SWOV RESEARCH ACTIVITIES 1

SWOV
Institute for
Road Safety
Research

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# Towards a sustainable safe traffic system in the Netherlands

**Since the early 1970s, road safety in the Netherlands has improved considerably. While in 1972, 3264 road fatalities were recorded, by 1992 this number had fallen to 1285 (reduction of more than 60%), despite the fact that, over the same period, the degree of mobility had increased considerably. The Netherlands is one of the safest, highly motorised countries in the world. The number of road accident casualties per 100,000 inhabitants in the Netherlands is 8.5, which makes the Netherlands, together with countries such as the United Kingdom, Sweden and Norway, relatively safe. This is also the case when we relate the annual number of fatalities to the number of kilometres travelled where the Netherlands again scores favourably. Nevertheless, in recent years the annual number of road fatalities has ceased to drop sharply, and now seems to hover around some 1,300 road accident fatalities a year.**

The fact that the number of traffic fatalities has not diminished more markedly also means that the road safety targets as formulated by the Dutch Government in 1987 in the Long Term Plan for Road Safety 1987 - 1991 have not been achieved. This plan formulated a concrete task for policy: 25% fewer road accident casualties in the year 2000 with respect to the number in 1985 (1385). A plan drafted by the Dutch Government, in which the desired mobility developments in the future and the investment in the infrastructure are broadly outlined (SVV-II, 1990), also includes the targets for the year 2010: 50% fewer fatalities ▸

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## SWOV RESEARCH ACTIVITIES

**This issue of SWOV Research Activities contains summaries of some of the research projects carried out by the SWOV Institute for Road Safety Research in recent years. In the past we published a summary of our activities in English once every two years, with the most recent example covering 1990 and 1991. With this new-style magazine, our aim is to keep you up-to-date with our work a little more regularly. Therefore from now on our 'Research Activities' publication will appear in this form twice a year. The current issue covers research projects which were completed in 1992 and 1993.**


and 40% fewer hospital admissions resulting from road accidents; meeting this objective implied a greater challenge to policy, although a controlled growth in mobility of 35% was considered acceptable.

### Sustainable safety

The SWOV Institute for Road Safety Research, in close cooperation with a number of other research institutes, was asked by the Dutch Government to develop a scientifically supported, long term concept for the implementation of a considerably safer road traffic system. Since the UN Brundtland Commission introduced the concept of sustainable development in 'Our common future', sustainability has become an important point of departure for many areas of policy: how can today's needs be met without burdening future generations with the consequences of our consumption and production methods. This concept has also inspired the vision we have developed for road safety: no longer do we accept that we hand over a road traffic system to the next generation in which the Netherlands tolerates that road transport leads to thousands of fatalities and tens of thousands of injured, no longer do we respond with hindsight to the results of thoughtlessness, lack of expertise or simply afford the issue inadequate policy priority.

Instead, we should try to drastically reduce the probability of accidents in advance, by means of the infrastructural design. And where accidents still occur, the process which determines the severity of these accidents should be influenced such that serious injury is virtually excluded. This is our interpretation of the concept of sustainable safety.

The concept of 'sustainable safety' is based on the principle that man is the reference standard. A sustainable, safe traffic system has an infrastructure that is adapted to the limitations of human capacity through proper road design, vehicles fitted with ways to simplify the tasks of man and constructed to protect the vulnerable human being as effectively as possible and a road user who is adequately educated, informed and, where necessary, controlled.

### Three functions

The principle for a sustainable safe infrastructure is that every road is appointed a specific function and is designed such that the road or street in question meets the specific functional requirements as optimally as possible; most of all, that it guarantees optimal safety. Here, three functions can be distinguished:

- *the flow function: rapid processing of through traffic;*
- *the access function: rapid accessibility of residential and other areas;*
- *the residential function: accessibility of destinations along a street while making the street safe as a meeting place.*

The problem of our road transport system today is that roads and streets are expected to fulfil several incompatible functions at the same time, where the road user generally has to guess what to expect from the road traffic situation, and is presumed to guess what others expect from him: one thousand times it goes smoothly, until one time, he makes an error.

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

1. *prevent unintended use, i.e. use that is inappropriate to the function of that road;*
2. *prevent large discrepancies in speed, direction and mass at moderate and high speeds, i.e. reduce the possibility of serious conflicts in advance;*
3. *prevent uncertainty among road users, i.e. enhance the predictability of the road's course and people's behaviour on the road.*

### Realisation

Based on assessments for the Dutch situation, it can be concluded that simply by upgrading the roads that currently tend towards a flow function, even without introducing the envisaged design, and by 'downgrading' the roads that currently have a mixed flow and access function, it is possible to realise a redistribution of traffic and hence safer roads, so that the road accident risk will be reduced by at least one third.

Also in the field of vehicular improvements, there are gains to be made, both in the sphere of passive safety, i.e. provisions that reduce the severity of an accident, and with regard to active safety, i.e. facilities that improve observation and emergency manoeuvres carried out by the road user.

In a sustainable, safe road transport system, the road user represents the most important link. He must in principle be prepared to accept a road system, vehicles, rules of behaviour, information and control systems that markedly restrict the freedom of the individual in return for a greater level of safety. In addition, the road user must be kept informed about the code of behaviour for the various categories of roads: ease of recognition through clear information are essential in this regard. Furthermore, attention should remain focused on adequately informing the road user in all phases of his life as a road user. And it will still remain essential to discourage certain groups from using the road, e.g. those driving under the influence of alcohol.

A sustainable, safe road traffic system cannot be realised from one day to the next. Apparently, there is no social base of support for this vision as yet, therefore it is not realistic to expect that immediate realisation is feasible.

In addition, implementation demands many years of consistent effort, the cumulative effect of which will only become evident in the long term. Study in the Netherlands has shown that at present, there are no administrative organisations which are able and willing to realise a 'sustainable, safe road traffic system'. There is currently too little integration between the tasks of the State, provinces, regions and municipalities. To implement the sustainable safety concept, there should be interaction and task-oriented application of means within and between the various administrative organisations.

To realise a sustainable, safe infrastructure implies that the system of immediate recognition of traffic situations should be universally applied. This means, in turn, that all those involved in the implementation of policy should be involved, in particular municipalities, regions and provinces. A lack of commitment does not fit into the approach. The main challenge will prove to be to organise real commitment, and this will differ from country to country, given the differences in administrative responsibilities between countries.

## Costs

Tentative estimates have been made to investigate what the introduction of a 'sustainable, safe traffic system' would cost, based on the principle that 'sustainable safety' is realised at the same rate as, and running in parallel with the standard maintenance of the infrastructure. In this context, a period of 30 years is a reasonable period for the Dutch circumstances. This would therefore mean that of the 5 billion guilders that are made available each year for infrastructural work, a sum of less than 2 billion would have to be made available to gradually introduce sustainable safety in the given thirty years. It is proposed to first investigate whether this can all be realised with the existing budget. If this is not sufficient, it will be necessary to draw additional funding from elsewhere.

Also from a macro-economic perspective, the savings are considerably more than the costs of 'sustainable safety'. One fundamental problem is the fact that the savings do not naturally come back to the bodies provided the means. Those to benefit from the savings include insurance companies and insured parties (lower premiums), while the government - and therefore the tax payer - or the users of the infrastructure will tend to bear responsibility for the expenses.

The conclusion we must therefore draw is that a sustainable, safe road traffic system is not only feasible, but also affordable.

The sustainable safe traffic vision has meanwhile been incorporated into the policy applied by the Dutch government to improve road safety. The basic principles now receive support from all principal traffic organisations in the Netherlands, and also from a very large proportion of Dutch Parliament. The question is how this acceptance can be converted to actual deeds. This shall be attempted along three different lines, as is shown in a response by the Minister of Transport and Public Works to Parliament. The first approach is oriented towards clearing up current, manifest road hazard. The second approach aims to prevent the occurrence of new hazards, while the final approach is intended to interpret the need for legal support of guidelines to ensure the safety of the infrastructure and the vehicles. These three lines of approach have now been translated into concrete plans of action.
The results are not yet available.

| Country | 1990 | | 1991 | |
|---|---|---|---|---|
| | Deaths per $10^9$ motor vehicle km | Deaths per $10^5$ inhabitants | Deaths per $10^9$ motor vehicle km | Deaths per $10^5$ inhabitants |
| D | 21.100 | 13 962 | - | - |
| D (W) | 17.243 | 12.613 | | - |
| I | - | 12.383 | - | 14 019 |
| UK | - | [illegible] | 11.219 | 8.245 |
| [illegible] | 12.698 | 9.346 | 11 099 | 8.149 |
| [illegible] | - | 19.919 | | 18 541 |
| [illegible] | - | 14.638 | - | - |
| [illegible] | - | [illegible] | - | |
| D (O) | 48 308 | 19.107 | - | - |
| NL | 14.188 | 1.239 | 13.020 | 8 634 |
| [illegible] | - | 32.209 | - | - |
| D | - | [illegible] | - | 16.754 |
| [illegible] | - | 9.054 | - | 8 672 |
| A | 27.890 | 10.336 | 26.960 | 19.910 |
| CH | 15.678 | 13.865 | 14.654 | 12 357 |
| DK | 17.322 | [illegible] | [illegible] | [illegible] |
| [illegible] | 16.327 | 13.048 | 16.135 | 12 645 |
| N | - | [illegible] | - | - |
| IRL | 11.200 | 13.645 | - | - |
| L | - | 7.989 | - | - |
| [illegible] | - | 9.600 | - | - |
| USA | 12.960 | 17.353 | 11.930 | 16.442 |
| J | 23 219 | 11.807 | - | 11.638 |
| AUS | 14.207 | 3 684 | - | - |
| [illegible] | - | 21 530 | - | 18.956 |

# Experiment to reduce speed on 80 km/hr roads proves successful

**An experiment using automatic speed warning and monitoring systems was organised on four roads with an 80 km/hr speed limit in the provinces of Utrecht, North Brabant, Gelderland and Overijssel**

The aim of the research project was to investigate whether driving speeds could be reduced by providing information, road signs, automatic enforcement and fines. The average speed on the test roads dropped by 6 km/hr and the number of accidents fell by 35%. The number of people breaking the maximum speed limit dropped from 40% to 10%.


