coordinated basis for the development of checklist and laboratory tests, the field tests should be conducted according to the standards that have been developed.

Measures to increase traffic law acceptance: some strategic considerations

Paper presented at the 5th European workshop 'New developments in traffic safety research', Bern, May 2-3, 1996
Dr. Ch. Goldenbeld.
D-96-19. 25 pp. Dfl. 17,50.
(in English)



The set of traffic laws and rules intends to maximise the possibilities for free movement in the traffic system, while at the same time safeguarding road safety. Acceptance of traffic laws depends in part on properties of the laws and rules themselves that determine how they will be perceived or understood by the public. The first part of this paper, focuses on the criteria and qualifications the laws and rules themselves will have to meet, if any effect on road user behaviour is to be expected.

Then, in a general sense the various measures are considered that may accompany or support a traffic rule or law, e.g. publicity, enforcement, education. It is argued how important it is to agree on an a priori strategy for implementing various measures. As an example of such a strategy, a multi-phase model of measure implementation is presented, describing a sequence of measures intended to increase law acceptance, depending upon the situation at hand.

Finally, in the last part of the paper problems with traffic law acceptance and possible remedies of the foregoing are presented with respect to five spearheads of national policy (drinking-and-driving, seat belt use, speeding, young moped riders, and heavy traffic).

The effects of 'non-infrastructural' measures to improve the safety of vulnerable road users

A review of international findings, prepared for the OECD Scientific Expert Group 'Safety of vulnerable road users'
M.P. Hagenzieker.
D-97-4. 51 pp. Dfl. 22,50.
(in English)

This report reviews the evaluated effects of what can be called 'non-infrastructural' measures to improve the safety of vulnerable road users: the pedestrians and bicyclists. It has been written as a contribution to the OECD report on the safety of vulnerable road users. Many types of 'non-infrastructural' measures to increase the safety of vulnerable road users can be distinguished. Three selected areas are discussed: education and training, measures to enhance visibility and conspicuity, and protective devices for bicyclists (bicycle helmets). Other types of non-infrastructural measures (such as rules and regulations, enforcement, telematics, and improved car designs) are briefly mentioned.

Education is often put forward as an effective preventive measure. However, evaluating precisely the effects of educational programmes is difficult, e.g. as to accident involvement. Examples are presented that illustrate the difficulties in evaluating educational programmes. It appears that the safety effects of Traffic Clubs for children are still inconclusive. Contrary to the many educational programmes available for (young) children, very few

intervention programmes for elderly pedestrians and cyclists have actually been implemented (and evaluated).

It appears those retro-reflective markings accentuating the form of the bicycle or a person (pedestrian), and stressing movements of these road users, are the most capable of having these road users recognised as such. The biggest problem is probably not the effectiveness of visibility aids but rather encouraging more widespread use of even the most basic aids in times of darkness. Only (a small) part of bicyclists use their lights, and conspicuity aids for pedestrians are used even less.

The use of bicycle helmets can markedly reduce head injuries among bicyclists. However, in most countries only a small minority of children and adults wear helmets. Compulsory usage - in several states in Australia and the US - of the bicycle helmet leads to substantial increases in helmet use. However, in many countries it appears that such legislation is not feasible, both governments and cycling - organisations are not willing to make helmet use mandatory (e.g. Germany, the Netherlands) or await high usage levels before planning to start legislation (e.g. UK, Sweden). Therefore, bicycle helmet use must be promoted on a voluntary basis. This is not an easy task, because overall negative attitudes to the usage of helmets exist among (both adult and children) cyclists and among representatives of cycling and road safety organisations.

It is stressed that these measures should not be taken instead of other measures such as infrastructural improvements, they should rather be seen as complement to other measures. Vulnerable road users can protect themselves, make themselves more visible and have (theoretical and practical) knowledge and skills acquired from education and training. However, they should not be solely responsible for their safety.

