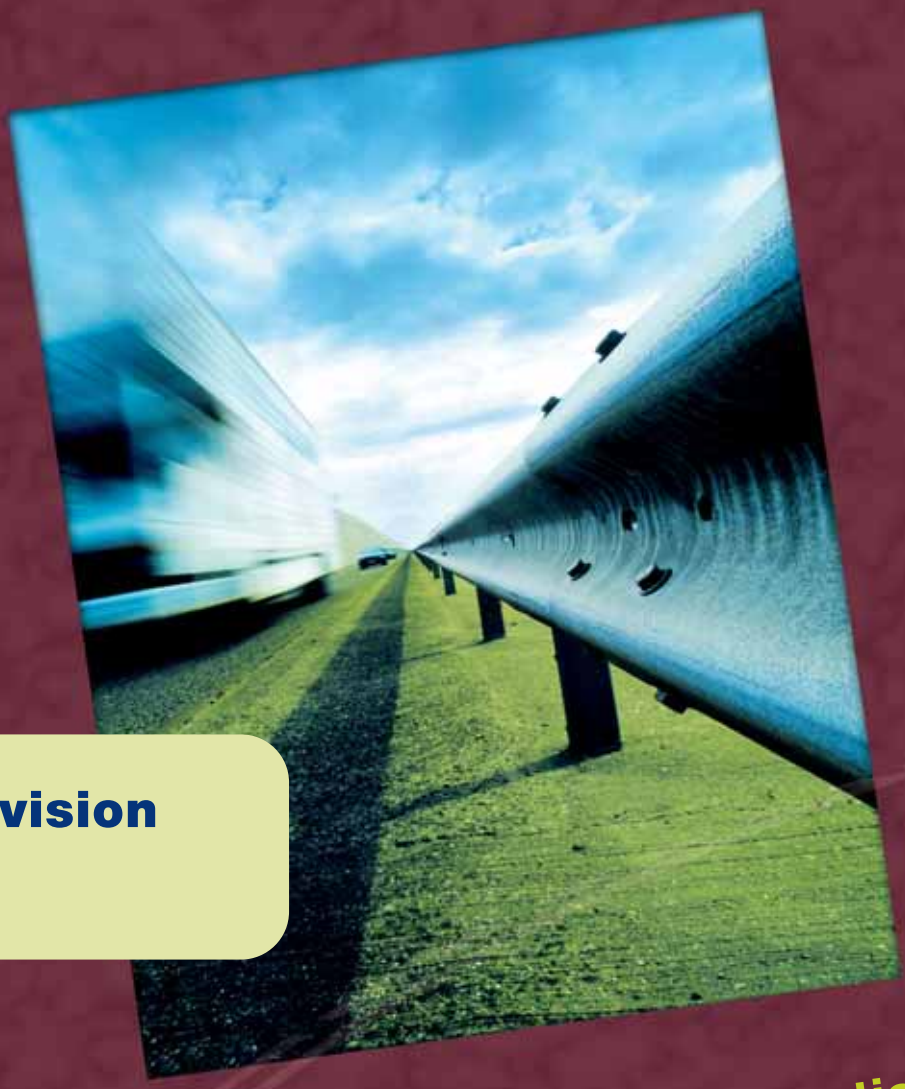
Advancing Sustainable Safety



The advanced vision in brief

National Road Safety Exploration for 2005-2020

SWOV Institute for Road Safety Research

SWOV
INSTITUTE FOR ROAD SAFETY RESEARCH

FOREWORD

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Each year there are about 1,000 road deaths in the Netherlands and many thousands of road users are injured. Fortunately, these numbers are slowly but surely declining. Compared with many other countries, Dutch traffic is among the safest in the world. However, good as it may be, there are still too many traffic casualties every year. Every year, a disaster occurs that society does not experience as such and therefore does not deal with as such. The average Dutchman does not really seem to care about all these anonymous deaths: road crashes are simply part of life. The chance of being killed in a road crash seems too abstract to worry about. However, it's another story if one of the deaths involves a neighbour, a colleague at work, a good friend or a relative. Only then do we wonder how this could happen, and ask if and how it might have been prevented. But what are the answers?

Anyone can have an accident. Everybody makes an error now and again; there are more than enough examples. People make errors and the risk of fatal errors increases when people consciously break traffic laws and regulations. This explains the need for safeguards against these errors. This is the Sustainable Safety approach in a nutshell.

Advancing Sustainable Safety; National Road Safety Exploration for 2005-2020 is an update of the original Sustainable Safety vision that was published in Dutch in 1992. ***Advancing Sustainable Safety*** critically examines the Sustainable Safety vision. Amendments have been made where necessary, because we have learned from our initial steps on the way towards sustainably safe road traffic. Advancing insights and new developments also necessitated an update of the Sustainable Safety concept. The book, which will be published by mid-2006, is not a policy document. However, we want the advanced vision to inspire the policy agenda of all tiers of government, the private sector, social organizations, etc. ***Advancing Sustainable Safety*** contains many recommendations that provide points of departure.

In this much smaller edition of the book, we offer you a cross section of all the chapters. Naturally this limitation required choices to be made. As a result we have only touched on some aspects and omitted others. We hope that this summary provides sufficient food for thought to interest you in the full edition. By mid-2006, the full text of ***Advancing Sustainable Safety*** will also be available at www.sustainablesafety.nl.

As in the full edition of the book, this abbreviated version first deals with the backgrounds and analyses of the Sustainable Safety vision successively. Next we discuss various types of measures, such as those dealing with: infrastructure, vehicles, Intelligent Transport Systems, laws and their enforcement, and education. We then address specific problems or target groups: speed, drink-and-drug driving, young and novice drivers, cyclists and pedestrians, motorized two-wheelers and heavy goods vehicles. Both the book and this short edition conclude with the preconditions for a successful implementation of Sustainable Safety. The conditions we discuss involve the organization of policy implementation, quality assurance, financing measures and various subjects together called 'accompanying policy'.

With ***Advancing Sustainable Safety*** SWOV wants to give Sustainable Safety a fresh impulse. I hope that the advanced vision will inspire you to further promote road safety during the coming years.

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Colophon

SWOV Institute for Road Safety Research
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www.swov.nl

The principles of Sustainable Safety

There are five principles that lead to sustainably safe road traffic: functionality, homogeneity, predictability, forgivingness (of the road layout and of road users) and state awareness (by the road user). The last two principles are new in this advanced Sustainable Safety vision. All five principles have their origins in scientific theories.

The goal of inherently or sustainably safe road traffic is to prevent crashes and, where this is not possible, to reduce the chance of severe injury to (almost) zero. We can achieve this by means of a proactive approach with 'man as the measure of all things' as a starting point. This approach recognizes people's physical vulnerability, but also what they are capable of (people make errors, after all) and what they are willing to do (people do not always abide by the rules). In the first place, the surroundings, such as the road and the vehicle, must be modified to meet these human characteristics. In addition, education should optimally prepare people for the traffic task and their final behaviour must be checked.

The proactive approach of Sustainable Safety means that measures are taken in the chain of 'system design' to 'traffic behaviour' as early as possible. By preventing system errors, human error and/or serious outcomes of crashes can be prevented; road safety thus becomes less dependent on the individual choices of road users. This implies that responsibility for safe traffic not only lies with road users but also with those who design and manage the elements of the traffic system such as infrastructure, vehicles and education.

Five principles are crucial for a sustainably safe traffic system (see *Table 1*). These are the three well-known principles of the original Sustainable Safety vision and two new principles: forgivingness and state awareness. The principles are based on theories from traffic planning and engineering, biomechanics and psychology, and are explained below.

Traffic planning

Also in the advanced version of Sustainable Safety, the road network should be ***functionally*** subdivided into three main road types. The two 'extreme' road types are through-roads (which allow traffic to flow) and access roads (which provide access to destinations). The third type are the distributor roads, to literally and figuratively connect the two 'extreme' road types. Because traffic functions are mixed on distributor roads (and no monofunctionality exists), this road type has relatively high crash risks.

Preventing unsafe acts

People can act at three levels: knowledge-based, rule-based and skill-based. The more experienced people become in performing a particular task, the more automatic the acts become and the fewer (serious) errors they make. In order to minimize dangerous errors, Sustainable Safety aims at avoiding knowledge-based behaviour when performing acts. To achieve this, road users must of course be sufficiently trained in their task of traffic participation on the one hand, while the road design should meet their expectations on the other hand. To meet the expectations of road users, the principle of ***predictability*** is used. In the advanced Sustainable Safety vision, we have translated this principle as *continuity* and *consistency* in road design: the layout should support the road user's expectations along the entire route, while all elements of the road design should conform to these expectations.

People not only make traffic unsafe by unintentional errors but also by *deliberate violations*. The original Sustainable Safety vision did not emphasize deliberate violations explicitly as causes of

crashes as much as this advanced version. When the traffic environment does not more or less automatically invite correct and safe behaviour, road users should comply with the rules from an inner motive. In this case, behaviour is the most consistent and thus sustainable. To improve rule acceptation, rules should be appropriate to the traffic environment and credible to road users, and people should be educated to accept the usefulness of rules. For those who still fail to obey the rules, the Sustainable Safety vision includes enforcement with a fairly good chance of being caught when violating rules.