### The reason for the experiment

The experiment was organised because nearly all roads outside built-up areas in the Netherlands have an 80 km/hr speed limit, yet in general this limit is exceeded on a fairly massive scale.

These roads also show a considerable spread of speeds. Roads with an 80 km/hr speed limit are dangerous in comparison with other roads.

On the basis of theoretical considerations, it was postulated that there is a link between driving speed, accident risk and the seriousness of injury in accidents. Research in Finland and Sweden has demonstrated this relationship empirically: a slight drop in driving speeds led to a considerable drop in accident rates in these countries. Up to now there were no Dutch figures on the relationship between these factors.

The experiment was commissioned by the Dutch Ministry of Transport to reduce speeds and danger on roads with an 80 km/hr speed limit.


The project was be carried out by regional road managers, and the police and ministry of public prosecutions also participated.

### Phase 1

The first phase of the experiment started at the end of November 1990. A warning system was placed on two regional roads with an 80 km/hr speed limit in Gelderland and Utrecht. The system consisted of signs showing the speed limit and, above them, electronic signs. When a driver broke the speed limit they displayed the text 'U rijdt te snel' (You are driving too quickly). On the roads in North Brabant and Overijssel drivers were also warned when they drove slower than 60 km/hr: in these provinces the sign read 'Safe Speed 60-80 km/hr' while the electronic sign indicated '60 80' when the driver was going too fast or too slow.

### Phase 2

From 15 March 1991 drivers were not just warned when they broke the speed limit, but fined as well. Radar equipment and cameras were placed at different places along the road, allowing driving speeds to be measured in both directions. A sign reading 'Radar speed checks' informed drivers of what was happening. Drivers breaking the limit had a high chance of being caught by the automatic speed check system. Drivers who broke the speed limit were subsequently fined.

### Application potential

At the very least the system can provide a short term solution for situations where the speed limit is exceeded on unsafe road surfaces. A national or regional priority scheme would have to be established to determine where and how often this sort of system could be implemented.

# Accidents with heavy goods vehicles

**The effect of heavy vehicles on road safety has been an issue in the Netherlands for some time, partly because accidents involving such vehicles are usually relatively serious. The assumption that road transport could increase significantly in the future has further highlighted this problem.**

The number of trucks on the roads is small in comparison with passenger cars. So although trucks cover greater distances, their share in total traffic is nevertheless fairly small at less than 7% of all car kilometres travelled. Per kilometre travelled, trucks do not have a higher accident involvement rate than passenger cars. Therefore normally the danger caused by special traffic should not deserve special attention. However, this conclusion would be incorrect. It has been proved that collisions with heavy vehicles tend to be quite serious on average. More than 16% of fatal road casualties occur in accidents where heavy goods vehicles are involved. The main road safety problem of heavy goods vehicles is the seriousness of the accidents.

There is another difference with passenger cars, namely the distribution of casualties between the two vehicles. Drivers and passengers in heavy vehicles are exposed to a relatively small risk. In collisions, most of the victims are found among the other party. Cars, which offer passengers and drivers reasonable protection, are definitely the weakest party in conflicts with heavy vehicles. This comes as no surprise, given the mass and structure of heavy vehicles. In contrast to cars, speed is far less of a factor in determining the seriousness of accidents involving heavy vehicles.

Heavy vehicles drive relatively frequently outside built-up areas and on larger roads. A large share of the victims of accidents involving heavy vehicles are to be found outside built-up areas.

More than half of all serious injuries caused by accidents involving heavy vehicles occur outside built-up areas.

Articulated vehicles (trucks and tractors with trailers and semi-trailers) account for slightly more than half of all heavy vehicles and are also showing the greatest growth. For their occupants, these vehicles are safer than single trucks.

### Vans

When assessing the development of heavy vehicle road safety, vans should also be considered. The large traffic increase noted in this category could point to some goods transport being shifted to lighter transport methods. In turn this development will also lead to a shift in road safety.

# Driving speeds on 80 and 100 km/hr roads

**On behalf of the Ministry of Transport SWOV carried out speed measurements on 80 and 100 km/hr roads in the twelve provinces of the Netherlands in 1992. The measurements were performed on seven types of road (distinguished according to the presence or absence of route numbering).**

The results of these extensive nationwide measurements confirm the findings obtained from previous studies. The driving speeds are high: the 85th percentile value lies between 10 and 26 km/hr over the limit and the percentage of offenders is measured at between 20 and 56%. Only the narrow one-lane rural roads have an 85th percentile value below the limit of 80 km/hr. The standard deviation is also fairly high: 12-16 km/hr. The excess speed percentages on the 80 km/hr roads are high, between 40-55%, and are greater for passenger cars than for lorries. On the 100 km/hr roads, the percentages measured for lorries are greater (60%) than for passenger cars (25%), which can be explained by the lower limit of 80 km/hr applicable to lorries on these roads.

When we consider the various provinces, we see lange differences: Flevoland scores highest in almost all cases, which can be explained by the structure of the road network (long straight polder roads with a good view).

**Differences**

It can be concluded that the speeding problem for passenger cars and lorries on non-motor-way main rural roads is great. The speed measured on the narrow one-lane rural roads is low. However, in consideration of the limited lane width, the speeds on these roads can still be regarded as relatively high. A major reduction in accidents may be expected if the 85th percentile value of the driving speed is lowered to the limit, as reflected by the task setting formulated in the MPV (Long-term Policy for Road Safety) with respect to the spearhead on speeding.

We note a large difference between the speed of passenger cars and lorries traffic, which can lead to many overtaking manoeuvres. This could have an unfavourable effect on road safety. The results show that the distinction made between roads with and without route numbering is not very relevant. Also, due to the changes introduced to the entire route numbering system after January 1, 1993, it is recommended that this distinction not be used in future.

# Road safety and *porous* asphalt (ZOAB)

**Draining road surfaces made of (very) porous asphalt (ZOAB) have been used on Dutch roads since 1987. The principal advantage of ZOAB, aside from a reduction in noise level, is the virtual lack of water on the road surface during rainy periods. This would lead one to expect that road safety is promoted through the application of ZOAB.**

The Civil Engineering Division (DWW) of the Department of Public Works commissioned the SWOV to carry out an accident analysis in order to assess to what degree, and in which manner, the road hazard associated with porous asphalt (ZOAB) differs from that of non-porous asphalt (DAB), in particular during rainy conditions or on wet road surfaces.

The study consisted of a statistical analysis of accidents (resulting in death, injury or material damage only) registered on the main carriageways of motorways, distinguished according to driving direction and number of lanes.

Only those sections of road which did not contain acceleration lanes, exit ramps, bifurcations or weaving sections were considered.

Due to differences in the composition of the selected DAB and ZOAB road sections, the study was divided into an examination of all road sections and an examination of a selection from this group: pairs of road sections. The aim was to select ZOAB road sections each of which could be matched as closely as possible to a DAB road section, similar as regards road and traffic characteristics. The combined result of both studies formed the basis for the conclusions.

In order to discover the (complex) influence of differences in road and traffic characteristics between the group of DAB road sections and the group of ZOAB road sections, statistical analysis techniques and testing methods were applied.

In total, the analysis database comprised 5596 accidents over approximately 3700 kilometres of DAB road sections, and 619 accidents over approximately 262 kilometres of ZOAB road sections.

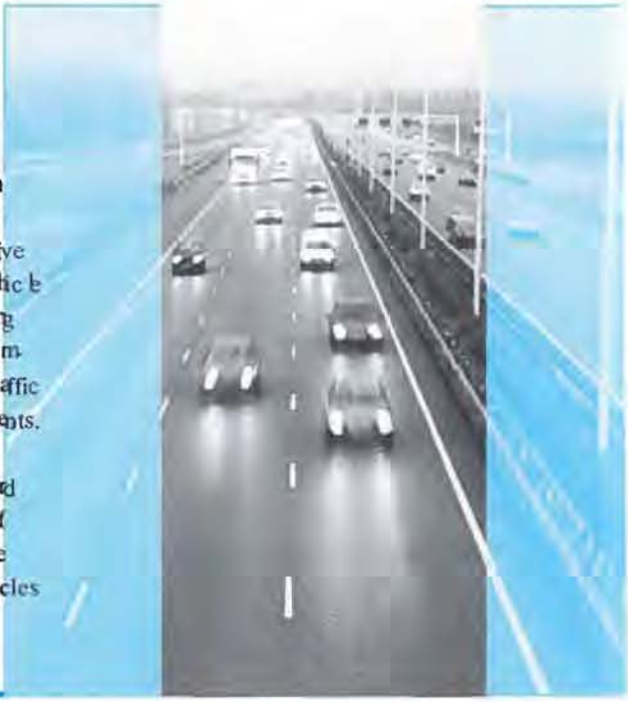
For the road section pairs, 433 accidents were recorded on 199 kilometres of DAB road sections and 367 accidents were recorded on 151 kilometres of ZOAB road sections.

This study (primarily) considered 75 pairs of DAB and ZOAB motorway sections at 53 locations, with two lanes per carriageway.

