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the pedestrian as a road user

The main points of a number of SWOV-reports

INSTITUTE FOR ROAD SAFETY RESEARCH SWOV

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The Institute for Road Safety Research SWOV was founded in 1962. Its object is, on the basis of scientific research, to supply the authorities with data for measures aiming at promoting road safety. The information obtained from this scientific research is disseminated by SWOV, either as individual publications, or as articles in periodicals or via other communication media.

SWOV's Council consists of representatives of various Ministries, of industry and of leading social institutions.

The Bureau is managed by E. Asmussen, SWOV's Director. Its departments include: Research Policy, Research Co-ordination, Research Services, Theoretical Research Pre-crash Projects, Applied Research Pre-crash Projects, Crash and Post-crash Research and Information.

More information is to be found in the booklet Aims and activities, available at request from the Information Department SWOV.

Contents

Foreword

Accident statistics and statistics for pedestrian crossings in the Netherlands were collected in a number of towns as early as 1967. The idea was that if research was to be done into pedestrian safety in built-up areas, this might take place in Amsterdam because of that city's extensive mechanical facilities for processing the data. The representativeness of Amsterdam for this purpose as compared with a number of other Dutch cities was examined (Ref.2).

Since 1969, the Institute for Road Safety Research SWOV has been actively studying pedestrian safety. This led, among other things, to an interim report being made to the Minister of Transport and Waterways in April 1971: Pedestrian Safety in Built-up Areas. In mid-1971, the then Minister of Transport and Waterways decided that recommendations on this subject should be made by an official working party. In the meantime, this interim report has been worked out further and systematically finalised.

Next to being represented in the OECD Road Research Group Pedestrian Safety (Ref. 1) SWOV was the member for The Netherlands of the semi-independent Working Group on Pedestrian Safety of the Organisation for Economic Co-operation and Development, which is now called OECD-CEMT Special Research Group on Pedestrian Safety. As part of the work of this international group, SWOV undertook comparative research into the effect of various combinations of facilities (zebra crossings, with signal-controlled crossings, footbridges and subways) on pedestrian safety in urban areas. This report has meanwhile been published (Refs. 9, 11).
Contributions were also made to the Project Group on Pedestrian Safety of the NATO Committee on the Challenges of Modern Society (CCMS), in which Rijkswaterstaat and SWOV represented The Netherlands. This Group dealt with the subjects of pedestrian behaviour, regulations and law enforcement, and a review was given of regulations relating to pedestrian and driver behaviour on or near zebra crossings applying in all West European countries and the United States (Refs. 7,8).

This publication, The Pedestrian as a Road User, presenting the main points from earlier SWOV reports, was compiled by J.H.Kraay, Sociologist (Department of Applied Research Pre-crash Projects SWOV), with the collaboration of the Information Department. Unlike the customary SWOV reports, this publication does not contain a full analysis of the problem, nor a catalogue of possible solutions or their functional requirements or evaluation.

The first section gives an overall description of pedestrian safety. In view of the limited nature of the available material, already pointed out on a number of oc-

casions, it is unfortunately impossible to make any immediate suggestions for means of reducing dangers to pedestrians. As part of the policy-preparatory research which SWOV regards as (one of) its major terms of reference, these data are thus of limited value. They may, however, serve to indicate the extent and nature of the problem.
The second section discusses possibilities of increasing pedestrian safety. It briefly gives the results of literature research into the effect of facilities, regulations and initiatives in providing guidance, training, information and publicity campaigns. Measures relating to urban infrastructures are also discussed. This section can be regarded as initial impulse for more thorough evaluating research - the second major field of SWOV research.
The third section goes into the scope for research into the effect of urban planning measures. This is a field in wich more direct influence on road-user behaviour is likely. By using research methods differing from those customary in the past (Refs. 10, 12, 13) a contribution can also be made to SWOV's third area of research: that of basic research centred on an all-round widening and deepening of knowledge.

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Introduction

Living and working

Increasing industrialisation led to specific work areas being built on the outskirts of towns. The demand for labour caused a migration from the country to the town. The towns grew steadily and distances between living and working locations became wider. At first, these distances were covered by public transport, by walking and by using two-wheelers.
In recent decades, service industries have expanded as well, yet rapid urban growth has been due to the increase in the working population.
The accumulation of businesses and factories in the town centres brought about a big local reduction in housing density. Factories went on building on the outskirts of the towns. There was also a tendency to establish or extend smaller residential areas some distance from the cities.
The consequence has been that distances between living and working locations have become longer and longer, with a big increase in the number of travelling persons. At present, public transport only meets the increased demand for transport to a minor degree.