Advancing Sustainable Safety also emphasizes that traffic should be sustainably safe for *everybody* and not just for 'the average road user' (whatever that means). This is illustrated by a task capability model. This model states that the task capability level of road users is the result of their competences and their situational state (e.g. influenced by fatigue, stress, drugs, etc.). To be a safe road user, the task capability should be good enough to cope with the task demands. These task demands are dominated by the environment, but may be altered by the road user himself, for example by driving faster or slower.

Sustainable Safety principle	Description
Functionality of roads	Monofunctionality of roads, as either through-roads, distributor roads, access roads, in a hierarchically structured road network
Homogeneity of masses and/or speed and direction	Equality in speed, direction and masses at medium and high speeds
Predictability of road course and road user behaviour by a recognizable road design	Road environment and road user behaviour that support road user expectations via consistency and continuity in road design
Forgivingness of the environment and of road users	Injury limitation through a forgiving road environment and anticipation of road user behaviour
State awareness by the road user	Ability to assess one's own task capability

Table 1. *The five Sustainable Safety principles briefly described.*

Road types combined with allowed road users	Safe speed (km/h)
Roads with possible conflicts between cars and unprotected road users	30
Intersections with possible transverse conflicts between cars	50
Roads with possible frontal conflicts between cars	70
Roads with no possible frontal or transverse conflicts between road users	≥ 100

Table 2. *Proposal for safe speeds, given possible conflicts between road users.*

People differ in their task capability. For example, inexperienced road users and the elderly have poorly developed or declining competences and thus a lower task capability. The average road user also has a lower task capability if he is tired or under the influence of alcohol or drugs, for example. This is why basic *generic road safety measures* must be supplemented with *specific measures* targeted at groups with a diminished task capability. These specific measures are mainly a matter of education and Intelligent Transport Systems (ITS) aimed at the new Sustainable Safety principle of ***state awareness***. If road users can correctly assess their own task capability (or state), they can decide not to travel or make fewer demands on themselves when they assess themselves as being insufficiently capable of driving a car. Examples are: not having enough driving experience, being too tired, having drunk too much, etc..

Very capable road users can also help prevent crashes through the social elaboration of the ***forgivingness*** principle. Forgiving road behaviour (e.g. anticipating behaviour) by more capable road users should enable less capable road users to make errors and go unpunished. In order to work correctively, the less capable should recognize their errors as such, but the errors should less often result in a crash.

Dealing with physical vulnerability

When road users are involved in a road crash, their physical vulnerability is at issue. Sustainable Safety attempts to minimize the seriousness of the outcome with the principles of ***forgivingness*** (of the surroundings) and ***homogeneity***. The first principle is elaborated in safe road shoulders. The last principle states that conflicts between different road user types must be avoided by separating them in the infrastructure. If conflicts cannot be prevented, speeds should be managed in such a way that any crash will not have serious consequences. For various traffic situations, Sustainable Safety proposes a system of 'safe' speeds for cars (see *Table 2*).

Road safety developments

Over the last 30 years, road safety in the Netherlands has improved considerably. However, there are still too many road deaths in crashes that would not have occurred or would have had a better outcome in completely sustainably safe road traffic. Future social developments such as increased mobility and an aging population also emphasize the continued need to focus on how sustainably safe road traffic may be achieved.

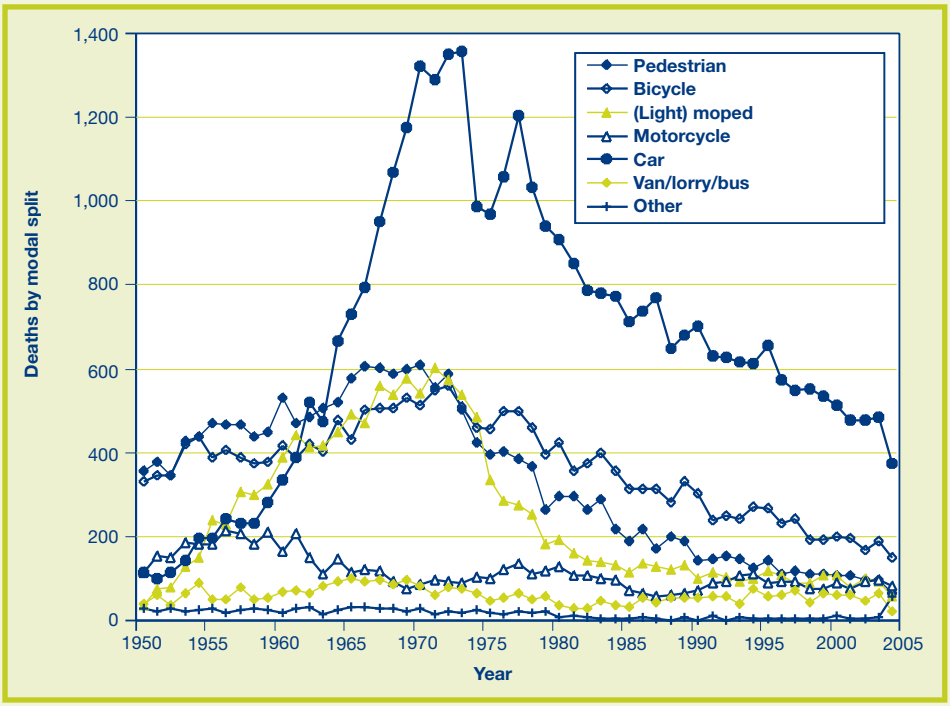

Figure 1. *Annual registered number of road deaths in the Netherlands by modal split 1950-2004. Source: Transport Research Centre.*

Due to growing mobility, and as a result increased exposure to risk, the number of road casualties increased during the twentieth century right up to the early 1970s. From then on the trend changed into a downward one. This is still the case, in spite of ever-increasing exposure. The Netherlands has a good record compared with other countries. Together with the United Kingdom and Sweden, it is one of the safest countries in the European Union and the world. Despite this, the safety level in all three countries is still unacceptably high. With regard to the Netherlands, there are a number of prominent issues.

Two modes of transport are particularly notable: motorized two-wheelers because of their relatively high crash rates (per vehicle kilometre), and cars because of their dominant road safety role (see *Figure 1*). Although car crash rates are relatively low and still declining continuously, a large proportion of casualties are car occupants. In crashes, the car has a dual role: in collisions with pedestrians and cyclists they are disproportionately strong and with respect to heavy goods vehicles and obstacles they are the weaker party.
The highest crash rates are those on rural roads with an 80 km/h speed limit for all vehicles and urban roads with a 50 km/h speed limit. This is partly a result of the relatively high speeds combined with the combination of different types of road user. A high proportion of crashes on rural roads results from single vehicle conflicts. Crashes on urban roads tend to be on intersections and transverse conflicts.

Young people (and especially young males) and the elderly (over 75) stand out because they have a high casualty rate. This is generally age-related: young people lack experience and have a tendency to show off, while the elderly are more physically vulnerable.

Road crash causes

In the first place, the danger of traffic lies in the 'basic risk factors': speed, differences in mass between road users, and people's physical vulnerability. In a sustainably safe traffic system, these basic risk factors are minimized.
Furthermore, the crash rate rises due to 'road user-related factors' such as a lack of driving experience (especially among young people), use of psychoactive substances (including alcohol and drugs), fatigue, emotions and distractions (e.g. using a mobile phone while driving).
Road crashes are mainly the result of unsafe (i.e. dangerous) road user acts: unintentional errors and deliberate violations. A sustainably safe traffic system attempts to exclude such acts as far as possible, or at least prevent any serious consequences.

Future developments

Various social developments can affect future road safety. It is important that policy applies a sustainably safe basis to tackle them. In the first place, the growing economy will lead to greater exposure of both cars and lorries. Any changes in the pricing policy will influence this, although what these influences are is not yet known. We can also expect better quality vehicles from a growing economy. On the other hand, a growth in the 24-hour economy will lead to increased fatigue among road users.

Demographic developments are that the population is aging and is becoming increasingly individualistic. This will mean greater distances between dwellings and a greater distance to travel. In addition, families where both parents work will create more traffic near schools as they combine commuting to work with the school run.

With regard to social-cultural developments, the Netherlands will remain a country with a wide variety of (sub)cultures and denominations. Together with higher traffic volumes and traffic densities, we have to face increasing problems of aggression and intolerance in traffic.
Expressing the need for life's 'norms' and 'values' will increase and be accompanied by a greater need for a healthy and clean living environment. This is expected to have particularly great effects on spatial planning; road safety requirements must be included in this planning.

Finally, government organization shows a clear tendency towards greater decentralization on the one hand, and more EU influence on the other hand. There is also a tendency to create a shift in responsibility from the authorities to the individual.

But this can only be a safe solution if the government has taken sufficient regulating measures on a sustainably safe basis.

Sustainable Safety to date: effects and lessons

The implementation of Sustainable Safety resulted in many improvements during the period 1990-2005. However, the future requires a shift in emphasis. There has been too little focus on the non-infrastructural aspects of the vision, whereas this is considered to be essential. Furthermore, we must acknowledge that in the practical application of the vision, the demands may have been overly moderated because of the rather low-cost design of the infrastructure.

During the last decade, Sustainable Safety has been the leitmotif behind improving road safety in the Netherlands. This vision is also internationally regarded as authoritative. Perhaps the most important step taken since the launch of Sustainable Safety in 1992 was the *Start-up Programme Sustainable Safety* of 1997. This agreement contained 24 action plans of the government and the regional and local authorities. The parties cooperated successfully, both in the preparation and in the implementation of the *Start-up Programme*. Regional and local authorities spent even more money in the implementation than actually planned in the subsidy arrangement.