The result of the study is that the safety of porous asphalt (ZOAB) is equivalent to that of standard non-porous asphalt (DAB). A spread in the result was shown, so that the anticipated actual difference in risk may vary between - 10 to 15% (ZOAB safer) and + 10 to 15% (DAB safer). In addition, this study did not discover a statistically significant difference between the risks associated with the DAB and ZOAB road sections during either rainy or dry conditions.

Perhaps a better visibility on ZOAB roads during wet or rainy conditions causes motorists to drive at higher speeds and with less vehicle spacing than on DAB roads during wet or rainy conditions. It is recommended to study these aspects of traffic behaviour by means of measurements.

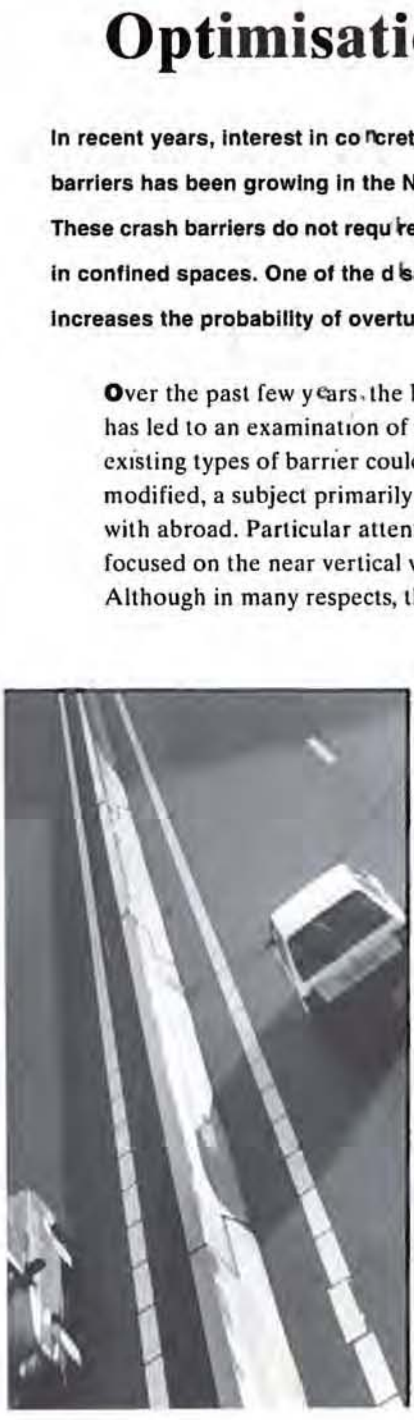
It is recommended to also conduct study into the road hazard associated with the application of porous asphalt (ZOAB) for those sections of motorway where vehicles enter, exit or weave.



# Optimisation of the profile of a concrete vehicle barrier

**In recent years, interest in concrete vehicle barriers has been growing in the Netherlands. These crash barriers do not require much maintenance and can even be utilised in confined spaces. One of the disadvantages of a concrete barrier is that it increases the probability of overturning for small vehicles.**

**O**ver the past few years, the latter has led to an examination of whether existing types of barrier could be modified, a subject primarily dealt with abroad. Particular attention has focused on the near vertical wall. Although in many respects, this type of barrier seems to function adequately, it is nevertheless associated with a clear disadvantage in that even minor collisions result in considerable damage to the vehicle. Therefore, SWOV carried out a study and also investigated a modification which is intended to allow the impact of minor collisions to be transferred via the wheels, avoiding marked contact between the barrier and the body of the vehicle.



### Literature study and simulations

**T**he report discusses a literature study and the results of 48 simulated collisions with a more or less vertical wall at four different gradients, namely 2 degrees, 6 degrees, 11 degrees and 17 degrees. Simulations were carried out using three types of vehicle, viz. a light (900 kg) and a heavy (1500 kg) passenger car and a lorry (16 ton). The associated impact conditions are derived from the CEN regulations.

In addition to this series of simulated crashes, simulations were also carried out on the more or less vertical wall under the same conditions, but with the application of a step measuring 25 cm in height and 5 cm or 10 cm in width at the foot of the wall. After establishing the most favourable gradient, simulations were carried out with both types of passenger car on both the 5 cm and 10 cm wide step, based on a small angle of approach (2, 5 and 10 degrees) and an impact speed of 80 km/hr.

The results of the literature study and the simulation study concur well with each other. They show that the gradient of the more or less vertical wall can be maximally 10 degrees in relation to the rolling movement of the vehicles. The application of a 5 cm wide step (extension) has no deleterious consequences. When the step width is increased to 10 cm, this does result in some increase in the angle of roll, but not to such an extent that it causes the car to overturn. Therefore, the application of a step to the foot of the wall can be regarded as a potentially useful modification of the (near) vertical barrier.

# Roudabouts have favourable effect on road safety

**The first accident study into roundabouts carried out by SWOV in 1990 related to 46 roundabouts. It was found that roundabouts were considerably safer than intersections. No statement could be made about which types of engineering facility were most suitable for cyclists and moped riders.**

Since about 300 roundabouts have been built in the meantime, a second study into the road safety aspects of roundabouts has been carried out. This study selected 201 roundabouts which were put into service prior to January 1, 1991. These roundabouts were all constructed on the basis of the new priority rule, with one lane and radially oriented access roads. Two main subjects were investigated:

*1. The safety level after conversion of an intersection to a roundabout.*

*2. The differences in safety between the various roundabout designs.*

The second point devoted particular attention to the three possible engineering facilities catering to cyclists and moped riders: a separate cycle path, a bicycle lane on the roundabout or no specific cycle facility.

### Favourable effect on road safety

It was established that substitution of an intersection by a roundabout has a particularly favourable effect on road safety: a reduction of 47% in the number of accidents and 71% in the number of road accident victims (after trend correction). However, the various categories of road user did not all profit from the change to the same degree: a large reduction in road accident victims was noted amongst occupants of passenger cars and pedestrians (95% and 89%, respectively) and a slight reduction amongst cyclists ('only' 30%).

There are three types of engineering facilities for cycles:

- *separate cycle paths*
- *bicycles tracks on the roundabout*
- *no specific facilities.*

It was established that for the three types of engineering facility for cycles, no major difference in the number of accidents could be demonstrated. Based on the registered number of casualties it was determined that at a daily traffic intensity of over 8,000 motor vehicles, approximately, a separate cycle path clearly scores more favourably than both other types of cycle facility. At lower motor vehicle and cycle intensities, it is not possible to indicate which of the three types of cycle facility is preferable. It is recommended to base selection on the design of the connecting roads.

In consideration of the marked fluctuation in victim statistics as the age of roundabouts increases (duration of use), it is recommended that the future development of the number of accidents and road accident victims on roundabouts continues to be monitored.


# Almost 25% less injury accidents by introducing 30 km/hr zones

**The 30 km/hr zones attempt to improve road safety and living quality in areas which predominantly serve a residential function. During a previous study of 15 experimental 30 km/hr zones, it was concluded that the total number of accidents after introduction of the measure had dropped by 10 to 15%. With respect to the number of injury accidents, there were indications that the reduction may have amounted to double that figure. Due to the limited scale of the study, the effects demonstrated a large spread, however.**

In a follow-up study, the effect on the number of injury accidents in a large number of 30 km/hr zones was more specifically determined. Of 151 such areas, 660 injury accidents were recorded:


417 prior to introduction of the measure and 243 during the follow-up period. In order to enable correction of effects which were not associated with the realised measure, all injury accidents inside the built up area were collected for the same municipalities over similar periods (control areas).

### Less accidents

Following correction based on the trend shown in the control areas, it was determined that the number of injury accidents in the 30 km/hr zones had dropped by 22% (± 13%).

Again, the effect on the number of injury accidents still demonstrated a large variation. Taking into consideration the (average) results, however, the measure can certainly be considered successful.

Over half of the surveyed municipalities had not yet commenced work to realise 30 km/hr zones even though the survey held amongst officials from the traffic departments of the municipalities in question demonstrated that a positive attitude prevailed. Intensive stimulation to foster implementation of 30 km/hr zones on a broader scale is therefore recommended, while further study into the causes of the reticence shown by many municipalities would be useful. Furthermore it is advisable to check if the quality of the applied countermeasures in the 30 km/hr zones are functioning as planned and if this is not the case to find out why, in order to avoid this in the future.

It has been shown that those areas which are designed as 30 km/hr zones tend to carry a lower volume of motorised (through) traffic, while the number of cars taking shortcuts through these zones has also diminished to a significant degree.

# Seat belts and child restraint devices in passenger cars

**Since 1968 a survey is conducted yearly on the presence and use of seat belts on the front seats of passenger cars. Since 1989 this survey was extended to child restraint systems and seat belts on the back seats of passenger cars.**

On January 1st 1971 a law was effectuated necessitating the presence of seat belts on the front seats of new (imported) passenger cars. This was followed by a law necessitating the use of these belts per june 1st 1975. On january 1st 1990 the presence of seat belts on the back seats of new (imported) passenger cars was stipulated by law and on april 1st 1992 the use of rear seat belts when present was made compulsory. The SWOV has calculated the impact of these measures on road safety in terms of road accident casualties. The reference year chosen was the same as that used for the Long-Term Traffic Safety Plan (1985). When calculating the effect of the seat belt policies, various assumptions were made concerning wearer percentages and the effectiveness of seat belts and child seats (in the sense of the protective effect for individual users). It is expected that in the year 2000 there will be approximately 80 less deaths and 360 less people hospitalised than in 1985. In 1985 714 passenger car occupants died and 5.612 were injured in road accidents.