Pedestrians and other road users

The increasing use of motor cars has greatly affected our way of life. Wheeled traffic and parked cars block the streets, especially in city centres, and in many places make it impossible for pedestrians to cross the road safely.
Many people feel that pedestrians are a forgotten group of road users. For half a century we have been planning and building many roads for wheeled traffic. But there has been a failure to provide adequate protection for pedestrians.
On the whole the smooth flow of both wheeled and pedestrian traffic will not cause any great problems. Only in small areas where, as it were, vehicles move through streams of road-crossing pedestrians, with or without the aid of pedestrian crossings (for instance very busy shopping streets) is the flow of both categories liable to stagnate.
Any reference to pedestrian safety immediately arouses associations of conflict situations with wheeled traffic. Though some dozen pedestrians die every year in single accidents on a public road (through falling for instance) these are not by definition recorded as traffic accidents. (In The Netherlands only accidents are registrated as road accidents if they took place on a public road, involving at least one moving vehicle and resulting in injury to at least one person involved. N.B. Only injury accidents are included in Dutch road accidents statistics).
Practice proves that in impacts between pedestrians and wheeled traffic the pedestrian is nearly always worse off than the driver.

1. Pedestrian safety

1.1. Pedestrian safety over the years

The number of pedestrians dying annually through road-traffic accidents in the Netherlands was always about 600 in the period 1965 to 1972; in recent years there has been some reduction. In the past ten years their proportion in the total number of recorded road-user fatalities has decreased further to about one in six. Although figures of pedestrian casualties (fatalities and injuries) must be treated with some caution, their trend is on the whole in the same direction. But it must not simply be concluded that pedestrians are now safer. In fact there is a steeper increase in the number of other road casualties. This in turn is largely due to a sharper increase in the number of private cars (and the aggregate mileage they cover) relatively to the number of pedestrians (inferred from the growth in the population).

1.2. Pedestrian safety as related to exposure

The dangers facing various groups of road users can be expressed in absolute terms. But relative figures can be used instead. These indicate the extent of the safety as related to *exposure* to traffic during a given period. Exposure criteria include the (corresponding) number of inhabitants or the annual mileage (taken for instance from the time spent away from home). A more realistic criterion for pedestrians would seem to be the number of road-crossings per type of crossing.

The annual pedestrian mileage is not really known. Researchers in different countries have reached widely differing results. In The Netherlands, some questions on this subject were included, as an experiment, in national interviews.
The respondents' answers suggest the following:
(a) The average Dutchman walks about 1000 kilometres a year;
(b) People aged 5 to 24 generally walk more kilometres a year than those in higher age groups;
(c) As between males and females (both from 15 years on) there is only a slight difference in annual pedestrian mileage;
(d) The lower the family prosperity level, the greater the number of kilometres covered by walking.
(e) People from 15 on in the three big cities walk twice as much as those in rural areas; in the case of the under-15's the difference follows the same trend, but is less pronounced.

As compared with the annual pedestrian mileage, the *number* of road-crossings by pedestrians according to *type* of crossing – zebra, signal-controlled, or away

from such crossings – and *place* – intersection, bend, corner or straight road – is a better criterion for exposure to traffic. The interviews mentioned above show that as people grow older they cross less often per day, but more crossings are on zebras, and that in the big cities there are more road-crossings than elsewhere, in rural areas least of all on zebras.

1.3. **Severity of pedestrian accidents**

Investigations in 1964 showed that the percentage of fatal accidents involving pedestrians was seven times as high as that of impacts between wheeled traffic and five times as high as for all recorded accidents. Since 1967, such comparisons have no longer been possible because of the change in accident registration.
The percentage of fatalities in recorded pedestrian traffic casualties is higher than among other road casualties. The same applies, though to a less extent, to the severely injured.