The implementation to date

But did the *Start-up Programme* itself adequately reflect the Sustainable Safety vision? What aspects of the original vision have been put into practice and what effects have they had? To date, Sustainable Safety has mainly been translated into measures for a safer road infrastructure. Although it is important to focus extensively on the infrastructure, the vision embraces the whole interaction between 'human', 'vehicle', and 'road'. The past 15 years have certainly seen developments in education, enforcement, and vehicle improvement, but either they have not been as elaborate as the infrastructural measures or they have been too separate from the *Start-up Programme* and its underlying vision.
Furthermore, safety-improving ITS developments have only become visible in the last few years and will provide a great contribution to sustainable road safety improvements in the future.
Advancing Sustainable Safety also wants to

emphasize these non-infrastructural aspects of the vision and the integrated approach of all these elements.
The application of the vision to infrastructure has found its way into manuals and guidelines for road design and it is being implemented in practice as well. Over the last few years, practically the entire road network has been categorized into three functional categories and five different types of roads. In addition, the *Start-up Programme* chose to target access roads because of the wide support among the population to do something about these roads. This emphasis diverted attention somewhat from the distributor roads. These have a relatively high crash rate and it is difficult to introduce Sustainable Safety principles in practice here. This is why little has been done as yet to deal with distributor roads, other than the construction of roundabouts and cycle tracks.
We must also acknowledge that, although access roads were targeted, they have only been dealt with partially. Even though more kilometres were converted into 30 km/h and 60 km/h zones than planned, this was mostly done in a low-cost way. This was understandable because of the limited funds and the desire to implement Sustainable Safety on a large scale. However, we must now ask ourselves whether this was all too low-cost, not being as effective as expected.

Effects and lessons for the future

We do not know enough about the safety effects of Sustainable Safety measures yet. These measures have not been structurally assessed, although we were able to make rough estimations of their safety effects. Ad hoc evaluations indicate moderate to very positive effects of various (infrastructural) measures. On this basis, we have estimated that all the infrastructural Sustainable Safety measures taken at the time of the *Start-up programme* have together saved 6% of severe casualties (fatalities and in-patients) in the Netherlands. In the same period, the construction of 30 km/h and 60 km/h zones saved an estimated 60% and 40% respectively of severe casualties per kilometre road in these zones. However, if we remember that in such zones there should no longer be any severe casualties, we must conclude that the low-cost implementation was too great a compromise for road safety. Furthermore, there are indications that the speed of motorized traffic has not decreased sufficiently in these zones.

On the right track

We must conclude that we are certainly on the right track, although we do not have a sustainably safe traffic system yet. In addition, we still need to gather more information regarding the contents of the measures, in the area of infrastructure as well as in the areas of education, enforcement and vehicle and technological measures. All this information is important if we are to work cost-effectively towards a sustainably safe road system. For the continued implementation of Sustainable Safety, new agreements between the police, judicial authorities, social organizations and industry are required for effective and efficient implementation of policies. This process can be facilitated by the recently implemented National Road Safety Initiative.

Infrastructure

The planning and design of the road infrastructure are important subjects in the Sustainable Safety vision. Until now, the design principles of functionality, homogeneity and predictability have been the core principles. In the future we also want to focus more on the principle of forgivingness in the traffic environment.

Over the last few years, the original three Sustainably Safe vision principles have been translated into Dutch guidelines for road design on a large scale and applied in practice. Adapting the infrastructure has had a rather positive overall effect already. The effectiveness of individual measures ranged from 20% to 60% casualty reduction. Infrastructural measures taken between 1997 and 2002 have saved about 6% of fatalities and hospitalizations nationwide.

Functionality

It has not yet been made possible to assess plans to categorize roads in five different road types on their ability to meet the requirements of the Sustainable Safety vision. Additional require-

Road type and general speed limit	Bottlenecks in the actual road design
Through-road (100 km/h)	Categorizing of the 'old' trunk roads (with a single carriageway and a 100 km/h speed limit) as *regional through-road* without essential changes such as separation of driving directions and grade separated intersections.
	Grade separated intersections have only been incidentally constructed because of a lack of physical space and funds.
Rural distributor road (80 km/h)	*Separation of driving directions* has mostly been done by road marking only, instead of a physical separation which prevents head-on collisions.
	Parallel roads are often used by a combination of agricultural vehicles, mopeds and bicycles, leading to huge differences in mass and (mostly) speed.
	Many *intersections* of distributor roads do not (yet) have traffic signals; the question is how to achieve a safe speed of 30 km/h (for mopeds and bicycles) or 50 km/h (for motor vehicles).
Urban distributor road (50 km/h)	Speed of motorized traffic at *pedestrian and bicycle crossings* is often higher than the safe speed of 30 km/h.
Rural access road (60 km/h)	*Speed limit* of 60 km/h is too high, especially at intersections.
Urban access road (30 km/h)	*Implementation* is often too low-cost, which lead people to drive faster than 30 km/h.

Table 3. *Several important bottlenecks in the design of various road types in the Netherlands.*

ments for road networks are elaborated. In addition, there are still several bottlenecks in the design of the various road types (see *Table 3*). Sometimes there is still insufficient knowledge to tackle them with concrete proposals.

Homogeneity

The principle of *homogeneity* (of mass, speed, driving direction) has been further elaborated in the advanced vision. Where crashes can occur, the driving speed should be lowered to the extent that only 'safe collision speeds' remain. This idea is not incorporated into the existing design guidelines and the situation leaves a lot to be desired particularly on rural distributor roads and access roads. Many road authorities in the Netherlands are working on designs to make roads really sustainably safe.

Predictability

For the principle of *predictability* the essential features of the five Sustainable Safety road types must be defined. They should provide a minimum level of Sustainable Safety, which is something that the current 'essential *recognition* characteristics' cannot do yet. There are also some remaining questions about their basis. In any case, in order to determine the ultimate, essential Sustainable Safety characteristics, more knowledge is required about the recognition and predictability of the various road categories, especially when it concerns the expectations of road users at intersections.

Forgivingness

For the infrastructure, the application of the new principle of *forgivingness* is mainly a matter of road shoulders, especially on rural distributor roads. A vehicle that leaves the road should not collide with any obstacles or road furniture, resulting in severe injury. There is already sufficient knowledge to completely apply this principle to the Netherlands' infrastructure. However, additional research is needed to answer questions such as: when are roadside safety structures needed and which criteria should they meet?

In summary

If we look back at the field of infrastructure in the Netherlands over the last few years, it is clear that there have been significant developments and that these have led to increased road safety.

However, we do not fully understand how to plan and to design in a sustainably safe way. SWOV recommends initiating a platform to further analyse the problems of infrastructure and develop possible solutions in the Netherlands.

Vehicles

Vehicle safety is and will remain particularly important in the Sustainable Safety vision with regard to the principle of homogeneity. After all, the outcome of collisions is strongly determined by differences in speed, direction and mass. But if there is a crash, the vehicle should also be forgiving to its passengers by providing protection, and to the crash opponent.

In the past, improvements in vehicle safety have reduced the number of road casualties significantly, especially because severe injury has been prevented. The question now is how we can further sustainably improve vehicle safety. An independent national policy can only make a modest contribution in this respect. The main issues are international regulations, the policy of vehicle manufacturers and developments such as the EuroNCAP programme. A combination of governments, research institutes and consumer organizations tests car safety in this programme. However, not all vehicle developments are directly aimed at road safety. Examples of this are cleaner and quieter engines, increasingly heavy vehicles, new technological possibilities (ITS, hybrids) and consumer wishes (e.g. wanting to drive a SUV). We should conduct more structural investigation into whether these developments offer possibilities or are actually a threat to road safety.

Mass, protection, and compatibility

The heavier the car, the safer it is for its occupants and the more dangerous it is for a lighter crash opponent. This is clearly a problem in collisions with vulnerable road users. It is therefore essential to intensify vehicle requirements, not only for pedestrian safety but also for the safety of cyclists and motorized two-wheelers. An example is the car front designed to be cyclist-friendly as well as pedestrian-friendly.

The problem of incompatibility is also important between lorries and cars and, increasingly, among cars. A particular problem is the heavy, high, rigid SUV. A collision between unequal vehicle types usually has severe consequences for the occupants of the lighter cars, even if they meet the current crash criteria. After all, crash tests do not take (the weight of) the crash opponent into consideration. Therefore heavier vehicles should meet stricter requirements.

Crash criteria and road layout

In a sustainably safe traffic system, the vehicle features must correspond with the road layout as far as possible so that any crashes can end without severe injury. We examined the extent to

which this is the case by comparing current crash tests and test speeds with the various conflicts and the corresponding collision speeds permitted in a sustainably safe road layout. The bottlenecks are all on rural roads, in situations where the car can offer too little crashworthiness to its own occupants and crash opponent (see *Table 4*). To solve these bottlenecks with safer vehicles, the crash tests must be extended and adapted. Until this is possible and because the conflicts concerned cannot be eliminated, the driving speed in these situations will have to be lowered to ensure a 'safe collision speed' (see also *Table 2*).