### Consequences

Not complying with the seat belt laws and injuries sustained as a result of this can have the following consequences:

- *a fine for trespassing the compulsory seat belt usage,*
- *a part of the total costs as a result of sustained injuries not being compensated by the insurance company; in the jurisprudence 25% can be found,*
- *this behaviour can result in a claim by (the insurance company of) belted occupants that were wounded because of this non-wearing of the seat belt.*

### Results from the annual survey

- *From 1991 to 1992: a large increase in the percentage of seat belt use on back seats when a seat belt was present: on city roads from 15% to 31%, on rural roads from 12 to 37%. The percentage is still low.*
- *On the front seat the following was found: from 1991 to 1992 the percentage increased from 62% to 66% in built-up areas and on rural roads no significant change was found, around 80%.*
- *More than 90% of the drivers and back seat passengers knew about the law on seat belt use.*

- *Television as a tool for presenting information is scoring very high, about 80% of the interviewed persons have seen spots regarding seat belts on TV.*
- *Around 50% of drivers and back-seat passengers motivated the non-use by 'forgetting'.*
- *Around 70% of the interviewed persons would like to get a signal in the car when the seat belt was not used.*
- *The motivation 'persuasion by another person' to use the seat belt was given by less than 20% of the interviewed persons.*
- *The probability of being fined by the police was estimated to be almost nil.*

### Recommendations

- *Information campaigns should promote 'social persuasion' for reasons of increased risk of getting injured sustained by a non user of the seat belt and the possible negative financial consequences.*
  *Further the non-user can inflict injuries to other belted occupants and as a result can be sued for damage compensation by them or their insurance company.*
- *Enforcement by the police during several weeks can result in an increased use of seat belts through habituation.*
- *Technical provisions giving an audible and/or visual signal when passengers in front and back seats are not belted.*
  *The search for belts lost under the seats can be prevented through technical means.*

### Incorrect use

Seat belts and child seats are only fully effective when they are used correctly. It is assumed that incorrect seat belt use could be an important explanation for the disappointing reduction in injuries achieved by seat belts. In spring 1991 the SWOV measured the incorrect use of safety devices.

Incorrect use refers to:
- *fitting seats or cushions to cars incorrectly;*
- *placing children in seats or on cushions incorrectly;*
- *using seat belts incorrectly.*

Sixty-nine percent of child seats proved to be used incorrectly. Only 21% were used correctly and 10% partially correctly. Baby seats fitted facing backwards were found to have the lowest incorrect use percentage (at 35%, still a considerable figure).

The highest degree of incorrect use was found in front-facing seats where children wear separate seat belts: in this group, 75% incorrect usage was encountered. The most common problems were too much play in the child seat belt and the seat being incorrectly attached with the standard seat belt.

In the front seats, seat belts were used considerably better than child seats. Incorrect use was encountered in 35% of such cases.

Very frequent faults found in seat belt use include: too much free space between shoulder and belt because the seat is placed too far backwards, shoulder belts virtually slipping off shoulders and twisted lap belts. It is striking that men wear seat belts better than women. People in the passenger seat wear the belt worse than drivers. This is because drivers often adopt a better position than passengers. They sit properly behind the wheel and their seat is usually pushed a little more forward.

Occupants of four-door cars score worse as regards seat belt use than two-door car occupants: the shoulder section of the belt goes too far to the outside and there is too much free space between the belt and occupants, because in four-door cars the mullions are placed too far forward when the chair is pushed as far back as possible. Cars with seat height adjusters were found to have only slightly lower incorrect use percentages, probably because people do not know how to use them.

### Rear seat belt use

Research into rear seat belt use showed that such safety devices were mainly worn by children aged younger than 12. There was a high percentage of incorrect use, at no less than 75%. This was to be expected given the short body length of children.

Many of the problems encountered with child seats are not to be blamed on the parents or those who have put the child in the car seat. Often it is difficult to fit chairs to cars effectively.

### Survey and field study

To arrive at a structural solution, a process for an international system of vehicle regulation is currently under way. In order to realise a solution specific to the Dutch situation in the short term, the SWOV carried out another study. Surveys were held amongst importers and manufacturers of child seats and passenger cars. The field study involved a standard set of child seats being fitted to three types of passenger cars, each group representing seven different brands. The choice of car brands is based on the market share and countries of origin (European and Japanese). The choice of child seats was primarily based on the actual problems per principal group, and secondly on the fixation distance from the belt.

The measurements were performed for three seat positions: front passenger seat and central and window position on the rear seat. Based also on the degree of play and the position of the buckle of the standard belt with respect to the child seat, it was examined whether the child seats fitted properly. If not, the reason for the poor fit was established.

### Trouble areas

Three trouble areas were determined which influence whether child seats could be properly fitted to cars or not. These include:

- *length of short belt sections (incl. full buckles) which are not appropriate for the fixing of child seats;*
- *outer anchoring points on the rear seat which are positioned too far forward;*
- *belt knots which prevent the belt from being pulled tight.*

The most notable point which became apparent during the survey is that five of the eight importers/manufacturers of child seats were not aware of the interface problems of child seats and passenger cars.

### Solutions

Solutions for these problems were proposed, where a distinction was made between seats still to be purchased and those already in possession.

The report also cited specific (information) activities aimed at the following target groups: importers of passenger cars and garages, importers/manufacturers of child seats, shops and consumers.

# The *importance* of head rests for passenger cars

**The Ministry of Transport asked the SWOV to provide an update of an earlier report on the effect of head rests. Based on the accident data for 1975 and 1976, this effect was established at a 25% risk reduction for neck injuries sustained during rear-end collisions (relating to a comparison between cars with and without head rests). The update was requested in order to assess whether the Netherlands would be in favour of a measure to make head rests in passenger cars compulsory; such a ruling is also being considered by the EC in Brussels.**

Because the purpose of head rests is to prevent or restrict injury during rear-end collisions, recent accident data have been used to chart the development in the number of rear-end collisions and the passenger cars involved. Since 1983, there appears to have been a marked increase in the number of rear-end collisions, the number of passenger cars involved and the number of victims of rear-end collisions. In view of the overall accident trend during the same period - a drop in the total number of road accidents and cars and passengers involved - there is question of a particularly marked relative rise in the number of vehicles and people involved in rear-end collisions, representing a virtual doubling of the figures.

### Injury problem

This development is entirely based on registered (police) data which are known to be associated with a marked level of underreporting. The actual scope of the problem of rear-end collisions is therefore

likely to be considerably greater. It is even less easy to chart the specific injury problem. Although rear-end collisions are associated with minor injuries (so-called whiplash injuries), they are known in some cases to lead to serious and chronic health complaints. It is estimated that an annual increase of 2,500 whiplash patients is seen in the Netherlands, although estimations of the resulting group with chronic complaints are widely divergent.

The scope and severity of the specific whiplash problem, including the long term effects, should therefore be studied more closely.

### Use of head rests

Next, it was established via recent observations to what degree head rests are fitted to front seats and how they are used.

It was found that although head rests have been installed in virtually 100% of cars for some considerable time, their proper use seems to be seriously inadequate. More than half the observed front seat passengers did not seem to use the head rest at the correct height. Men used the rest considerably more ineffectively than women.

In many cases, the head rests were improperly adjusted: the user did not set the head rest at the correct height ('ear height'). It may also be possible that the head rest cannot be raised sufficiently.

The problem was explored by determining the required head rest height for the Dutch adult population, based on the data available on human physical dimensions (so called DIN ED table). This was compared to the minimum height prescribed by the current head rest regulations (voluntarily adopted by manufacturers). This size (75 cm) proved to be too low for well over half the Dutch male population.

In order to adequately protect at least 95% of all Dutch men (and thereby also still Dutch women), a minimum head rest height of 85 cm is required.

In addition, the current efficacy of head rests was examined, based on the previously determined 25% effect. It was thought that the effect will on the one hand have been reduced by improvements in the car structure, leading to reduced vehicle decelerations during collisions. On the other hand, the effect will have increased because the head rests themselves have improved and the relative speeds at the moment of impact have become greater as a result of the average increase in driving speeds. It is estimated that the resultant effect will still be of the same order of magnitude as was measured originally.

A general conclusion was that on an annual basis, the presence of head rests is responsible for a reduction in whiplash injuries equivalent to approx. 1,450 cases.

### Head rest compulsory?

From a cost-benefit consideration, there are no objections to making head rests compulsory, since 100% of cars already have them installed. Therefore, although making head rests compulsory will not lead to major additional costs, neither will it offer additional benefits as long as the problem of the limitation in height adjustment is not solved.

It is recommended to endeavour in the short term to improve the use of head rests by informing the user (via car dealers, consumer organisations etc.). In addition, the regulatory requirements should be modified to ensure that the minimum height of the head rest is adequate to meet the needs of at least 95% of the (Dutch) population.

The practical problem of inadequate adjustment as observed agrees with the experiences noted in other countries.

The solution to the problem is to ensure that the head rest cannot be used incorrectly. This can be realised through the use of fixed head rests (head rests which form part of the back rest of the seat), which should in that case be sufficiently high. This aspect should also be reviewed in the current (international) regulations.