1.4. **Nature of injuries in pedestrian accidents**

The Medical Records Association SMR collected data on road accident victims admitted to hospitals in 1970 and 1971. They show that head and brain injuries (nearly half the total), followed by leg injuries (about a quarter of all injuries) are the most common ones both in the case of pedestrians and of all road users together. Only leg injuries occur in all age groups relatively more among pedestrians than among all road users together. The distribution of other injuries to pedestrians hardly differs from that of the overall group of road casualties.

1.5. **Analysis of pedestrian casualties (fatalities and injuries)**

1.5.1. *Distribution by sex*

In The Netherlands from 1968 to 1971 about twice as many male pedestrians died as females died through road accidents. During these years, moreover, the proportion of males increased, though only slightly.
Most accident research on this subject in other countries concludes that more male pedestrians than females are involved in road accidents.

1.5.2. *Distribution by age*

Distribution by age shows that from 1968 to 1971 four out of ten pedestrians killed were aged 60 years or older. Three out of ten pedestrian fatalities were under 10. These two age groups occur more in pedestrian fatalities than among other road fatalities.
These tendencies are also found in research in other countries. British researchers concluded, for example, that the risk of an accident (as a road-crossing pedestrian) is twice as high among young people under 16 as among pedestrians between 16 and 60, while pedestrians over 70 run about four times the risk run by the 16 to 70 group. In seeking the cause, some factors are: differences in reaction, speed of

movement, experience of traffic conditions and the different ways in which the various age groups use pedestrian crossings.

1.5.3. *Distribution by accident location*
The three provinces with the greatest numbers of inhabitants: Zuid-Holland, Noord-Holland and Noord-Brabant, had the highest absolute numbers of pedestrian fatalities in the period 1968-1971. Per inhabitant, however, the provinces of Groningen and Zuid-Holland compared favourably with the rest of The Netherlands; the greatest numbers per inhabitant are in the provinces of Friesland, Drenthe and Limburg.
The smaller the population of the municipality the higher the number of pedestrian and two-wheeler fatalities per 100,000 inhabitants. Municipalities with over 200,000 inhabitants are an exception as regards pedestrian fatalities. But if a subdivision is made for inside and outside built-up areas in such municipalities, the above tendency does not apply inside. This means that in the very smallest and moderately sized municipalities there are relatively more pedestrian and two-wheeler fatalities outside built-up areas.
From 1968 to 1971, there were nearly twice as many pedestrian fatalities inside built-up areas as outside.
Nearly one out of every three pedestrian fatalities inside built-up areas is younger than 10 and nearly one-half over 59. Outside built-up areas, the same applies to young people; the proportion of old people is also about one-third.
Inside built-up areas in 1968 to 1971, six out of ten pedestrian fatalities were males, outside seven out of ten.
Both inside and outside built-up areas, male pedestrian fatalities are represented more than females in nearly all age groups. There are relatively more young and older male fatalities inside, more other male fatalities outside. There are relatively more female fatalities up to 60 outside, more older female fatalities inside.

1.5.4. *Distribution by location on road*
From 1968 to 1971 in The Netherlands about three-quarters of pedestrian fatalities occurred on mid-blocks. Most of the other fatalities were at intersections. One out of eleven pedestrian fatalities inside built-up areas occur on a zebra-crossing. (This is about one out of sixteen of all pedestrian fatalities). About three-quarters of these are 60 years or older. As to this, there is no difference between zebra-crossings at intersections or on mid-blocks.

1.5.5. *Distribution by month, day and hour*
As regards distribution by months, those of October, November and December compared unfavourably with the other months in the period 1968 to 1971.
Out of all the days of the week, most pedestrian fatalities occur on Fridays.
The number of pedestrians dying through daytime road accidents is twice as high per hour as through nighttime accidents. Children under 10 are almost exclusively killed in daytime accidents.
On Sundays and public holidays there are about half as many fatalities among these youngest persons as on average working days or Saturdays.
In the 20 to 29 group it is striking that the percentage of nighttime accident fatali-

ties on working days is so high compared with the nearest age groups and the distributions between working days/weekends and day/night.
Most pedestrians dying through road accidents are 60 years or older, as stated earlier. About 90% of these accidents happen during daytime. For this group, however, there are no major differences between the contribution to daytime or nighttime accidents nor to accidents on working or other days.
Calculated by hour of day, the highest peak in the youngest age group is from 4.30 hours in the afternoon to 6.30 hours and the second peak from 10.30 hours in the morning to 12.30 hours. After 8.30 hours in the evening there are no more fatalities in the under-10 years group. The most dangerous time of day for pedestrians aged 60 years or older is also between 4.30 hours in the afternoon and 6.30 hours. There appears to be no obviously dangerous time for the other age groups.