Location	Mismatch of crash test and practice
Through-road 100 and 120 km/h	Too dangerous in rear-end collisions.
Distributor road 80 km/h	Side impact tests only go up to 50 km/h whereas 64 km/h is essential. Speeds should be max. 70 km/h in case of possible frontal car conflicts.
Access road 60 km/h	Pedestrian-friendly car front is not adequate for cyclists.
Intersection 80 km/h roads	No crashworthiness in side impacts up to 64 km/h (although crash tests do match an intersection speed limit of 50 km/h).
Pedestrian and/or cyclist crossing	Cars are faster than a safe 30 km/h.
Obstacles 80 km/h roads	Car side not adequate in side impacts.

Table 4. *Differences between crash criteria and current speed limits.*

Intelligent Transport Systems

The use of Intelligent Transport Systems (ITS) deserves a prominent place in the advanced Sustainable Safety vision. ITS is an important tool for making road user behaviour less dependent on or even independent of individual choices.

Intelligent Transport Systems can make their own unique contribution to improving road safety. The expectations are particularly good for systems directly aimed at safety. It has been estimated that safety-directed ITS could lead to 40% less fatalities and injured. In reality, however, many of its potential has not been (fully) developed yet. Moreover, large-scale implementation may bring all sorts of problems to light. In addition, the net effect of many of these systems is rather uncertain as yet: the interaction with human behaviour (such as risk compensation) is often still not researched, and large-scale implementation is very complex. Another reason why ITS has not contributed more to greater safety is because its introduction has not been directly aimed at road safety, but rather at congestion relief and driving comfort. Road safety aspects are not always included, and certain ITS applications can even undermine road safety. Despite this situation and associated uncertainties, ITS has great potential to further promote road safety (see *Box*).

Promising ITS

Informing and warning ITS applications are more promising than intervening variants, at least to start with, because they often have more public support and can therefore be implemented faster. These are systems aimed at speed management and dynamic speed limits by the use of ISA (Intelligent Speed Adaptation which assists the *predictability* of the road).

It is also important to join in strong, promising ITS developments, e.g. in the field of congestion relief, increasing comfort and environmental improvements. Road safety should be integrated in this, by making use of navigation systems to direct road users along the shortest and safest routes, for example.

In a next phase, one could think of implementation of advanced systems, such as ITS applications that regulate safe access to traffic (*state awareness*). An example of this is the alcohol interlock (alcolock), but one could also think of driving licence locks and seatbelt locks.

Long-term plans to create sustainably safe road transport will perhaps involve the automation of more and more of the traffic flow in order to prevent human errors. A vehicle will thus drive itself, while the driver only has a controlling function. But there is still a long way to go.

More than ever, it is important that all the parties involved in ITS applications (governments, industry, knowledge institutes, interest groups, representatives of consumers' organizations, etc.) join forces to ensure that the potentially effective ITS instruments result in casualty reduction indeed. At the same time, it is important to continue with the more traditional measures as well, and not to wait for ITS applications to make their entrance. The future is too uncertain for this.

Graphics: Siemens VDO Automotive

THE POWER OF ITS: FLEXIBLE AND DYNAMIC

The current traffic system is largely statically organized, whereas the traffic should be safe for the various road users in highly changing conditions: in both busy and quiet conditions, and in both fine weather and slippery conditions and fog.

To this traffic system, ITS adds dynamics and flexibility (adaptation to changes in time and circumstances). With the right information at the right place and at the right time, ITS makes it possible to respond to specific conditions. This further helps traffic to become inherently safe.

Education

In its many manifestations, traffic education plays an important role in Sustainable Safety, but until now it has perhaps been somewhat underdeveloped in the Netherlands. *Advancing Sustainable Safety* defines five behavioural themes as educational aims. These five areas greatly enlarge the playing field to which we are traditionally accustomed.

Learning in and about traffic is crucial. People learn more or less continuously from their own experiences and from examples set by others. Learning from formal education only accounts for a small part. Because of inherent time constraints, it is a challenge to focus formal education on issues on which it will have the greatest impact and the highest effectiveness. For this reason, in the advanced version of Sustainable Safety five themes were chosen as the main focus of traffic education. These are:

- insufficient road safety problem awareness and low acceptance of Sustainable Safety measures;
- no or insufficient use of strategic safety considerations in traffic choices (vehicle choice, route choice);
- deliberate violations;
- incorrect and dangerous behavioural habits;
- poorly prepared novices.

These five themes share the characteristics of being very relevant to road safety: they involve relatively large groups of road users, education is the appropriate instrument to do something about these themes, and it can be realized. Education should primarily focus on subjects which people cannot learn from being in traffic, because their relation to road safety cannot be clearly derived from traffic itself. Examples are the relation of road safety to driving speed, to the organization of the transport system, to the road design, and to the permitted manoeuvres (e.g. understanding the 'essential recognition characteristics'), to self-overestimation etc. The principles of *state awareness* and *forgiving* traffic behaviour can be developed here. Furthermore education must focus more on avoiding dangerous situations. In the Netherlands, traffic education should change its focus from improving operational skills (e.g. vehicle control) to promoting the traffic insight which is crucial to safe road use.

A broader learning environment

In the Netherlands, traffic education has become too much the task of the government (including schools) and, as a result, does not achieve its full potential. This is why education should be broadened. Responsibility for training operational skills in novices should be returned to parents and coaches: an informal education of this kind can lead to the strengthening of behavioural routines that were correctly taught in formal education. More than was the case in the past, we should remember that road users continuously learn from their own experiences. We can steer the learning process in the right direction with a coherent package of measures. In order to create a 'broader learning environment' of formal and informal education, we need cooperation between organizations as well as support with respect to the educational materials. Such cooperation will provide these organizations with sufficient knowledge, as well as sufficient funds, to execute their task. An important guidance role for the Dutch government lies in the traffic education renewal process described here.

Laws and their enforcement

In traffic we are obliged to obey many rules. This can be done most 'sustainably' when it is easy and does not involve any negative feelings. To achieve this, legislation should logically fit the traffic environment (predictability). Sustainable law enforcement intervenes at the earliest possible time and prevents dangerous behaviour (state awareness).

Laws such as speed limits, mandatory wearing of seatbelts or crash helmets, alcohol limit, priority regulations, etc. are not sustainably safe. After all, they can be violated intentionally or unintentionally. We need more for a sustainably safe embedding of laws in the traffic system. The reasons why people comply with rules are important here.

Intentional and unintentional compliance

One reason for *intentionally* obeying laws is the threat of punishment, for example. However, we usually comply with rules because we think that we will ultimately benefit from them and the 'costs' are too high if we do not (e.g. a greater chance of a crash or fine). We can also comply with rules because we really believe in them, 'because that's how we ought to behave' (normative perspective). This last motivation is the most 'internalized' and thus sustainable. We comply with rules *unintentionally* or spontaneously when they are prompted by the environment: the road layout incites correct behaviour or we imitate the correct behaviour of others.

Preconditions for spontaneous compliance

A sustainably safe traffic system should aim at *spontaneous* compliance with rules, i.e. unintentional compliance or compliance governed by inner motivation. To achieve this, rules must fulfil a number of preconditions. Naturally the first one is that we know the rules. Then it is important that rules are clear, specific and understandable, and that violations are easy to identify.
We comply more easily, perhaps even subconsciously, if they logically fit the road environment. Moreover, if the link with our own safety is clear and we sense that the rules are fair and neutral, we experience them as 'just' and are willing to comply with them.

Enforcement

However, not all of us are motivated to comply with the rules all the time. Even if the above preconditions have been met, we need (some) pressure. This can be achieved by traffic

surveillance with a sufficiently high (subjective) chance of being caught, e.g. targeting specific groups, and with sufficiently heavy penalties. In sustainably safe road traffic, enforcement and surveillance before road users have even started their journey (e.g. alcohol locks or seatbelt locks) are particularly suitable.
In the future, intelligent transport systems will be able to help reducing the number of violations in this way. They will be able to warn a driver when he or she is unintentionally violating a rule.
They can also be used as a radical method for specific target groups such as recidivists or heavy offenders.

Speed management

With speed management, we can influence both the homogeneity of road traffic and the predictability of road user behaviour and the road course. Speed management is thus an important means of achieving sustainably safe traffic and offers sufficient potential for action, both in the short and long term.

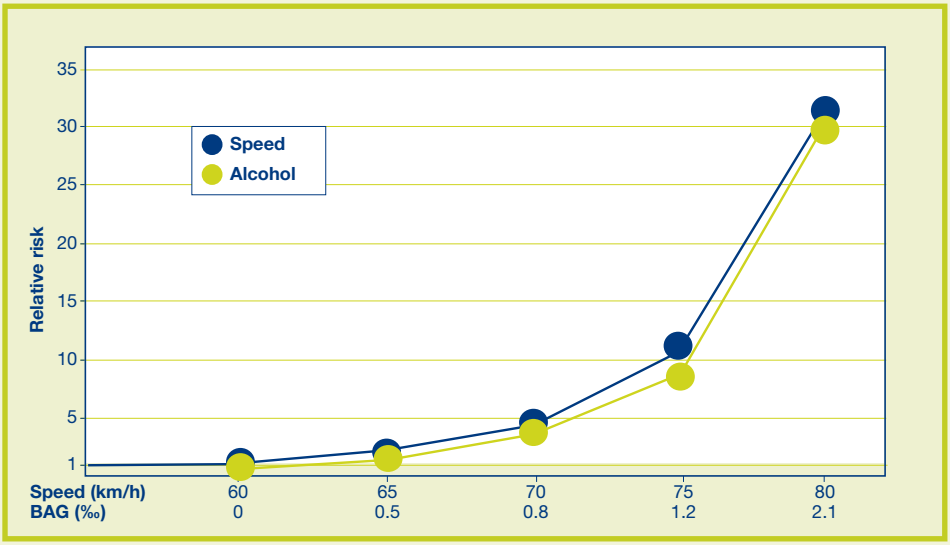

Figure 2. *The relative crash risk whilst driving under the influence of alcohol and at different speeds (on Australian urban roads with a speed limit of 60 km/h). From this graph it can be concluded that driving too fast is at least as dangerous as driving under the influence of alcohol.*

The exact relationship between speed and crashes is complex and depends on a wide range of specific factors. However, in general it can be said that the higher the speed, the greater the risk of a crash and severe injury (see *Figure 2*). It is precisely these two risks that Sustainable Safety tries to minimize.