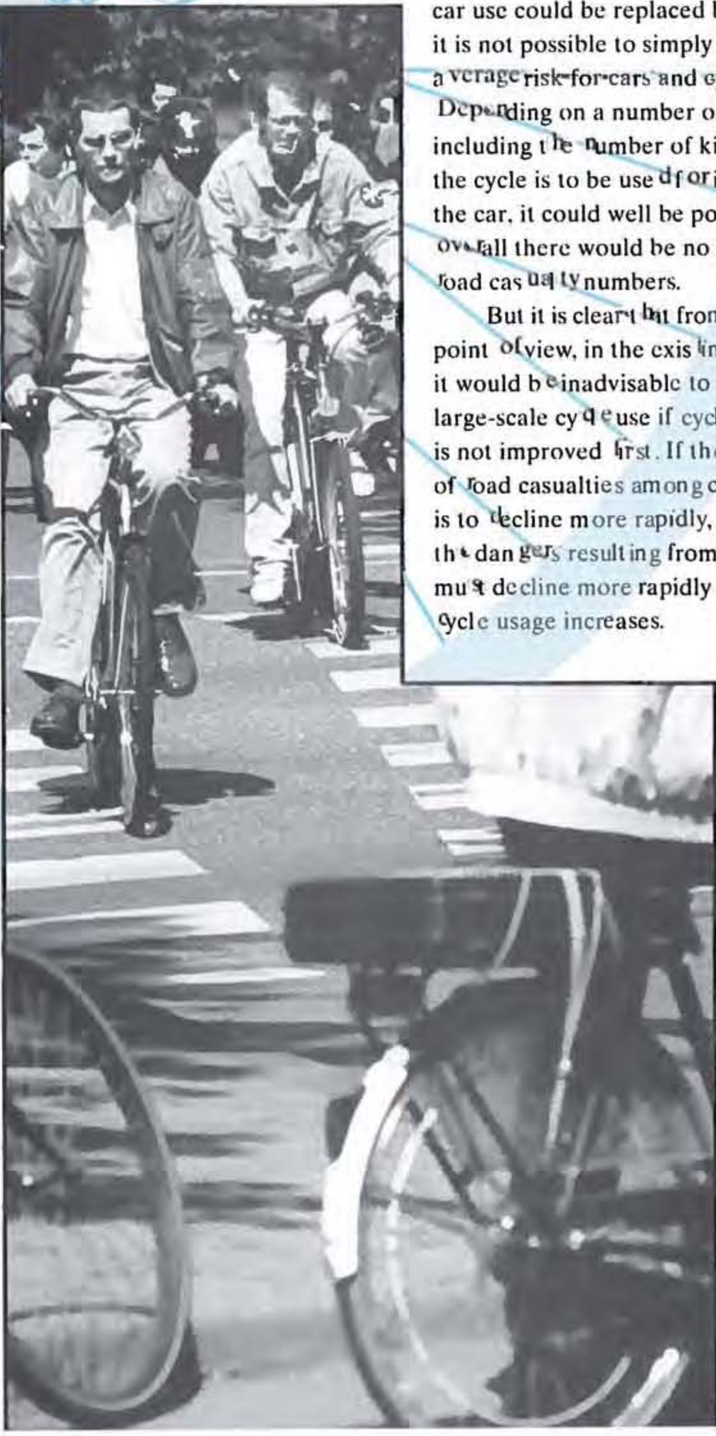
# The Netherlands, a country of cyclists

**The Netherlands is a country of bicycles. Their popularity can be clearly seen from statistics on the number of cyclists in the Netherlands, and the number of cyclists involved in road accidents. At present there are approximately 11.5 million bicycles in the Netherlands. This means that nearly eight out of ten Dutch people have a bicycle. According to the official statistics, every year nearly 300 cyclists die in road accidents, 3,000 are hospitalised and another 8,000 suffer less serious injuries. In reality the situation is even more serious. In practice nearly nine times more people are injured in road accidents than the recorded figures show, according to a 1989 survey. Cyclists account for no less than half of all the people involved in road accidents in the Netherlands, according to the survey. This is the negative aspect of the popularity of cycling in the Netherlands.**

The Netherlands provides many facilities for cyclists like cycle paths and specially adapted traffic lights. Yet the Netherlands has taken few special measures for cyclist safety. Probably this is because little if any consideration is given to measures which would limit the freedom of a large number of cyclists.

The main opportunity for improving cyclist safety can be found in modifying roads. This includes laying out cycle paths alongside busy roads and adapting small roundabouts in built-up areas. The behaviour of car drivers towards cyclists would also have to change. This would be possible with a package of measures including information, driver training, codes of conduct and policing. Cyclist behaviour could also be changed by improving cycling lessons. The content and form of such lessons should be adapted to meet the needs of various age groups. In practice little is happening in this respect, with the exception of lessons at junior school.

Measures which increase cyclist freedom can also increase the problem of cyclist safety. Many problems arise, for example, because cyclists are not required to follow the direction of the traffic flow, use cycle lanes and paths or respect traffic lights. It will be clear that great care must be exercised in taking such measures.



## Cycling instead of driving

In the Netherlands the aim is to encourage cycle use at the expense of car use. At first sight any such shift in behaviour would lead to an increase in the numbers of road accident casualties. This is because the number of fatal casualties per kilometre travelled is three to four times higher for cyclists than for car occupants. On the other hand cyclists and drivers display a different age distribution and there are differences in the circumstances when cycles and cars are used. Therefore in so far as car use could be replaced by cycles, it is not possible to simply use the average risk for cars and cycles. Depending on a number of factors, including the number of kilometres the cycle is to be used for instead of the car, it could well be possible that overall there would be no increase in road casualty numbers.

But it is clear that from the safety point of view, in the existing situation it would be inadvisable to encourage large-scale cycle use if cyclist safety is not improved first. If the number of road casualties among cyclists is to decline more rapidly, then the dangers resulting from cycle use must decline more rapidly than actual cycle usage increases.

# Moped and low-speed moped riders: the highest risk group

**Mopeds first appeared in the Netherlands at the end of the 1940s. A large number of people were feeling a greater need for mobility, but many did not yet have the resources to buy a car. Mopeds were a cheap and handy means of daily transport, mainly for adults. Partly as a result of changed attitudes and improved application possibilities, the new means of transport grew in popularity. The number of mopeds increased from 4,000 in 1949 to 2,000,000 in 1970. At present this figure has dropped to around 400,000; in many cases cars are now used where mopeds were preferred in the past. The low-speed moped was first introduced in 1975. At first adults were the main users of low-speed mopeds (for which it is not obligatory to wear a helmet). It is estimated that there are 100,000 low-speed mopeds in the Netherlands. Therefore in total the Netherlands has some half a million mopeds and low-speed mopeds.**

The popularity of mopeds and low-speed mopeds has taken its toll from the road safety point of view. From their first introduction in 1949 through to 1991, some 12,000 moped riders have lost their lives.

The number of deaths per year evolves in line with moped numbers. In 1990 there were some 100 deaths among moped riders, two-thirds of which involved people younger than 25.

Since 1975 more than 80 lives have been lost among low-speed moped riders, 60 of whom were older than 65. In the last couple of years some 15 people have died on low-speed mopeds annually, with 10 of them being older than 65.

### Risk

The absolute number of deaths in a given road user category is just one way of measuring risk. But a far more revealing standard is the risk of fatal injury per kilometre, proportionate to the total number of kilometres travelled by a vehicle.

Moped and low-speed moped riders face a higher risk than all other road users. They face risks three times higher than those affecting cyclists and no less than ten times higher than those affecting car drivers. The specific risks run by low-speed moped riders is not known, but are estimated to be somewhere between those of moped riders and cyclists.

### Recent developments

In 1990 8,312 male moped riders and 3,556 female moped riders were injured in road accidents. In 1991 these figures dropped to 6,696 and 2,935 respectively. In 1990 270 men and 169 women were injured on low-speed mopeds. In 1991 these figures increased to 358 and 251 respectively. Out of all moped road casualties, the 15-17 age group is larger than the 65+ age group. Two-thirds of the fatal casualties among low-speed moped riders were aged 65 and more.

### Problem

The moped road safety statistics indicate there is a serious problem. A large part of that problem is to be found in a small group of moped riders: young men aged 16 and 17. One reason is that this group speeds up their mopeds artificially and rides far too quickly. SWOV measurements have proved that this group does indeed ride faster than other moped riders. But in more general terms, it can be said that young moped riders incur such large risks due to a lack of experience and youthful recklessness.

It seems that low-speed mopeds are set to become a road safety problem, unless something is done quickly. The increased number of victims is mainly the result of increased use. This is primarily due to the range of attractive models, the fact that helmets are not obligatory and (for a small group) the ease of speeding up the vehicle.

### Speed

Speed measurements show that 48% of low-speed moped riders exceed the maximum speed limit of 25 km/hr which applies both in and outside built-up areas. Young male riders are involved here in particular. In general women seem to display a somewhat more moderate attitude to speed. The speed limit for mopeds in built-up areas is 30 km/hr.

Measurements show that 72% of riders exceed the speed limit, 15% of them by more than 15 km/hr. There is no clear distinction between men and women in this group. The majority (75%) of moped riders identified in built-up areas were aged below 20, and 77% of them rode faster than the speed limit. Of these 10% rode more than 10 km/hr over the limit. People aged over 20 are generally a little more moderate.

The speed limit on roads outside built-up areas is 40 km/hr. Here 20% of all riders break the speed limit (18% for women and 22% for men); 15% do so by no more than 5 km/hr. The age distribution among moped riders on roads outside built-up areas does not differ greatly from that within such areas: 73% are aged below 20.