1.5.6. *Distribution by weather conditions*
Most pedestrian fatalities occur in dry weather. One out of three of these is younger than 10 years, and one out of three 60 years or older. In bad weather over half the pedestrian fatalities are 60 years or older.

1.5.7. *Distribution by colliding vehicles*
Of all pedestrian fatalities from 1968 to 1971 nearly nine out of ten occurred as a result of an impact with a private car or truck.

1.5.8. *Distribution by vehicle manoeuvres*
American research showed that two-thirds of pedestrian accidents occur at intersections with vehicles driving straight on. Furthermore, as regards traffic turning left and right, the percentage of accidents involving pedestrians before the intersection is lower and increases the further the intersection is traversed.

1.6. **Other aspects of pedestrian accidents**

1.6.1. *Influence of drinking*
American research into drinking by pedestrians over 18 *not* involved in accidents showed one out of every ten to have a blood-alcohol concentration (BAC) of 100 mg/100 ml or higher. Of all pedestrians who had been drinking, over a quarter had a BAC of 100 mg/100 ml or higher.
Of pedestrians over 18 who *had been* involved in accidents, one-third to almost one-half had a BAC of 100 mg/100 ml or higher. Of all accident-involved pedestrians who had been drinking, an average of seven out of ten had this BAC or higher.
In view of these figures, it seems most advisable to examine in further research to what extent drinking by pedestrians plays a part in accidents to pedestrians.

1.6.2. *Influence of social factors*
A possible relationship between accidents and social factors is difficult to trace in The Netherlands from accidents statistics because these contain no social data. In a number of investigations on this subject in the USA, a.o, some conclusions are:

(a) that underprivileged, low-income groups are overrepresented in fatal pedestrian accidents (compared with control groups);
(b) that where children had more accidents, one or both parents worked more often and/or more outside the home, than compared with control groups;
(c) that children from broken or socially unstable families were more accident-involved than children in control groups;
(d) that children from very big families where little guidance is given during play are extra vulnerable to traffic accidents;
(e) that unstable, aggressive, undisciplined children frequently have accidents and distinctly more than children in control groups.
Interpretation of foreign research in terms of Dutch conditions is difficult without further research.

1.6.3. *Estimating speed of approaching vehicles*
British research has shown that it is difficult for pedestrians to make an accurate assessment of speeds of approaching vehicles travelling at 50 km/h or more. In such cases the time needed to cross the road is therefore often misjudged.

1.6.4. *Seeing.....*
The conclusion from British investigations was that in pedestrian accidents seven out of ten pedestrians over 15 had not seen the vehicle that hit them. This was said to be mainly due to not looking before crossing.
Older pedestrians did watch out more, but fewer had noticed the approaching vehicle.
Out of every ten children hit by a vehicle at least six had not seen the vehicle (four out of ten had 'not looked' and two out of ten had 'more or less looked' but had not noticed the vehicle).

1.6.5. *.....and being seen*
Pedestrians are often in the supposition that in the dark they are still visible to drivers 100 metres away. But research has shown that car drivers with low-beam headlamps driving at 65 km/h do not (or cannot) see road-crossing pedestrians wearing grey or black clothing in time to stop.

2. Possibilities of improving pedestrian safety

Possibilities of influencing road users' behaviour so that the number of conflicts between motorised traffic and pedestrians is reduced can be subdivided as follows:
1. Facilities for road-crossing pedestrians (such as zebra-crossings, signal-controlled crossings, footbridges and subways for pedestrians and two-wheelers) (see Section 2.1.).
2. Regulations and their enforcement (see Section 2.2.).
3. Initiatives in training, information and publicity campaigns (see Section 2.3.).
4. Measures relating to the urban infrastructure (see Section 2.4.).

2.1. **Facilities for road-crossing pedestrians**

The Netherlands have the following types of pedestrian crossings:
1. Zebra-crossings. These are marked crossings protected by law but without any other form of regulation.
2. Signal-controlled crossings. If the signals at such crossings only operate for a part of the day, they qualify as signal-controlled only when the lights are working. A variation is the type with push-buttons for pedestrians to operate the signals themselves.
3. Footbridges and subways for pedestrians and two-wheelers.