We drive too fast and we enjoy it

On average, 40-45% of drivers in the Netherlands exceed the posted speed limit. Furthermore, some drivers enjoy driving fast, finding it exciting and challenging. We have calculated that if 90% of all drivers kept to the speed limit, there would be 25% fewer fatalities and in-patients a year in the Netherlands. Authorities should therefore aim to ensure compliance with the speed limits within the next 10 years.

Safe, credible limits and good information

The key concepts in a sustainably safe traffic system are safe, credible limits and good information about them. The following must be done if sustainably safe speeds are to be achieved in the Netherlands.

1. Determine safe speeds and safe limits

First of all we must determine the safe driving speed in order to set the speed limit corresponding with this safe speed. Whether or not a speed is safe depends initially on the number and type of potential conflicts (*homogeneity principle*). In Sustainable Safety this has led to the requirement that where motorized vehicles mix with vulnerable road users, the motorized vehicle's speed must be lowered. The complexity of the situation also determines what speed can be regarded as safe.

2. Credible limits

Limits must also be credible. Motorists must acknowledge the limit as the 'logical' one in the local conditions; that the limit corresponds with the road layout (*predictability principle*). When a limit is not credible, there are two options:
1. change the road layout, or
2. change the limit.
This last point means that the limit may be raised or lowered, within the margins of safe limits.

3. Proper information

An obvious precondition is that the road user is always aware of the current speed limit. Hectometre posts can give information about the limit, as is currently done along the 100 km/h segments on the motorway network. However, other types of marking and signing can also be used. Eventually, ITS applications may be able to provide information about the actual speed limit to the driver inside the vehicle. The information must be applied very consistently and, also, it must be properly explained to the road user.

4. Logical location and correct dimensions of physical engineering measures

When the (safe) limit corresponds with the road characteristics and the surroundings, the use of physical speed reduction measures such as speed bumps, could be reduced. Using speed bumps, raised areas and roundabouts should be limited to 'logical' locations, e.g. at zebra crossings, junctions or school exits.

5. Credible enforcement

With safe, credible limits and sufficient information about these limits, we expect the number of speeding offences to drop considerably. However, as long as motorists can choose their own speeds, there will always be a group that deliberately, and perhaps regularly exceeds the speed limits. To reach this group, enforcement remains essential for the time being. Speed enforcement is a topic that is currently subject to much public debate. Common complaints are that only the minor offenders are caught, preferably at moments when there is no other traffic, and that speeding fines are only meant to support the National Treasury. In other words, the credibility of speed enforcement still requires some improvement.

6. Dynamic limits and ISA

A speed limit system is more credible when it not only takes the general circumstances into account, but also the specific circumstances at that moment. An example of such a flexible limit is a limit determined by weather conditions. For example, for the last twenty years, speed limits on French motorways have been lowered in rainy conditions.
Ultimately, the aim is to create a system of completely dynamic limits in which the safest limit is adjusted to the current circumstances. Information about the actual speed limit, depending on these circumstances, should be given to the driver inside the vehicle everywhere and at all times. Such a system could be integrated with Intelligent Speed Adaptation (ISA).

Drink-and-drug driving

In a sustainably safe traffic system, there is no room for drunk drivers. However, drink driving is still a persistent problem to which the relatively new problem of drug driving has been added. Advancing Sustainable Safety gives various ways in which we can lessen drink-and-drug driving and possibly exclude it.

Drink driving

In the Netherlands, the proportion of drink driving offenders among motorists has declined by more than three quarters over the past 30 years. At first sight this would seem to indicate a very successful policy, in view of the fact that alcohol is such a large crash risk factor. However, the effect on the alcohol-related road toll is somewhat disappointing. The proportion of alcohol-related serious injuries (i.e. the sum of fatalities and in-patients) has declined much less than the proportion of offenders (see *Figure 3*).

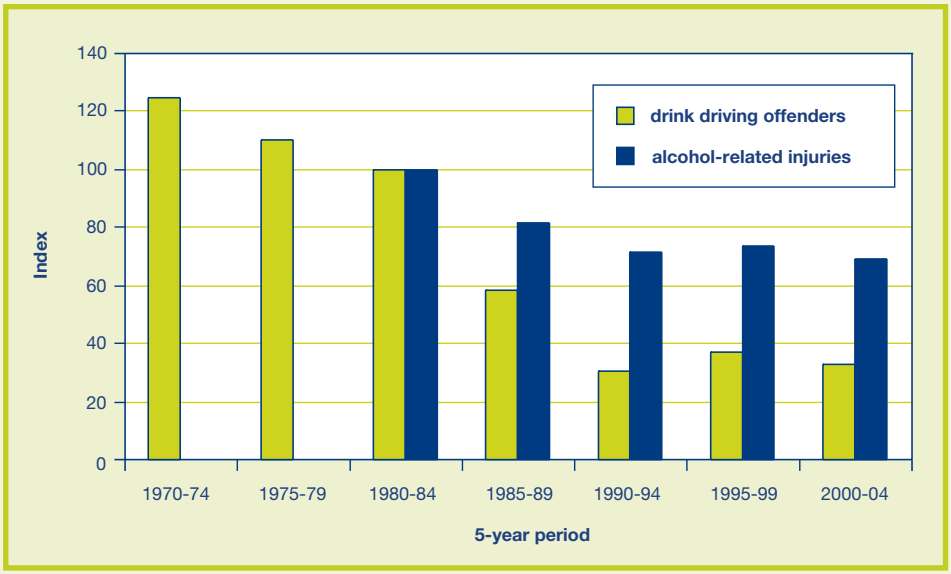

Figure 3. *Indexed development of the proportion of drink driving offenders among motorists and the proportion of serious injuries that is alcohol-related (1980-84 = 100).*

Exact data on the number of alcohol-related road injuries in the Netherlands is not available. The police do not systematically record alcohol-related crashes and we know that the official data grossly underestimates them.
A recent regional SWOV-study showed that, in the 2000-2003 period, 25-30% of serious road injuries among car drivers were attributable to drink driving. In a third of these cases, a combination of alcohol and drugs had been used.
The simultaneous use of various drugs and the combined use of alcohol and drugs result in a considerable increase in crash and injury risk.
The problem of alcohol in traffic can no longer be dealt with separately from the problem of drugs in traffic.
Research in the Netherlands has also shown that heavy drinkers are only a small proportion of all offenders, but that they are responsible for three quarters of all alcohol-related serious road injuries. Traditionally, the problems are concentrated during nighttime hours, among customers of pubs and discos etc., and among young men. This last group is also the largest user of drugs together with alcohol.

Approach

Drink driving is tackled at various levels: by legislation, police enforcement, education, punishment, rehabilitation and disqualification. The proportion of drink driving offenders in 2004 was the lowest ever in the Netherlands. Since the beginning of the new millennium, police

enforcement of drink driving has more than doubled; at present, more than two million drivers are tested annually at random for alcohol. SWOV recommends using some of the available police capacity specifically at times and places with high rates of serious offenders. Improvements are also possible once serious offenders have been caught; their cars could have an alcolock installed as part of their rehabilitation (*state awareness*).

Zero tolerance for drugs in combination with alcohol

For drugs used in combination with other drugs and/or alcohol, the lowest possible legal limits are appropriate, the so-called zero-tolerance approach. However, efficient drug driving enforcement is still difficult due to a lack of legal limits and reliable screening devices. Practical and reliable screening methods are being developed.

Alcolock for everybody?

Of all possible measures against drink driving, the alcolock seems to fit the Sustainable Safety vision best. For serious offenders, the alcolock has proved to be effective and for them it should be introduced in the Netherlands as quickly as possible. In the longer term, it might be possible to install alcolocks in all cars. However, we should first investigate if the benefit of the compulsory use of the alcolock by all drivers makes up for the costs and other possible disadvantages. If this is the case, it will probably not be difficult to obtain sufficient support for the measure from both population and parliament. After all, social acceptance of drink driving in the Netherlands, as in other EU countries, is very low.

Young and novice drivers

Traffic is the prime cause of death for young people. As novices, their task capability is less than that of more experienced road users. Therefore, in sustainably safe traffic, it is a prerequisite for safety that the young correctly assess their own capability (state awareness) and are prepared to limit their traffic participation to situations they can safely handle. This should also be the focus of driving instruction. In addition, specific measures should target young and novice drivers who still intentionally violate traffic rules.