Effectiveness of daytime motorcycle headlights in the European Union

F.D. Bijleveld.
R-97-9. 39 pp. Dfl. 20,-.
(in English)

Motorcyclists are road users with a particularly high accident risk. In particular, motorcycle accidents are severe in nature, due to the relative lack of protection of motorcyclists once an accident takes place. Furthermore, given the young age of many victims, these accidents often result in a high loss of life expectancy for fatalities and high social economic costs for severely injured motorcyclists. Therefore, even a moderate reduction in the number of accidents will result in relatively large benefits for the potential victims, and social - economic savings for society.

It is sometimes stated that the main reason for the high risk potential is the active risk taking of motorcyclists, but research has shown that a considerable number of motorcycle accidents is due to the fact that car drivers failed to detect their presence.

Because of their inconspicuousness, motorcyclists themselves often use headlights during daytime. There is strong evidence for the effectiveness of this measure. Therefore, in a number of countries (e.g. Austria, Germany, Belgium, France, Spain and Portugal) daytime running lights (DRL) for motorcyclists are compulsory. Because of the positive effect on detection by other road users, the daytime running light measure is even made compulsory for car drivers as well in a number of countries.

However, although a large majority of motorcyclists already use their headlight in daytime in countries where the measure is not compulsory, (about 90% in the early nineties in the Netherlands), there is still potential for improvement of the effect, by raising the use up to 100%.

Arguments against an obligatory use of daytime running lights are often a mix of factors such as the feeling that motorcycle accidents are primarily caused by the risk seeking behaviour of the motorcyclists and economic or environmental arguments, related to extra battery usage, extra fuel costs or costs for light bulbs. Furthermore, it is argued that such measures should be taken at an European level.

In order to prepare legislation on a national as well as European level, it is important to describe the state of the art with regard to practice, effects on accidents and of the legislation in various European countries.

The aim of this study is to give a synthesis of the state of the art of the (obligatory) use of running lights for motorcyclists during daytime. This synthesis gives an overview for various European countries of the following issues:

- *statistics on motorcycle accidents during day and night, and their severity;*
- *practice of headlight usage during daytime and the existing legislation;*
- *estimated effects of this use in reducing accident risk and the potential to improve this effect;*
- *a short discussion of the advantages and disadvantages of a general legislation on motorcycle daytime*

running lights and implementation aspects of such a (safety) measure.
The conclusion is that it is assumed that the conspicuousness of the motorcycle is improved by the use of daytime running lights of motorcyclists themselves although such improvement maybe less if accompanied by the use of daytime running lights by cars.

Mandatory behavioural requirement is probably insufficient to raise the DRL-use for motorcyclists in the European Union in a substantial way. Since motorcyclists by far have the highest risk of all road users, a European vehicle standard of DRL for motorcycles is recommended, in order to decrease the approximately 4,000 fatalities and 99,000 injured every year.

In summary, a technical measure that would increase the use of daytime running lights by motorcyclists would have several positive effects:

- *From the point of view of the individual motorcyclist, there is less chance being involved in an accident and as a result of that, a smaller chance of being injured or killed in traffic.*
- *From the viewpoint of society, a reduction in the number of accidents involving motorcycles and consequent on that a reduction in the number of victims and substantial socio-economic savings are to be expected. Additionally, those countries that have mandatory use of daytime running lights bear the cost of maintaining their use at a high level.*
From experience, it is known that police enforcement will be necessary and a vehicle standard is likely to be the best option to minimise such costs.

It is sometimes argued that motorcyclists using daytime running lights may assume other road users to see them and as a result ride less defensively and there is some indication that the speed of motorcycles using daytime running lights is estimated lower than the speed of motorcycles without their lights on. There will also be a slight increase in the fuel consumption and wear of bulbs together with the environmental consideration of the visual effect of headlights moving in the scenery.

However, these adverse effects seem to be well compensated by the fact that in many other cases, daytime running lights would have helped and thus that the net result is beneficial, significantly reducing the number of fatalities and serious injuries from accidents involving motorcycles.