### Measures for moped riders

The following measures could be considered in order to improve moped rider safety:

1. *Measures against speeding up engines, by police checks with mobile power testing equipment. The law says that mopeds and low-speed mopeds must be built in such a way that it is impossible or difficult to speed them up. Official approval by the government's road traffic department ensures that this is the case. The procedure could be changed so that afterwards, official approval can be withdrawn if a given machine proves to be often speeded up in practice. This will probably encourage dealers and manufacturers to take additional self-regulation.*
2. *The introduction of a full theoretical and practical examination with additional training. This could compensate for the lack of experience. One possible additional consequence could be that before they even start, a number of future moped riders find the training and examination barrier too high and give up the idea of using a moped.*
3. *Increase the minimum age from 16 to 18. This measure is the most far-reaching and therefore would only be considered seriously if 16- and 17-year-olds had enough alternative ways of getting around, for example on adapted versions of low-speed mopeds, cycles, public transport or lifts with other people. Measures 2 and 3 would allow the moped to be viewed as a motor vehicle in built-up areas. It could then be subject to the same rules regarding road position, priority and the same maximum speed of 50 km/hr.*

Mopeds would continue to be classed as slow-moving traffic outside built-up areas. This would end the nuisance to cyclists caused by moped riders in built-up areas. Various sources of misunderstanding between moped riders and car drivers would also become a thing of the past. The moped would also become more attractive for other age groups.

### Measures for low-speed mopeds

The following measures could be considered to improve low-speed moped safety.

1. *Measures to stop engines being speeded up, similar to those for mopeds.*
2. *Optional voluntary training.*
3. *Encouraging the voluntary use of helmets.*
4. *Making vehicle specifications more stringent, so that low-speed mopeds can once again become what mopeds used to be: motor-assisted cycles.*

# *Safer infrastructure for cyclists and moped riders*

**The Dutch Ministry of Transport wishes to further stimulate the choice of the bicycle as mode of transport, by reducing existing objections to its use as much as possible. Three important disadvantages can be counteracted by taking measures against bicycle theft, by improving the link between cycle traffic and public transport, and by reducing the risk of injury for cyclists.**

The latter objective can be realised by making the infrastructure for cyclists safer. Three methods are indicated for this objective:

- *by separating cycle traffic from motorized traffic;*
- *by controlling the speed of motorized traffic where necessary;*
- *by regulating intersection between motorized traffic and cycle traffic.*

Road designers should first know in what cases they should select any of these methods. They should then know which technical facilities or reorganisations are safe and - again - under what conditions. In order to arrive at recommendations with respect to these two points, five approaches were followed:

- *a recapitulation of relevant conclusions from previous study;*
- *a theoretical assessment which, based on the aim for a sustainable-safe road traffic system, results in the basic principles for the safety of cycling facilities;*
- *discussions with road authorities in order to establish experiences in practice;*
- *an analysis of accident data, in particular of situations with and without separate cycle tracks, where a distinction is also made between urban and non-urban environments;*
- *behavioural observations in order to collect indications for safer road designs.*

These activities were prepared separately. Each of the approaches has led to findings which could relate to each of the three cited methods to increase the safety of the infrastructure. This report offers a summary of all these matters by regrouping the findings according to these three methods and organising them logically.

Previous study had led to the opinion that separate cycle tracks are safer on stretches of road between intersections but more hazardous at the point of intersection. Therefore, in this study the intersections and connecting road sections have not been separately studied; rather, larger cycle route sections have been defined, which consider intersections and connecting road sections as one whole. It was concluded that, considered in this way, the average safety level for cycles on separate cycle tracks was no different to that for cycles on the carriageway. Differences were noted, however, between the urban and non-urban environment and between situations with much and little motorized traffic.

# Safety assessment of cycling routes in Oud-Beijerland

**SWOV carried out an evaluation of safety aspects with respect to two cycling routes in Dutch towns, one in Oud-Beijerland and one in Eindhoven. The evaluation emphasised the relationship between intended behaviour and actual behaviour observed.**

In order to study this relationship, a methodology was designed specifically for this purpose and introduced for the first time during this study. The results illustrate that discrepancies are often found between actually demonstrated and intended behaviour.

The nature and scope of these discrepancies differ markedly from one location to another and also depend on particular characteristics of the infrastructure (for example, presence or absence of certain engineering measures for cyclists, presence of certain traffic control installations, relative intensities of mopeds, cycles and motor vehicles and measured speeds).

How the infrastructure available is used determines to a great extent whether the potential safety offered by a measure is indeed expressed in practice.

# Road safety and fog

**Accidents caused partly by fog constitute a small share of the total number of road accidents in the Netherlands. The percentage of road casualties involved in fog-related accidents out of the total number of road casualties varies strongly every year, fluctuating between 0.5% and 2%. Deaths in fog-related accidents mainly occur in motorway collisions. They occur together in large numbers relatively frequently, due to motorway pile-ups.**

The disastrous character of these sporadic accidents attracts the attention of public opinion and political circles. On average fog-related road accidents cause macro-economic damage of nearly 100 million guilders a year. Fog-related accidents on motorways account for 25 million guilders of this total. Therefore from the economic point of view a fog detection system, like that installed on the A16 near Breda at a cost of 7 million guilders, can be cost-effective.

### Measures

It can be concluded that serious (and massive) fog-related accidents occur mainly during routine journeys and road use on standard roads during relatively heavy traffic, with the fog being local and temporary. Drivers have no advance information in good time and no link is made to the correct behaviour to be followed in the event of fog. Therefore inadequate behaviour is the result of an inability to act correctly, rather than a lack of responsibility. Consequently little is to be achieved by measures like general information, general rules of thumb and a call for responsible behaviour when fog occurs. Time- and place-related measures have more effect and contribute to reduce uncertainty about coming road and traffic conditions and increase the uniformity of traffic flows and traffic behaviour. Electronic equipment could also prevent fog-related accidents in the future.

In the shorter term other measures could prevent fog-related accidents to a limited degree. Examples include:

- *measures to reduce fog-related disruption, like planting trees and improved road-holding;*
- *measures to improve visibility, by improving road lighting and marking, vehicle lighting and signalling and fog/brake/rear light configurations;*
- *policing, like speed checks and the formation of traffic blocks by having police cars drive slowly before the traffic;*
- *reducing the seriousness of road casualties by temporarily banning heavy vehicles from motorways.*

# Public support for daytime running lights

**In response to a request by the Ministry of Transport, the SWOV commissioned the bureau MarketResponse BV to carry out a nationwide representative survey in October 1992 amongst the Dutch population aged 18 years and above, in order to assess public support with respect to the use of daytime running lights (DRL).**

The survey entailed a telephone poll amongst 802 respondents, subdivided into 145 'inveterate' motorists, 441 people who both drive and cycle and 216 people who mainly cycle. The survey was carried out over a period of one week, prior to commencement of a nationwide information campaign to promote DRL.

It is commonly recognised that a car in traffic may not be seen during the day, although this is not always considered to be, or experienced as being, hazardous. Therefore, to confirm that there is a visibility problem in traffic is one thing, whilst translation of that observation into a road safety problem is another. A positive attitude with respect to DRL promotes the actual use of DRL. In that context, a clear relationship apparently exists between age, attitude towards DRL and the use of DRL at present. People aged below 50 are more likely to be prepared to cooperate, both on a voluntary basis and in the event DRL were made compulsory.

About half the respondents believed that the government should conduct an active policy with respect to DRL, this group representing a greater proportion of cyclists than motorists. If DRL were made compulsory, 87% of motorists stated they would certainly comply, while approximately 10% did not wish to give an opinion yet. Over half the respondents believed that further information is essential. The needs expressed in the main included insight into the advantages and disadvantages of DRL, information about the whys of DRL and how DRL could 'benefit' road safety.

# The impact of *highmounted* stop lamps

**In 1984 SWOV found that it could not be stated unequivocally that highmounted stop lamps had a favourable impact on road safety. Since then more information has become available. On 1 September 1985 the United States made it compulsory to fit new passenger cars with a highmounted (third) stop lamps. In addition, further studies were carried out on a smaller scale in various countries. Within Europe, the process has been started to make highmounted stop lamps an obligatory feature for new passenger cars.**
**Questions have also been asked about advanced stop light systems. These systems aim to make drivers more aware of the braking manoeuvres of the cars in front of them.**

After highmounted stop lamps became obligatory in the United States in 1985, a study was made of their effect on accidents. It found that there had been a 17% reduction in the number of rear collisions. When SWOV recalculated the figures, it found the reduction to be 13%. However, the reliability of these figures has come under doubt, because of the implicit assumption of the effect of the model year on the one hand, and the variations in the impact of highmounted stop lamps on fatal accidents in two different years on the other.


It is impossible to predict the impact in the Netherlands in percentage terms. This is firstly because the effect of the compulsory introduction of highmounted stop lights varied greatly between the various American states (results vary from 7 to 24%, according to American figures).

Secondly, the rear light configuration of European cars is different from that of American vehicles.

Laboratory tests were used to calculate the effect of highmounted stop lamps in a scenario where rear lamps were left permanently switched on during the day. Given that such studies can only provide an approximate simulation of reality, then the results could indicate rough general tendencies only. There are indications that highlevel brakelights would have an effect in cases where stop and rear lamps are located in one fitting and/or where the difference in the brightness of both lamps is small.

More research is necessary in order to obtain a better understanding of the way brake lights 'function' in the car following situation. This could lead to an adaptation of the entire rear light configuration. The functions aimed for by the more advanced brake light systems must be included in such research. The random use of the advanced brake light systems currently on the market is not desirable, due to the lack of uniformity: this could lead to confusion in traffic situations.

In conclusion, highmounted stop lamps would probably have a positive impact in the Netherlands. Neither compulsory introduction nor prohibition of highmounted stop lamps was recommended.

# Street lighting and road safety on motorways

**One of the functions of street lighting is to encourage the safer and more rapid transit of traffic travelling at night. It is now broadly accepted that street lighting indeed assists in reducing the number of night-time accidents and that the associated level of luminance of street lighting plays a role. However, these assumptions still need to be confirmed through a specific relationship study.**

**S**WOV carried out a study which relates to the study of the cited relationship with respect to motorways outside the built up area.