Youngsters are a special group of road users. They begin their traffic 'careers' between the ages of 12 and 15 with successively different means of transport: they start with a bicycle, progress to a moped and ultimately switch to the car or even a motorbike or lorry. At the same time they are going through puberty and adolescence, involving life events such as major physical changes, increasing independence, finding a partner, choosing a profession. This is therefore a tumultuous period in their lives.

High crash rates

As an independent road user, the probability of a youngster becoming a crash casualty is much higher than for children and adults. In fact, traffic is the main cause of death for this age group. Although their crash rates have gradually decreased over the last 20 years, this has been less sharp than for other age groups. With car drivers for example, the difference in crash rates between young (18-24) and older drivers (30-59) is increasing. Twenty years ago, the fatal crash involvement rate of young motorists was three times higher than that of older motorists; today it is six times higher.

Age, experience and exposure to danger

The high crash rate related to young motorists is caused by a combination of age-related characteristics, lack of experience and exposure to dangerous circumstances.

This is the age of 'sowing one's wild oats', when many long for adventure, rebel against existing norms, may be strongly influenced by friends and overestimate their own capabilities.

Lack of experience plays its part in every new traffic role adopted by the young. In this phase it is mainly a matter of a lack of higher order skills such as traffic insight, self-knowledge, and hazard perception.

The young tend to be exposed to hazards more often due to the lack of injury protection offered by bicycles and mopeds. Furthermore, mopeds can reach high speeds. Youngsters also drive cars in situations when they are more vulnerable, such as at night and with passengers who could distract them.

What can Sustainable Safety mean to the young?

In general, a sustainably safe traffic environment will lower the high crash rate of the young (generic measures). But in a sustainably safe traffic system, their crash rate must also be reduced further by specific measures, preferably in the earliest possible phase. School and driving instruction (formal education) should place less emphasis on basic skills and greater emphasis on gaining traffic insight and self-knowledge.

The novice car driver should be stimulated to estimate his/her own capabilities and to adjust the traffic task accordingly (state awareness). Furthermore, it is important to realize that road users continuously learn from their own experiences and from the example of others (informal learning) and that this learning process takes much more time than learning basic skills.

Graduated driving licence

The most important specific measure to reduce the high crash risk of novice drivers is the graduated driving licence. This is a good way of gaining experience in safe circumstances: firstly by accompanied driving, then by solo driving in circumstances with a relatively low crash risks e.g. without passengers and/or not at night. In the final phase (the licence on probation in the Netherlands) there should be stricter rules than for experienced drivers, e.g. lower alcohol limits or a stricter points system.
A graduated licensing system might also be considered for moped riders and motorcyclists.

Other measures

Besides a sustainably safe education, police enforcement should make it clear to the young that they cannot 'sow their wild oats' in traffic. If they feel that there is a good chance of being caught, the number of intentional violations will decline. Therefore, the recent introduction of number plates for mopeds in the Netherlands will only result in fewer casualties if there actually is speed enforcement.
Eventually, we can also achieve an enforcing and disciplinary effect with Intelligent Transport Systems that record the driving behaviour of novice drivers (black box). Again, this measure will only be effective if the records are regularly checked and assessed.
In addition to suitable punishment for undesirable behaviour, a reward for desirable behaviour can promote safety. An example is a special 'rewarding' no-claim insurance discount for novice drivers.

Cyclists and pedestrians

Cycling and walking are very important means for children, school pupils and the elderly to participate in Dutch traffic. In sustainably safe traffic, these vulnerable road users should be separated from other traffic as much as possible. If this is not possible, there is the 'safe speed' of 30 km/h or less (homogeneity). To limit severe injury, vehicle adaptations also remain important (forgivingness).

In recent decades, the number of pedestrian and cyclist casualties in the Netherlands has declined enormously, even though cycling has increased by 30% since 1980, the distance walked has remained stable and motorized transport (the crash opponent) has increased by about 75%. Since 1980, the number of pedestrian fatalities has declined by two thirds and the number of cyclist fatalities by half. But more than 60 pedestrians are still killed each year and there are nearly 600 in-patients among pedestrians. For cyclists, these numbers are about 150 and 2,000 a year respectively.

Both pedestrians and cyclists are vulnerable because they are unprotected and regularly need to mix with motorized traffic going (too) fast. Crossing the road is the most dangerous manoeuvre for pedestrians and most of those killed are over the age of 75. Most of the in-patients are children under the age of 11. Cyclists are killed or hospitalized mainly after having been hit by a car (55%). These collisions often occur at urban intersections (58%), of which 95% have a 50 km/h speed limit.

Positive effect

The original vision of Sustainable Safety resulted in many measures with a positive effect for pedestrians and cyclists. Examples are:

- the physical separation of vehicles with major differences in masses, speeds and directions;
- the measure of directing mopeds onto the carriageway inside urban areas;
- the implementation of 30 and 60 km/h zones;
- the obligatory side-underrun protection for new lorries;
- the development of a pedestrian-friendly car front.

The first three measures are mainly intended to prevent crashes, while the last two aim to reduce the severity of crashes.

Sustainable continuation

Future developments in the composition of the population, spatial planning, mobility policy and new means of transport will lead to more cyclist and pedestrian casualties. To prevent this, it will be necessary to continue with the above-mentioned measures, especially the full implementation of the 30 and 60 km/h zones and the side-underrun protection for lorries, and the development of a car front that is not only pedestrian-friendly but also cyclist-friendly. Furthermore, vehicles can be fitted with speed adaptation or with night vision improvement systems that help motorists to see pedestrians crossing sooner.
The infrastructure should also be tackled. There should be a motor vehicle speed limit of 30 km/h when approaching a crossing location. In the meantime, there are provisional requirements for

the design of a sustainably safe pedestrian crossing. Detailed requirements for cyclist crossings are still being studied. Another idea might be the introduction of a combined pedestrian and cyclist crossing in the Netherlands (see *Figure 4*). Another innovative facility is the 'twee-pad' ('two-path'), a combined path for pedestrians and cyclists. This path is physically separated from motorized vehicles while pedestrians are visually separated from cyclists.
There are undoubtedly many more Sustainable Safety measures that could improve the safety of cyclists and pedestrians, but initially we must continue with the current approach.

Figure 4. *A combined pedestrian and cyclist crossing in Great Britain, known there as a 'Toucan' (two can cross). Photo: C. Ford.*

Motorized two-wheelers

Riders of motorized two-wheelers: motorcycles, mopeds and light mopeds have high crash rates. They move at high speeds and sometimes car drivers do not see them. Moreover, their own vehicle provides practically no protection in a crash. Thus, with regard to the homogeneity principle, motorized two-wheelers do not actually fit Sustainable Safety.

Motorized two-wheelers have high crash rates when compared with other road users. Their current death rates (per billion kilometres travelled) in the Netherlands are 75 for motorcyclists and 91 for moped riders, whereas they are 3 for motorists and 12 for cyclists. There are few Sustainably Safe measures that could reduce the number of motorized two-wheeler casualties.

Motivation

A large proportion of people riding a motorcycle or (light) moped do so for pleasure or as a hobby. For some motorcyclists it even constitutes a lifestyle. This type of vehicle gives their riders a sense of unrestricted freedom. Studies have also shown that motorcyclists often fail to have a correct hazard perception and risk awareness and this may also apply to moped riders. This combination of factors leads to unintentional errors, which in turn can lead to serious crashes.

Measures

There are no measures imaginable that could make motorized two-wheelers fit into sustainably safe road traffic and bring their death rates to levels of motorists' death rates. However, there are measures that could reduce their crash rates. For example, they can be fitted with advanced braking systems and ITS to influence their speed and visibility at intersections. In addition, number plates on (light) mopeds combined with extra enforcement will have a positive effect.
When choosing measures, one should make a clear distinction between young and novice motorcyclists on the one hand, and more experienced motorcyclists on the other hand, because the problems of the two groups are very different. For young and novice motorcyclists, elements from the graduated driving licence for motorists could be used, while skill training could be combined with training in road user behaviour and hazard perception. For more experienced motorcyclists, it is important that they learn to maintain a careful, safe and responsible riding style.

The above measures for motorcyclists naturally also apply to (light) mopeds, but in this case the emphasis will have to be on the problems of novice riders, as they are usually inexperienced young people.

Fundamental discussion

The riding style and hazard perception problems of motorized two-wheeler riders require fundamental discussion. We need to find answers for a range of questions: what crash rates for motorized two-wheelers are acceptable in society? What measures are reasonable and justified for reducing crash rates? Can we separate individual from collective responsibility for high-risk behaviour? Many interest groups are involved in motorcyclist safety, both nationally and internationally. They should initiate fundamental discussions with their governments to jointly choose measures aimed at actually, and preferably substantially, reducing the crash rates of motorized two-wheelers.

Heavy goods vehicles

From the point of view of homogeneity, large and heavy lorries should not mix with other road users in sustainably safe road traffic. In *Advancing Sustainable Safety* we have worked out how to achieve such a situation in the Netherlands in the long term. Short-term measures are also possible.

Because a lorry is heavy and rigid, the consequences of a crash are often serious, especially for the occupants of the practically always smaller and lighter crash opponent. A crash with a lorry can be fatal, even at low speeds. The involvement of lorries in fatal crashes is relatively large. In the Netherlands, there are about 130 fatalities among crash opponents of a lorry every year. The incompatibility of heavy goods vehicles and other road users is a fundamental problem and requires a fundamental solution.