A close look at the PROV

An evaluation of the Periodic Regional Survey on Road Safety (PROV)
Dr. Ch. Goldenbeld, dr. E.H. Hofhuis & G. Van Gils.
R-96-60. 157 pp. Dfl. 45,-.
(in Dutch)

A close look at the PROV: a summary

The main results of evaluation of the Periodic Regional Survey on Road Safety (PROV), carried out in 1996
Dr. Ch. Goldenbeld.
R-97-7. 75 pp. Dfl. 25,-.
(in Dutch)

The Periodic Regional Survey on Road Safety (PROV) is a survey to investigate the opinions of Dutch road users. Since 1990 the survey is carried out on a one-year frequency by research institute Traffic Test and is funded by the Dutch Ministry of Transport.

SWOV was asked to make an evaluation of PROV. Based on the answers provided in the evaluation, it can be concluded that the users are satisfied with the PROV's *monitoring function*. In regard to the PROV's second goal, the *charting of background information*, the answers are somewhat more vague.
On the one hand, the PROV provides background material and explanations, but it is nevertheless frequently necessary to search in one's own region for target groups and intermediaries.

It appears that *feedback to policy* and the evaluation of policy is the most problematic point.
The relationship between policy efforts and PROV results is difficult to establish at both the national and provincial levels. It often works better to obtain insight into this relationship with region-specific questions that are also part of the PROV. Several matters surrounding the PROV are well organised and do not need to be changed: its centralised management provided by the Netherlands Transport Research Centre AVV, the opportunity to consult the Regional Directorates when setting up research studies, and the opportunity to ask region-specific questions and to conduct the written survey on a yearly basis.

In regard to the practical value of the PROV, the following wishes were most frequently expressed: the linking of PROV data with objective data, reporting that is more directly adapted to the province, and a less sizable but more accessible reporting. The most frequently requested new subjects for the PROV were: moped certificate, 30 km/hour areas, information about and support for sustainably safe traffic, and mobility choices (also listed as a specific element under sustainably safe traffic).

The outcomes of the evaluation necessitate a new approach to the

PROV in 1997. The recommendations given should be further developed to lay the groundwork for a PROV 'new style'. The Transport Research Centre (AVV) works together with SWOV and Bureau Traffic Test to develop a plan for a new design of the PROV in 1997 which is expected to offer a better guarantee for reliability and representativeness of outcomes. Further, it is expected that the report about the outcomes as well the use of it will be improved.
The transition from PROV 'old' to PROV 'new' will be guided by methodological research so that continuity in results can be ensured.

Differentiating traffic risks according to type of road

Final report
F. Poppe
R-96-62 24 pp. Dfl. 17,50
(in Dutch)

One of the activities in the SWOV Research Programme was the updating of traffic risk data for several types of roads, this data being known as the key risk indexes.

Several reports were made:
- *Traffic risk on motorways (R 96-63).*
- *Traffic risks on major arteries inside built-up areas (R 96 64).*
- *Traffic risks on secondary and tertiary roads outside built up areas (R-96-65).*
- *Distinguishing risks according to road types: calculation and preparation methods (R-96 66).*

SWOV report R 96 62 is the final report of this activity and as such integrates the results.

First of all, the utilisation targets for the risk data are addressed according to the type of road. Based on the risk data, core data could be determined for the purpose of answering a specific research question. This research question can thus address the original policy question, which means that the choice for using certain risk data was dependent on the original policy question. Although often involving a comparison, four important different possibilities can thus be distinguished:
- *comparisons between alternatives (including possibly future alternatives);*
- *comparison of the current situation with a prognosis;*
- *quantifying a future situation to enable making a comparison with data unrelated to road safety;*
- *comparison of a specific situation with generally applicable reference data.*

Next, the most important data for all the different types of roads and intersections were assembled.
The tables contain the following three categories of risk indicators:
- *the number of injury accidents for every million kilometres travelled by motorised road vehicles (both per calendar year);*
- *the number of casualties per injury accident;*
- *the number of fatalities per casualty.*

For the number of injury accidents per million kilometres travelled by motorised road vehicles, the statistical upper and lower limits were also provided.

The report finishes with conclusions and recommendations about the methods used, the usability of the material, and the suitability of the calculation method.

COLOPHON

SWOV Research Activities is a magazine on road safety research, published twice a year by the SWOV Institute for Road Safety Research in the Netherlands.

SWOV Research Activities contains summaries of research projects carried out by SWOV.

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