The data for approximately 2000 kilometres of Dutch motorway were reviewed. 80% proved to be unlit and approximately 15% lit. For the remaining 5% this was not determined during the review, due to time pressure and the ensuing need to prioritise areas of study.

The study utilised all accident data (i.e. both injury accidents and accidents with material damage only) from the period 1989 to 1991 inclusive, selected on the basis of through main carriageways on motorways outside the built up area. The day/night distribution of accidents was based on the data provided by the Royal Dutch Meteorological Institute, KNMI.

The 'rough' analysis file was realised by joining the (combined) road characteristics, lighting characteristics and accident database based on the linking key, road number and hectometre indication. After deletion of non-relevant cases, this analysis file consisted of almost 28,000 accidents. Approximately 25,000 of these could be categorised either under the night or under the day period.

### Conclusions

The following (principal) conclusions could be summarised:

- *Roughly one fifth of the Dutch motorways is provided with street lighting.*
- *A relatively large proportion of night-time accidents occurs on unlit road sections.*
- *The night-time mobility (kilometres travelled) on both lit and unlit road sections on average amounts to one quarter of the total daily intensity on an annual basis; viewed on a monthly basis, this night/day traffic intensity ratio varies markedly, however, thereby casting doubt on the previously assumed constant value of one quarter of the daily intensity as a basis for night-time mobility.*
- *The risk experienced on Dutch motorways tends to be greater at night than during the daytime, both on lit and unlit road sections.*
- *The night/day risk ratios for lit road sections are generally lower, particularly at relatively high luminance levels.*
- *An interaction between traffic intensity and luminance level with respect to (night-time) risk is likely, although the pattern indicated by the calculated risks and the resultant night/day risk ratios offers only an indication, with no means of correcting the effect of the luminance level on the basis of traffic intensity (in relation to the number of lanes).*
- *Road sections with street lighting tend to be 'less safe' in the daytime than unlit sections: they demonstrate both a greater traffic risk, expressed in terms of the number of accidents per kilometre travelled, as well as a greater number of accidents per kilometre of road length, at least insofar they belong to the same intensity category. It could be deduced from this information that, in practice, it is particularly those road sections which are relatively unsafe that are provided with street lighting (the recommended installation criteria agree more or less with this inference).*
- *Unexpectedly, a comparison between road sections with 2x2 and 2x3 lanes did not offer any indication that this difference in lane distribution for lit road sections within the traffic intensity category of 45,000 to 80,000 vehicles/day had led to considerable differences in night-time and daytime risks or in the derived night/day risk ratios. In order to determine whether any distinctions can be made, further differentiation based on period per day should be carried out.*
- *The final conclusion that can be made is that most trends point towards the positive effect of street lighting. However, the nature and scope of the available data do not allow a reliable and accurate quantitative relationship to be established between the level of street lighting and road safety.*

# Influencing behaviour of the road user via the *price* mechanism

**Linking insurance provisos to safer driving behaviour or to the application or use of safety devices may offer a means of influencing the behaviour of road users in a favourable sense. When road users are aware that insurance companies reflect this concept in their premium system, a preventative effect with respect to hazardous driving behaviour may be realised.**

Recent literature offers few examples of study which draws a relationship between the level of the premium and accident prevention. Nevertheless, many assume variable premiums exert a positive effect on road safety, and it is also assumed that insurers - although they tend to operate on a commercial basis - can offer a contribution to the promotion of road safety. In view of the lack of adequate research results, it is therefore important to find more or new areas of application for financial stimuli and to test and evaluate their potential.

### Stimuli

The financial stimuli which may be offered by insurers to their customers can be distinguished on the basis of direct and indirect stimuli.

Direct stimuli relate to the immediate financial consequences of undesirable - or conversely, desirable - behaviour in traffic. Proof that these types of stimuli have the desired effect are, however, very scarce. In addition, with regard to the promotion of road safety, the literature about reward schemes states that an important point of discussion is represented by the question of whether it is best to reward damage-free driving or to reward concrete behaviour. In order to contribute to this discussion, it is recommended that both approaches be tested.

Indirect financial stimuli may relate to, for example, the co-financing of courses, contributing to the purchase of technical measures that have a favourable effect on safety and sponsoring. Based on indications from the literature which make mention of reasonable success, a number of pilot projects may also be developed around these themes (with affiliated research).

### Cost awareness

The development of cost awareness could also represent an instrument through which insurers can promote safety. For example, there are indications that commercial drivers are less likely to consider the higher costs resulting from their driving behaviour in comparison to other categories of road users. Also, the transfer of payment for material and personal damage plays a role in this regard. Therefore, it is recommended to investigate whether drivers of company cars (and in this regard with particular relevance to lease cars) are more frequently involved in accidents and/or accidents with a more serious outcome than a comparable group of private motorists (with regard to experience and exposure). Depending on the results, it may be considered whether insurance companies can develop a policy to enhance the cost awareness of employers and personnel.

# 4% of motorists in weekend nights under influence of alcohol

**Between September and November 1992, SWOV, in collaboration with 40 police control teams, conducted a roadside survey in order to establish the alcohol consumption of motorists in seven out of twelve Dutch provinces: Friesland, Flevoland, Gelderland, Utrecht, North and South Holland and North Brabant.**

The study which was carried out on Friday and Saturday nights between 22.00 and 04.00 hours represents a continuation of the nationwide studies into drink driving habits which were carried out between 1971 and 1991, 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 1992 sample includes 10,066 motorists.

The 1992 study showed that the number of motorists with a BAC over the legal limit of 0.5‰ had hardly changed: 4.0% in 1992 versus 3.9% in 1991. The number of motorists with a BAC of ≥ 1.3‰, however, had increased by one third: from 0.7 to 0.9%. As well as markedly increasing their risk of an accident, these heavy drinkers are also far more likely to sustain severe injury in the event of an accident.

The highest percentages of driving under the influence were measured:
- *amongst men aged between 35 and 50;*
- *in municipalities with more than 50,000 inhabitants;*
- *in the provinces of North and South Holland;*
- *after midnight.*

Those found to have been driving under the influence stated they had come from the following places:

| | |
|---|---|
| - *public place (pub, hotel, restaurant)* | *38%* |
| - *visit/party* | *33%* |
| - *home/work* | *16%* |
| - *sport canteen* | *7%* |
| - *other* | *6%* |

Of the group of heavy drinkers (with a BAC of ≥ 1.3‰), almost half were travelling from a public place.

Recommendations made by SWOV in order to further reduce driving under the influence include:
- *optimising the enforcement strategy and tactics of police, in combination with information campaigns and publicity;*
- *imposing a brief driving ban (2 hours maximum) without threat of prosecution on drivers who register a BAC of between 0.5 and 0.75‰ during a breath test for screening purposes;*
- *routine measurement of alcohol consumption for any person involved in an accident.*

Outside the immediate environment of enforcement and punishment, there are some further, potentially effective, means of reducing alcohol-related dangers in traffic.
In that respect, SWOV recommends the following:
- *study into the possibilities of having problem drivers found to be driving under the influence undergo treatment in exchange for (partial) remittance of the fine and/or prison sentence;*
- *study into the desirability of a lower legal limit for special risk groups, for example young and/or inexperienced moped riders, motor bike riders and motorists (for the latter two groups, perhaps combined with a provisional driving licence);*
- *intensifying the information campaigns on the risk of drink driving for the youth, particularly at secondary education level.*

# Youth, alcohol, drugs and road safety

**54 Boys and girls (mainly 15 to 16 years-olds) from secondary vacational (VBO) and scientific educational schools (VWO), spread across the Netherlands, have participated in 9 group discussions. The groups freely discussed topics such as going out, alcohol consumption (at home and outside the home), driving under the influence, smoking and drug use in relation to road safety and the role played by parents, police and schools in this regard. The policy of the schools included in this study is to combat the use of alcohol, cigarettes and drugs as far as possible. Many parents take this fact into account when selecting a school for their child. Both aspects will exert an influence on the opinion offered by children attending these schools. It may therefore be expected that the results of this attitude study would potentially be less positive without such a background.**

The major findings can be summarised as follows: Adults drink alcohol, particularly male adults. As a sixteen year-old, you already feel quite grown up. So when you go out, you also drink alcohol, with the knowledge that you are not held responsible for all your actions at this age. This is therefore the ideal age at which to experiment. Once you are eighteen, you are expected to know your limits and know what you want, otherwise you get into trouble.

### Alcohol

At home, young people are offered light alcoholic beverages, albeit in moderate quantities. Therefore, it is normal at this age to drink alcohol, certainly outside the home. However, they underestimate their potential to stop drinking 'in time'. The discussions show that a night on the town often ends up with the drinker at least becoming tipsy, but more often drunk - this applies to both boys and girls. Within a group, they feel no responsibility for each other. What and how much you drink is a personal matter. Someone else should not interfere!

After 'going out', people return home by bike (as a group). They believe the police do not apprehend drunken cyclists, and rightly so, they feel. Drunk driving on the bicycle is not a problem, since you can't kill anyone and there is hardly any traffic at night. People who cycle home in groups do so not on the basis of road safety considerations, but primarily because it reduces the social hazard. Furthermore, it is more sociable and meets the requirements of their parents if they want to go out.

The fact that adults drink and drive is irresponsible, in their opinion. They see it regularly occurring in their own environment, but as a child you are not entitled to comment.

#### Drugs

Smoking a 'joint' is less popular with most of the students, because of the information they receive about drugs through the schools. At home, the subject is virtually taboo. You only discuss 'joints' with your peers. If they have personal experience with drugs, the danger of drug dependency is very much underestimated. This underestimation is comparable to their underestimation of the amount of alcohol they can tolerate.