2.1.1. *Zebra-crossings*

General
The first legal recognition in The Netherlands of the status of pedestrians as road users dates from 1 November 1961. Wheeled traffic then became obliged to allow pedestrians on crossings to continue their way unhindered.
At first, it seemed that the introduction of these regulations had resulted in a decrease in the number of pedestrian fatalities, because in 1961 there were fewer fatalities than in 1960.
It was subsequently found, in view of the trend in the number of pedestrian fatalities as time went by, that the 1960 figure of pedestrian fatalities was exceptionally high, and hence this difference was attributable more to incidental fluctuations which indeed always have to be allowed for.

The risk of using zebra-crossings
British research indicates that using zebra crossings is about three times as risky as using signal-controlled crossings, but the risk on zebra-crossings is nevertheless over half as slight as where there are no such facilities. The area 45 metres on each side of pedestrian crossings, however, is about four times (zebra-cross-

ings) to over twenty times (signal-controlled) as dangerous as the crossing itself. Comparable figures given by other researchers show similar results.
If allowance is made for the numerical distribution these investigations give of pedestrians crossing at various places, it appears that the number of accidents in Britain is lowest on and near signal-controlled crossings; on and near zebra-crossings the number of accidents is about the same as elsewhere.
The figures of course depend entirely on the practice of construction with respect to location, pedestrian and wheeled-traffic densities, and also on the design of the crossing. The number of zebra-crossings and signal-controlled crossings in a given area is, of course, also a factor.

As already stated on page 12, one out of every eleven pedestrian deaths in The Netherlands from 1968 to 1971 inside built-up areas occurred on a zebra-crossing (this was about one out of sixteen of *all* pedestrian fatalities), and there were about as many males as females. Allowing for the fact that in The Netherlands in total nearly twice as many male pedestrians as females are killed, it might be concluded that women are more vulnerable on zebra-crossings, except that it is not known whether zebra-crossings are used by fewer men than women. Research indicated that this was true in Britain, but the difference is comparatively slight.
About three-quarters of pedestrian fatalities on zebra-crossings inside built-up areas were 60 years or older. One out of ten was younger than 10.

Pedestrian behaviour at zebra-crossings
It has been found in Britain that zebra-crossings are being used more as time goes by; pedestrians are crossing more and more on zebra-crossings (and signal-controlled crossings) than at other points. This change of behaviour can be ascribed to the increasing difficulty of crossing at other points, changes in zebra markings and stricter law enforcement.
As to the first reason, one might say that pedestrians no longer look upon zebra-crossings as obstacles in their (foot) way, but more as a fairly safe means of reaching the other side of a (busy) street without injury.
Investigations in other countries also showed that pedestrians' behaviour at zebra-crossings differed according to time of day and also depended on whether they were going to work or going home or doing shopping or going out for the evening.

Features in the vicinity of zebra-crossings
As regards the construction of pedestrian crossings, there are few, if any, precise criteria to work on. Following the Contributions to the Road Safety Memorandum (SWOV, 1965, 1967) it can be said that allowance must be made not only for the pedestrians' interests, but also for an effective flow of wheeled traffic.
The Contributions give the following criteria for constructing a zebra-crossing:
(a) density of pedestrian traffic;
(b) density of wheeled traffic;
(c) pedestrians' waiting time before they can cross;
(d) wheeled traffic waiting time at a zebra-crossing;
(e) the relative economic value of the pedestrian's waiting time as compared with that of wheeled traffic;

(f) the gain (or loss) in pedestrian safety compared with the (gain or) loss in safety of wheeled traffic and/or the economic value of this.

As yet there are no generally recognised norms for the correct lighting of zebra-crossings. There are various possibilities, for instance warning lights in the road surface, flashing lights, special lighting installations, or coloured lamps. A choice can be made between good street lighting or good lighting of zebra-crossings. In addition, it is important to have a warning notice over and just ahead of a zebra-crossing where traffic is dense. This makes it possible for vehicle drivers to observe the zebra-crossing in good time.
Depending on the street-lighting level, there should be either a negative contrast at each zebra-crossing (with the pedestrian as a dark object against a light background) or a positive contrast (with the pedestrian brightly illuminated against a dark background). Failing street or other lighting, it is cheaper in practice to provide a positive contrast than a negative contrast, which requires illumination covering 150 metres at both sides of the zebra-crossing. With a wet road surface, hardly be made uniformly bright. To obtain effective lighting, the Dutch Committee on Street Lighting recommends a lighting system in which the lanterns are ahead of and over the zebra-crossing seen from the direction of driving. The essential requirement is to have sufficient horizontal illumination of the zebra-crossing so that the zebra-crossing itself can be clearly recognised. At the same time, there must be enough vertical illumination of the pedestrian using the zebra-crossing to make him clearly visible.