Mobility

As road haulage is so important to the economy, reducing the distances travelled by lorries is not an option. Prognoses even indicate that distances travelled will (greatly) increase in the future. Our aim should be to prevent *unnecessary* mobility, for economic as well as road safety reasons. Such possibilities are: clever use of space, transport management (using ICT applications, for example), and transport savings (by adapting the product and its production process).

Separation

Little can be done structurally about the incompatibility of heavy and light traffic except to separate them. The sustainably safe solution is radical and can only be achieved in the long term: provide lorries with their own infrastructure (see *Box*). Two road networks are necessary for this: a) through-roads especially for heavy, articulated lorries and b) regional and local logistic routes for initial and terminal transport with light lorries. These light, unarticulated lorries must be suitable for mixing safely with other traffic. The two road networks thus also imply two lorry types. Such a dichotomy also involves different requirements regarding the driving skills of the lorry drivers. An example of this is to have drivers who are specialized in driving either heavy or light lorries.

Short-term solutions

In the short term, it would be possible to separate heavy goods vehicles by only allowing them to use motorways and single lane through-roads with only grade separated junctions. This means that heavy lorry journeys would practically all begin and end at company premises and terminals, while light lorries carried out further transport via the secondary road network.
Where the main road network is shared by lorries and cars, lorries should be equipped with safety provisions that allow for mixing with cars. For lighter lorries, these provisions should also be suited to mixing with mopeds, bicycles, and pedestrians.

Safety culture

At the moment, a safety culture in Dutch trucking companies is not the rule, but the exception.

A special infrastructure for heavy goods vehicles has many advantages

- Traffic on main roads becomes safer for cars and vans with the virtual disappearance of incompatible heavy lorries.
- There are no more problems with joining and exiting main roads with the lack of column-forming by lorries.
- Main roads are relieved of congestion so that fewer new roads and less road widening is necessary.
- Wear and tear of the main roads is greatly reduced because there is hardly any corrugation; 'light-roads' become a fact.
- Road construction design can become more focussed.
- Rollovers will no longer occur, provided the lorry infrastructure is narrow and has physical barriers on both sides.
- 'Lorry roads' can eventually be used for computerized, probably unmanned transport of containers, tank and bulk transport, and city boxes, for example.

Because of the fierce competition, a company only invests in safety if there is a legal obligation to do so, or if it is profitable for the company itself, and will improve its competitiveness, not damage it.
Road safety may suffer from the logistic pressure that is sometimes imposed on drivers. Both the haulage companies and their commissioners, the shippers, have a responsibility in this. Shippers can also impose safety requirements on haulage companies. Certifying haulage companies, as is already the case in Dutch bus companies, is another possibility for improving safety.

Organization of policy implementation

The Dutch administrative and policy environment in which road safety measures are implemented has changed radically since Sustainable Safety was launched in the early 1990s. The new administrative context partly determines whether the ambitions of Sustainable Safety can be achieved in the future. Therefore, a reconsideration of the implementation strategies is called for.

Decentralization

Since the end of the 1980s, government has become increasingly decentralized in the Netherlands. Drawing up, determining and implementing policy in various areas has now become the responsibility of regional and local governments. This also applies to road safety.
Regional governments can determine and implement road safety measures independently and introduce custom-made changes to their own region. In addition, people have come to realize that governments are not the only important players in road safety policy. Social organizations, interest groups, and the private sector such as the car industry, garage trade, insurance industry, driving schools and haulage and other companies together determine what happens in road transport. Finally, the Dutch 'lump sum' financing of regional and local traffic and transport policy calls for integration of road safety policy with other traffic and transport projects.
Implementing Sustainable Safety has therefore become much more complex in recent years and it is becoming ever more dependent on regional governments and social organizations. In fact, there is now a network that weaves its way throughout society and decision-making.

Integration of Sustainable Safety in other policy areas: difficult but essential.

Is decentralization consistent with uniformity?

This new administrative context in the Netherlands would seem to be at odds with one of the premises of Sustainable Safety, i.e. uniformity. However, decentralized implementation of road safety as part of an integral area-focussed approach certainly does not exclude uniformity. There are many other sectors where uniform standards and decentralized responsibility go hand in hand, for example the construction industry. But it is important that when formulating the uniform policy measures, use is made of the knowledge of decentralized governments and other sectors. This knowledge is necessary to optimally align the uniform package of measures to specific circumstances. This requires the development of safety measures in cooperation with regional and local governments. In the case of Sustainable Safety this can be achieved by letting regional and local governments look for allies by making additional agreements with provinces and/or other municipalities, for example. In all situations, stringent demands should be made on directing this interaction in order to ensure progress and quality.

Away games for Sustainable Safety

In the Netherlands, Sustainable Safety measures will be increasingly achieved within a broader traffic and transport policy. Road safety policy will be less and less exclusively its own policy area. This makes interaction with and knowledge of other policy areas inevitable and this broadening offers new opportunities. For example, we can reap the benefits by linking Sustainable Safety with spatial planning. In other words, Sustainable Safety will play fewer 'home games' and more 'away games'.

Away games do not make implementing Sustainable Safety any easier; we have to be present in the arenas of traffic and transport policy as well as urban planning. What is more, we have to ensure that we stand strong in the areas that are new to us to allow us to negotiate. Knowledge about cost-benefit studies could be useful here. At the same time, the support of forums such as regional consultative road safety bodies is indispensable.

The line-up of players

In which positions should the various Dutch governments play in away games?
The central government should play the role of 'policy innovator'. Additional policy innovations must be possible and also encouraged. Special attention should be paid to specific themes and integration with other policy areas. The directing role can be excellently combined with a function in research and knowledge dissemination. This task is made to measure for the central government, in view of its current role. In this policy development, knowledge institutes can fulfil a helpful role.

The role of the regional governments resembles the spider in its web. They fulfil a directing role in the implementation of Sustainable Safety, especially in the distribution of the funds made available by the central government. This requires definite and transparent choices between the various vested interests and, of course, 'road safety' will be part of these integral considerations.

The role of the local governments is one of integral harmony with inhabitants and other governments. Local politics can play a stimulating and active role between the (latent) demand of the population for greater safety and the concrete implementation of Sustainable Safety.

With or without ideological motives, social organizations are 'the constant itch' which ensures that actors are kept on their toes. Social organizations can connect Sustainable Safety with other social developments (sustainable society, environment and liveability, etc.). The Sustainable Safety vision offers the possibility of getting attention paid to a sustainable society that promotes the quality of life.

Quality assurance

The Dutch administration is going through many changes which certainly offer opportunities to the implementation of Sustainable Safety. For the fine-tuning of its various components, however, an important link in the chain is still missing: quality assurance.

Because of the decentralization of the Dutch government, more independent actors are responsible for the planning and design of the road traffic system. In the perspective of the Sustainable Safety vision, these actors should formulate and implement a coherent policy. A good example is presenting a recognizable road layout to the road user; this promotes the *predictability* of the road course and the behaviour of other road users. *Predictability* can only be achieved if all road authorities agree or are made to agree on a certain degree of uniformity. At the moment there are actually no safeguards for achieving uniformity.
A safeguard is desirable, certainly when road safety becomes an increasing part of other policy areas. The decision process does not guarantee that the correct road safety knowledge or vested interests are properly considered. Considering the complex decision-making and the attempts to compromise, there is a probability that too much water will be added to the road safety wine.

Revolutionary?

The proposal for a quality assurance system seems revolutionary in the Dutch 'world of road safety' because it is a new concept for road traffic, unlike the transport of dangerous goods. However, there are many other policy areas and organizations in which something similar already exists. Examples are aviation, railways and public health.

SWOV recommends that such a quality assurance system is first initiated for road authorities. For example, there can be expertise requirements for personnel, careful procedures for planning preparation and implementation, guidelines for road design, assessment procedures and analyses of crashes and near misses. Although this will not result in major changes, a quality assurance system does make clear to all those involved, both within and outside road traffic, that quality is not optional. It is certainly not intended to restrict the autonomous authority of parties. It is intended to ensure that the quality assurance is anchored, not only within one's own organization, but that it is even more firmly positioned and coordinated with the help of a supervisor, for example.

Fitting in with existing inspection

Advancing Sustainable Safety advocates starting with four issues in the Netherlands:

- obliging the minister to annually account for both the crash and casualty numbers and the processes within lower governmental bodies;
- carrying out road safety audits;
- reporting the road safety effects of major investments in road infrastructure e.g. as part of an Environmental Impact Assessment;
- revising current Dutch road design guidelines and recommendations in such a way that they can be used for the quality assurance advocated here.

If a small step is taken first, the organization of it all can fit in with the existing Inspection of the Dutch Ministry of Transport.

Financing

Many billion Euros are needed to implement Sustainable Safety in the Netherlands. Even if this is done gradually over 20 to 30 years, large annual amounts are needed. SWOV has studied three possible ways to finance implementation. In the short term the main source will lie in the deliberate and political choice to free more money from existing budgets.

Financing road safety measures, also those of Sustainable Safety, is a matter that continues to require attention as there are currently insufficient funds to cover all needs. Since the introduction of a special traffic and transport fund known as the broad goal-oriented grant (BDU), the budget for road safety measures is no longer earmarked as such and there is no longer any structural financing.

Sustainable Safety investments: robust!