#### Group behaviour

On the school playground, they want to identify with and belong to a group. Conformity to group standards therefore matters greatly, and it is important that the child is not tempted to join a group which has turned drinking, smoking and drug use into a code of behaviour.

VBO students generally participate in the social night life at an early age (from 12-13 years), in comparison to VWO students (14-15 years). The latter group in particular believes there is more to life than simply going out, drinking and smoking.

In short, at ages 15 and 16 young people are exercising their adult role. Alcohol forms part of that. Alcohol eases the establishment and bonding of social contacts with their peers, to which they attach great importance. It helps them to cross a 'threshold', loosens them up, makes them feel free, gives them a pleasant feeling and makes them feel quite adult when they are together as a group. Every new glass confirms the pleasant experiences of the previous one, until it is too late and they must cycle home tipsy or drunk. In group discussions, they become aware of this habitual behaviour and the implicit danger that later, as motorist, they will not know their limits either.

A solution to this problem was not suggested, but it offers a topic of interest for educational programmes.

# Alcohol and traffic in *secondary* education

**SWOV has carried out a study which investigates the determinants of behaviour which cause youth to drive while under the influence and to agree to ride as passengers with drunk drivers. The study also considers how such behaviour may be modified. During a subsequent phase, this target group analysis should result in a recommendation to the Dutch Road Safety Organisation VVN about the envisaged educational objectives for an information project on 'Alcohol and Traffic' for 15-16 year-olds in upper secondary education.**

**Three sources are used: a questionnaire held amongst upper secondary students, a literature study and discussions with groups of children.**

#### Questionnaire

The HBSC questionnaire (Health Behaviour in School Children) also contains information about upper secondary students with respect to alcohol consumption, driving under the influence and being driven by someone who has drunk alcohol, distinguished on the basis of school type, province, gender and town versus city. About 90% of the children had consumed alcohol at some stage. About 30% drank alcohol regularly (i.e. at least once per week). 42% had been drunk on at least one occasion. One quarter had been drunk less than two months prior to the interview. Children from a comprehensive school drink somewhat less, while lower technical school students drink somewhat more. Students from the south of Holland are slightly heavier drinkers. Girls drink somewhat more, as do children from villages. 18% of children had transported themselves home while drunk on at least one occasion, particularly if travelling by bicycle. It is likely that the term 'drunk' is linked only to times of severe inebriation; therefore cycling while drunk probably occurs with much greater frequency

than stated. It has happened to a larger number of lower technical school students, and is more common with boys than girls. Being a passenger in a car driven by a drunk driver, particularly one's father, has been experienced by one quarter of students. Two-thirds of the children interviewed are in favour of the attention devoted to alcohol and traffic at school.

### Literature

The literature study investigates the determinants of alcohol consumption, but is particularly interested in the social aspects of drinking: people drink most when together in groups. People choose friends with the same drinking pattern, conform to group behaviour and influence other group members. In particular, they experience a greater bond than in fact exists. It is concluded that at various phases of life, different determinants could be influential. The behavioural effects of alcohol consumption and also of presumed alcohol consumption are considered in brief. The effect is apparently also influenced by cultural aspects. Alcohol consumption leads to accidents: youth in particular do not cope very well with drinking, particularly if riding a moped or driving a car. In addition, little has been revealed through study as to why Dutch youth drive while under the influence, although overseas study results are available. It seems that people find it difficult to assess when they have drunk too much and underestimate the consequences. In the U.S., the tendency is for youth to use the car as an outing in itself which includes drinking, and not only as a mode of transport to and from a party. Driving under the influence and riding with a drunk driver occur in situations when alcohol is consumed. Standards adopted by the peer group are important, but are hardly expressed through direct pressure. The probability of accidents and the risk of being apprehended also play a role. It is difficult to motivate parents to intervene, although children are able to exert a positive influence on each other. Three theoretical approaches can be distinguished: The attitude theory of Ajzen and Fishbein, the problem behaviour theory of Jessor and the 'sensation seeking' theory of Zuckerman. The first is particularly relevant with regard to prevention through educational programmes. Numerous programmes have been developed, of which many are designed to develop social skills, particularly learning to resist group pressure. Here, role play often represents an important element of the programme.

### Interviews

The interviews with groups of children offer an impression of when and why people drink and how people travel after drinking. Again, the impression of group processes and group culture is confirmed. People go out as a group and order drinks together, adapting to the fastest drinker. It is difficult to disassociate from that pattern, in particular for boys. Drinking loosens inhibitions and promotes social contact. Drunkenness is also given a positive association. Parents disapprove of drunkenness, but can exert no authority. Drink driving, whether travelling by moped or by car, is not condoned, but cycling after drinking is considered normal. Nobody, not even parents, considers the dangers of cycling after a party. It is even stimulated from all sides, in particular cycling as a group, for reasons of social safety. Police enforcement is absent. Almost one third of children interviewed has at some time been a passenger with a drunken parent behind the wheel. Although they do not instigate a discussion, once the subject is broached, the responses are extensive. In general, people believe that the choice to drink and drive is up to the individual. The consequences are your own responsibility, but the interviewee would rather not be a passenger in that case. Children find it hard to define a clear boundary between 'having a few drinks' and 'drinking too much'. Parents can fulfil a role, and also have ways of exercising pressure: they supply some of the money spent, warn against drinking too much and forbid drunkenness, stipulate a certain time by which the child must be home and demand that they cycle home in a group. They also determine the choice of school, where the reputation in the field of alcohol and drugs plays a role. The school is expected to uphold a specific alcohol policy at student parties, determines the climate that forms group attitudes and is the place where people want to hear about and discuss drinking and driving problems. Bars and discos serve underage children. The discussions clearly indicate the presence of peer pressure, although people believe they are not necessarily forced into following the group. They also see a dilemma for the future: how, once in possession of a car, do people ensure they do not drive under the influence, since they are already used to drinking and cycling? No solution was forthcoming.

### Education

There are various potential areas on which education can focus. A more realistic impression of the effects of alcohol, in particular in traffic, is desirable. Social skills can also be stimulated, both with regard to resisting (often assumed) pressure, as with regard to stopping other people from drink driving, whether they are peers or family members. Cycling while drunk can be made less acceptable, in particular by associating this with future behaviour, when a switch is made to motorised transport. The school can offer a good podium for children to develop in this area.

# The SWOV Institute for Road Safety Research

**The SWOV Institute for Road Safety Research, located in Leidschendam, near The Hague, is the centre point for road safety research in the Netherlands. SWOV was founded in 1962 in response to a joint initiative by the Minister of Transport and private organisations. Due to the constant rise in road accidents, scientific study seemed to offer the only effective means of tackling this traffic problem. In doing so, the Netherlands fell in step with developments in neighbouring countries, where similar institutes had already been operating for some time.**

**The aim of SWOV, then and now, is to offer a contribution towards improving road safety by means of scientific research. SWOV has a staff of seventy, among them forty researchers, fifteen persons supporting the research and fifteen as administrative staff.**

Aside from work commissioned by the Dutch Ministry of Transport, SWOV is increasingly receiving assignments via regional and municipal governments, private organisations and industry. Studies are also requested by organisations overseas.

Over the years, SWOV has evolved increasingly towards a market-oriented institute, actively acquiring assignments.

In addition to scientific study, SWOV is also responsible for coordinating road safety research contracted out to universities and other specialised institutes. The study results are then integrated by SWOV and presented in a suitable form for the client. SWOV also issues recommendations to its clients on measures that should be taken to promote road safety.

SWOV's goal is to contribute to road safety by means of scientific research and dissemination of the results. Its activities cover all aspects and areas of road safety.

SWOV also contracts research to other research institutes. In this way it has a co-ordinating function in planning road safety research in the Netherlands. SWOV publishes public reports, mostly in dutch, but sometimes also in the english, german and french language.

Aside from activities in the field of research, SWOV also looks after the support and distribution of know-how, data and experience in the field of road safety, both at national and international level. In the more than 30 years since its foundation, SWOV has conducted or commissioned numerous studies, published many papers and organised meetings and conferences.

Most of the SWOV's research reports are published in Dutch, including those covering the projects discussed in this issue. Since 1993 all SWOV reports have included a summary in English. The SWOV has produced lists of all SWOV publications indicating the titles and author. There are separate lists of SWOV publications for the periods 1962-1981, 1980-1986 and 1987-1993. The listed title indicates the language in which the document was written.

The SWOV has also listed its publications which are written in a language other than Dutch. This is usually English, but in some cases documents exist in German or French. This list covers the years 1985-1993. The SWOV also produces publication lists ordered by subject.

Lists of publications on the following subjects are now available:

- *Accident registration*
- *Alcohol*
- *Children*
- *Collisions and simulations*
- *Conflict method*
- *Cyclists and moped riders*
- *Daytime running lights*
- *Driver training and young drivers*
- *Education*
- *Heavy goods vehicles*
- *Helmets*
- *Index numbers*
- *Injury prevention*
- *Lighting and visibility*
- *Medicines*
- *Obstacles in verges*
- *Older people in traffic situations*
- *Pedestrians*
- *Police enforcement*
- *Reconstruction of urban areas*
- *Road safety in rural areas*
- *Provincial road safety*
- *Road verge constructions*
- *Roundabouts*
- *Seat belts*
- *Speed*
- *The 25% Campaign*
- *Traffic behaviour*
- *Traffic flow models*
- *Tyres, road surfaces and accidents involving skidding*
- *Weather conditions*

These lists can be obtained free of charge from the SWOV.

COLOPHON

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

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