2.1.2. *Signal and push-button controlled crossings*
Another possibility of reducing the number of potential impact situations is to make a time-gap between traffic categories by means of traffic signals. A pedestrian crossing controlled in this way is relatively three times safer than a zebra-crossing, according to the international reference material. Road safety increases with the number of signal-controlled crossings in The Netherlands too.

A variant of the signal-controlled crossing is the Delft flexible traffic-signal system, which gives priority to road-crossing pedestrians. By means of push-buttons, the pedestrian calls up the traffic-control installation which ensures, for each direction separately, that a succession of pedestrian signals are synchronised. This cuts down unnecessary waiting times for pedestrians. A 'green wave' is created for pedestrians so that they can cross a complex junction without waiting. It is designed so that these pedestrian facilities do not hold up other traffic at the junctions. If there are no pedestrians, wheeled traffic can drive on with minimum waiting times.

Cutting down waiting times is also a convenience to the pedestrian; he will find this very attractive especially in bad weather (rain, snow, etc.). Moreover, it is believed that once they become familiar with the system pedestrians will cross less often against the red lights or near the crossing than in the case of other signal-controlled crossings. Consequently, this is also expected to increase road safety.

2.1.3. *Footbridges and subways for pedestrians (and cyclists)*
In theory, accidents with wheeled traffic are impossible with footbridges and subways. But if it is still possible to disregard these facilities, their effect will be greatly reduced. Building footbridges and subways is a very good means of protecting pedestrians (and cyclist) provided it is made impossible for them not to use these facilities and they are built as part of an integrated approach of traffic segregation.

2.1.4. *Conclusions*
The foregoing has indicated that the most widely used pedestrian crossing facility, the zebra-crossing, can be expected to have the least effect on pedestrian safety. It is probably used so widely because it is by far the cheapest. Dutch research indicates that zebra-crossings in cities have not increased pedestrian safety.

2.2. **Regulations and their enforcement**

2.2.1. *Criteria for behaviour codes*
Regulations relating to pedestrians are mostly behaviour codes. Generally speaking, if codes are to satisfy one of their functions – safe traffic control – they must:
(a) provide information, i.e. be comprehensible, relate to concretely defined situations or behaviour, and be capable of only one interpretation;
(b) be free from internal contradictions; i.e. cause no conflicts with other behaviour codes in practice;
(c) have practical validity, i.e. be significant for safe traffic control, and not be superfluous or incomplete;
(d) be such that the road user can obey them and that they can be enforced by the police. Obedience can be encouraged by initiatives in training, information and publicity (see page 20) and by enforcement (see below). ('Humps' etc. are an instance of how adapting the locality can compel obedience by regulating 'natural' behaviour in such a way that it produces the desired behaviour).
If codes do not satisfy all these criteria, they may cause problems for road users, thereby giving less legal security and perhaps impairing road safety.
Behaviour codes for pedestrians and motorists vary somewhat from country to country. The most detailed specifications relate to conduct on and near zebra-crossings. But in the light of the above criteria, they are far from optimal.

2.2.2. *Law enforcement*
Law enforcement can be defined as checking that regulations are complied with so as to ensure safe and efficient traffic control.
The literature mentions only a few investigations into the effects of increased levels of police supervision on pedestrian behaviour. A British project examined the work of the London police with respect to pedestrian behaviour on and near crossings. If a police officer was present, the behaviour of pedestrians using zebras improved considerably. The experiment covered only a very short period however. Such behaviour can be found via many investigations. In another British experiment, in wich a police officer was on duty at a zebra-crossing for certain periods, it was found that while he was present more motorists gave pedestrians

the right of way than when he was absent. There was also a pronounced increase in the number of male pedestrians using the zebra-crossing. German research also showed that the presence of a police officer reduced the number of unlawful crossings. But this applied less to older pedestrians.