But is the claim for Sustainable Safety investments realistic? Or is it just a pet notion of the road safety lobby? In 1992, the Netherlands Bureau for Economic Policy Analysis (CPB) joined other planning organizations to assess all claims. The proposals for the Sustainable Safety investments were found to be one of the few 'robust' ones: the investments are socially cost-effective and are part of the government's task.
In spite of this favourable judgement, the money has not yet become available. In its exploration of financing possibilities, SWOV limited itself to investments in the infrastructure, in particular the regional and local infrastructure. These investments are extremely relevant for a sustainably safe road traffic system. It is a well-known fact that the needs for financing such infrastructural measures are great and that the money available is shortcoming.

Are other financing sources available?

Three possibilities for financing the regional infrastructural road safety measures were studied:

- broadening the liability for crash damage;
- pricing road use;
- enlarging existing budgets.

The purpose of the first possibility, *broadening the liability for crash damage*, is to charge the liable parties with a greater proportion of the costs caused by road crashes. Here we are aiming mainly at the immaterial costs. Such a broadening of liability could lead to a rise in cost of third party insurance policies. A considerable share of the proceeds from these damage claims should be deposited in a 'Road Death Prevention Fund'. Realisation of such a proposal requires new legislation. In the short term therefore, this option will not lead to extra money to finance the regional sustainably safe infrastructure.

The second possibility, *pricing road use*, passes on the costs of construction and maintenance, including those of safety provisions, to the individual road user. This kind of 'kilometre charge' aims to make the user of a facility pay, taking the rate of use into account. Some kind of road pricing would appear to be a more efficient way of financing the infrastructure than the current methods. It is also suitable for financing a sustainably safe layout of the regional road network. However, if parliament decides that this system may not cost more than the present system, there will be no extra money for Sustainable Safety measures in the short term.

The third financing possibility studied is *enlarging existing budgets*. In this proposal SWOV examined if financing would be possible by raising the present traffic taxes or by spending their proceeds differently. For example, a one or two eurocent tax increase per litre of fuel could be used for this. The state's contribution to the broad goal-oriented grant could also be raised at the expense of the Multi-Year Programme for Infrastructure and Transport. Yet another way is

to use the yield of traffic fines for investments in the infrastructure. These possibilities require a political review for which the Social and Cultural Planning Office of the Netherlands and the Social and Economic Council of the Netherlands (SER) have offered various arguments.

A new committee at work

SWOV concludes that there are currently too few resources to finance a sustainably safe regional and local road network. This is also the case for roads which are the responsibility of a different road authority. A separate '*Financing a Sustainably Safe Infrastructure*' committee should be given the task to further elaborate the proposals.
In the short term, the best result is to be expected from altering the priority of existing budgets and/or a modest fuel tax increase. In the longer term, more funds can be generated by road pricing and extra income can be generated by broadening the liability for material and immaterial damage. However, there is still a long way to go in the decision-making process before these proposals are put into practice.

Accompanying policy

The implementation of Sustainably Safe will proceed better and more easily if, besides the actual implementation, attention is paid to four other subjects. These collectively cover the term 'accompanying policy': *integration, innovation, research and development* and *knowledge dissemination*.

Integration

Road safety is becoming an increasingly integral issue. Three goals are central in the Dutch *Mobility Paper*: improved accessibility, cleaner and safer. Many instruments, measures and interventions will constantly need to be examined in the light of these three goals. Once these considerations have been made, designing and managing a more integral policy will become more important for promoting road safety in the future. But *integration* with other policy goals and policy areas is difficult to accomplish. It does not come automatically and this subject deserves more specific attention than it currently receives.

Innovation

The Dutch *Mobility Paper* announces that central frameworks will be defined to allow national interests to interlace with decentralized traffic and transport policy, and here also road safety is mentioned specifically. Therefore here too, *policy innovation* (monitoring, benchmarking and, if necessary, adjustment) is needed.
Policy innovation should be a permanent process because we cannot simply continue to do the things we have done in the past. New and probably unorthodox measures are needed to make traffic sustainably safer. This requires several large steps or perhaps numerous smaller ones. How can we take them?

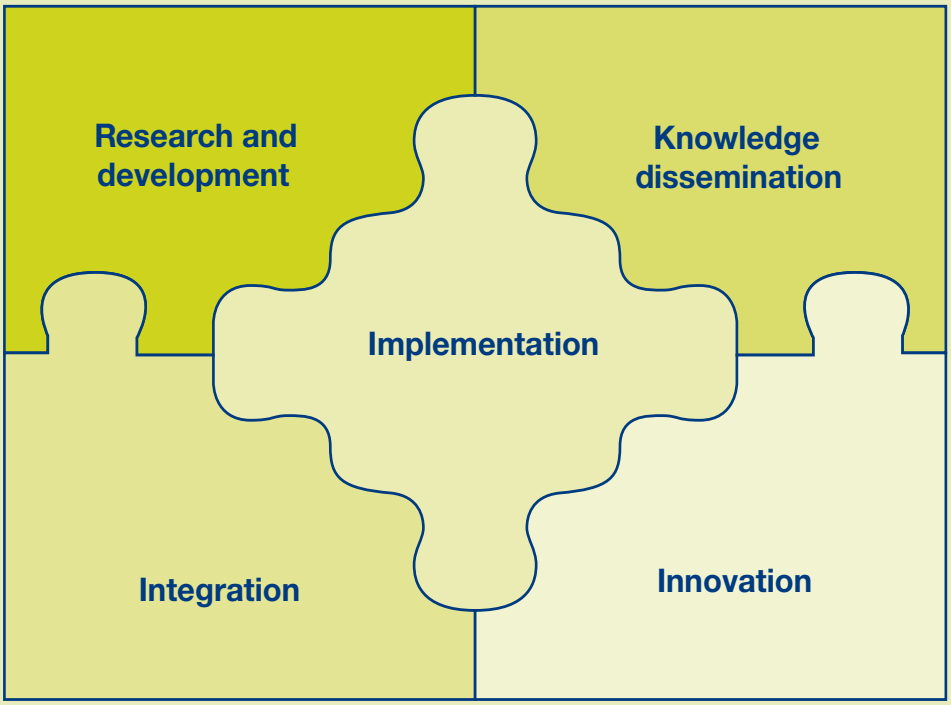

Figure 5. *The four components of accompanying policy as addition to the core: policy implementation.*

Policy innovation does not come automatically but should be stimulated. SWOV proposes allotting this innovational role to the Dutch Ministry of Transport.

Research and development

Greater efficiency in implementing existing measures remains an important subject for the coming years. So far our experiences with the implementation of Sustainable Safety have not provided us with knowledge in a much structural way. This makes it more difficult for us to take the next steps in the right direction. We can only implement existing measures better if we are prepared to invest in knowledge: what has been implemented, how has it been implemented and how much has it cost? In other words: *Research and development*.
Another argument in favour of research and development regards the concretization and elaboration of the possible measures in the advanced Sustainable Safety vision. A great deal of knowledge is also needed here that is not available and will have to be gathered.

Knowledge dissemination

The last of this quadruplet, *knowledge dissemination*, needs no argument; there is no point in having new knowledge if it is not distributed. The current methods of *knowledge dissemination* could be more coherent in order to reach road safety professionals in a qualitatively good and efficient way. More focus on education is required to achieve this. SWOV finally recommends using Sustainable Safety as a means of communicating information about road safety to citizens and road users. This will result in more social recognition for road safety, more widespread familiarity with Sustainable Safety principles and support for concrete measures.

Crucial

The above-mentioned components are crucial for the successful implementation of the various Sustainable Safety measures.

Launch of 'Advancing Sustainable Safety'

Sustainable Safety is a successful vision for safer road traffic. However, in spite of all its success, it was beginning to show signs of wear and tear. The latest insights have since been processed and incorporated in the updated *Advancing Sustainable Safety* vision. On 2 November 2005, the Dutch Minister of Transport and representatives from the police, provinces, municipalities and interest groups were presented with the first copy of the Dutch version of the book. An English version of this book will be published mid-2006 and will also be called *Advancing Sustainable Safety*.

The Dutch Minister of Transport Karla Peijs (third from the left) and representatives from the police, provinces, municipalities and interest groups are presented with the first copy of the Dutch edition of Advancing Sustainable Safety, by Fred Wegman, managing director of SWOV (on the left).

During the presentation in Leiden, various SWOV speakers introduced the guests to the advanced Sustainable Safety vision. Fred Wegman, SWOV's managing director, emphasized that the elaboration of complex questions in a complex context requires a great deal from those involved. Political will provides indispensable encouragement in this. Everyone involved must continue on the road already started and not avoid new possibilities and challenges.

In her reply, the Minister of Transport said she was pleased with the advanced Sustainable Safety vision. She is greatly concerned about road safety; new measures and initiatives are still essential. We must not forget that the 881 road deaths in the Netherlands in 2004 are the equivalent of 18 busloads of children, parents, partners, relatives and friends. Everybody's efforts and creativity are welcome in order to further reduce this number. She felt that she had a great deal of support in political debates from the strong argument that there is no single more socially beneficial measure than a road safety measure.

Advancing Sustainable Safety lays the foundation for further improving road safety and proposes various possibilities to do so. Implementation requires effort, initiative and cooperation.

by mid-2006:
www.sustainablesafety.nl

SWOV
INSTITUTE FOR ROAD SAFETY RESEARCH