Besides this, if the majority of road users regularly offend against one or more traffic acts, these offences are looked upon as folk crimes. The traffic regulations are then apparently not taken seriously and a new standard of behaviour is created. If the new behaviour has assumed firm, defined forms, it will be difficult to restore the behaviour contemplated by law by means of sanctions. If road users do not take the regulations seriously, a police summons is regarded as 'bad luck'. There are strong indications that many offences against traffic regulations have indeed become folk crimes, which impedes law enforcement.

2.2.3. *Objective and subjective risk of detection*
There are two important factors that may turn pedestrian offences into folk crimes:
(a) the slight actual (objective) and road users' estimated (subjective) risk of detection;
(b) an evident aversion on the part of the police to 'book' pedestrians, and police law enforcement practice towards pedestrians as a whole.

Pedestrians as such have generally had little or no experience of sanctions and hence hardly aware of the actual risk of detection which is (probably) very slight. The risk of a sanction (a summons, a fine, a sentence) in the individual pedestrian's case appears to be built up of the risk of detection and risk of being sentenced and punished after detection.
Assessment of the punishment following conviction also plays a part in creation of the overall effect. The overall effect, expressed in pedestrian behaviour, is a fairly complex product of these subjective values. This means, if one of these subjective values is very small, that the overall effect is very slight too.
As regards the effect of modifying behaviour upon pedestrian safety, however, there has been little research so far.

2.2.4. *Conclusions*
As long as the objective and subjective risk of detection are not increased (which would necessitate a change in police practice) most pedestrian offences will continue to be folk crimes. Brief campaigns, not held frequently, are therefore unlikely to increase pedestrian safety because they hardly increase the objective risk of detection and do not change the subjective risk.
It would therefore seem worth while paying more attention to supervising pedestrian behaviour for a longer period.
At the same time, the regulations are not consistent with the criteria for behaviour codes, which makes them difficult to enforce.

2.3. Initiatives in guidance, training, information and publicity campaigns

2.3.1. *School-crossing patrols*

For twenty-five years, The Netherlands have been extending the school-crossing patrols system. It is aimed at making the immediate vicinity of primary schools safer for children.
The system has the following forms:
1. A school patrol consisting of children from the highest classes of primary schools (about 12 years old).
The police should provide instruction for these children.
Calculations for Amsterdam show that with this systeem three children crossing roads and guided by school patrols are run down a year out of about fourteen million crossings by children with such guidance.
2. Junior traffic assistants (in Amsterdam). These are girls between 17 and 21 being trained by the Amsterdam police for police duties later.
During this training period they help schoolchildren to cross the road.
3. Adult patrols. These may be either volunteers or paid helpers recruited by the schools and trained by the police.

It is felt that these forms of traffic assistance work well and have become generally accepted. But there has been no evaluation in terms of accidents. It should, however, be realised that these systems are in fact a makeshift way of patching up a technically inadequate situation.

2.3.2. *Training*

The basis of traffic training is that proper road-user behaviour promotes road safety and that this behaviour can be achieved with proper training (plus the appropriate supervision).
It must be borne in mind that when children have learnt the rules properly, this is no guarantee that they will also behave as they should.
Moreover, a dangerous traffic environment contributes to children (and old people) being involved in accidents so often. Good training by tried and tested methods under traffic conditions, so far lacking at schools providing basic education, would probably improve this. Going by present knowledge, it is unlikely that training children by means of traffic gardens is the only way of making a pronounced, positive contribution to road safety, and certainly not for children up to about nine years old, After all, in traffic gardens play conditions are represented and not reality.

2.3.3. *Information and publicity campaigns*

Information and publicity campaigns are conducted for improving traffic behaviour of adults. Some investigations are known regarding campaigns for pedestrians, but most of them give no conclusions as to whether safety improved or not.
Analysis of the literature indicates that on the whole publicity aimed at changing mentality is hardly likely to bring about a direct or substantial contribution to road safety. It is assumed, however, that publicity may be effective in increasing road users' knowledge and interest in a number of conditions influencing behaviour and hence road safety.

2.3.4. *Conclusions*
As yet there has been no research into the impact of school-crossing patrols. Using only traffic gardens for training children to cope with traffic is to be advised against. Good teaching methods for traffic training will have to be developed. Information and publicity campaigns often prove to have only shortterm effects on pedestrian behaviour.
Besides the fact that older people's behaviour is more standardised and hence more difficult to influence, there are also such factors as less resistance to accidents and poorer mental and physical health. In view of the latter, more efficient medical guidance might be envisaged for this age group, enabling them to judge better what road-traffic activities they can take part in.

2.4. **Measures relating to the urban infrastructure**

So far little research has been carried out into the effect of various forms of urban planning on road safety in general and the safety of pedestrians in particular. The few investigations that have been made, however, show that it is quite possible to promote road safety in this way.
Clear design criteria for urban planning have not yet been adequately formulated. The explanation might be lack of contact between planners and researchers. In formulating design criteria, the assumption should be that pedestrian errors come second in the accident risk and the layout of traffic localities first.
This accident risk is very closely related to the quality of traffic localities as worked out in urban planning and the relevant traffic systems.

Measures that can be taken in regard to the urban infrastructure can be subdivided into more isolated, incidental measures and those with a systematic approach. Isolated measures include: pedestrian crossings and their presentation and approaches etc., residential and shopping streets closed to wheeled traffic (creation of small pedestrian precincts in city centres),play streets, and fences in front of school exits.
Measures based on a systematic approach include segregating or integrating traffic, one-way traffic systems, 'closing off' town centres, a distinction between areas for traffic and places of sojourn, a road categorisation system.

3. Final observations

On the basis of the foregoing it can be concluded that it will be impossible in many cases to avoid potential conflicts between pedestrians and wheeled traffic without taking drastic action. In cases where potential conflicts remain, traffic conditions should be as unvaried as possible. Less variation enhances predictability of events; the furnishing of information to road users (pedestrians and others) on such events will have more chance of success. This means that road users' tasks are eased and hence potential conflicts will be turned into actual conflicts in fewer cases.
As regards the measures discussed in this publication, it has been found that those aimed at influencing pedestrians' behaviour by means of guidance, training, information and publicity have so far often not had the desired effect. Those aimed at adapting localities to road users' abilities and limitations are likely to have more direct influence on behaviour, with both short and long-term effects. Such (urban planning) measures should therefore bring about more than merely a very low degree of improvement in safety. Potential conflicts between pedestrians and wheeled traffic can be largely eliminated.

The principle being developed and applied in The Netherlands in the last few years is that of complete traffic *integration*. Since strict traffic segregation would impose too many limitations on the wide variety of activities and contacts normally forming part of the residential locality. That is why the need has grown for a fresh approach to road safety in residential areas, based on traffic integration. This approach includes different designs for pavements, street and car parks and a different use of these by road users. Here and there it is already possible for children to play in a space where motor vehicles are also allowed. By means of a number of physical obstacles in and on such spaces potential pedestrian/driver conflicts have been reduced to a minimum.

SWOV's scientific task in these still fairly new developments is to *evaluate* the effects of new designs on road safety. Since statistical evaluation of a small residential area in terms of traffic accidents is impossible because of the minute numbers concerned, evaluation in terms of pedestrian/vehicle conflicts has been chosen.
For this purpose SWOV has put out research to contract to the Netherlands Institute of Preventive Medicine TNO (NIPG-TNO) with a view to developing a conflict observation technique suitable for this subject, in order to evaluate the impact of various urban planning designs on road safety. In the Dutch research a (serious) conflict is defined as: a sudden motor reaction by one (or both) of the road users involved in a traffic situation towards the other with a distance of 10-5-10 metres (i.e. from less serious to more serious conflicts) between these road users. In this way, not only serious conflicts but also less serious ones and normal

encounters can be determined both in absolute terms and relatively to one another.

Development of this conflict observation technique in experimental conditions in order to verify its reliability was already satisfactorily completed in the first half of 1975. Next, the method was tried out in the field; in two residential areas of Delft differing from each other in their urban planning aspects.

It is worth adding that this research centres on children's behaviour in traffic. The literature shows that pedestrian hazards can be localised inside built-up areas, with special reference to the 0 to 9 years and 60 years and older age groups. SWOV literature studies show that American research has found that of all accidents involving children up to the age of 15 about three-quarters occur in the immediate residential locality within a radius of 500 metres from their own homes. Children are also the most intensive users of this direct residential locality.

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