DEVELOPMENTS IN ROAD SAFETY RESEARCH

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Mr. Chairman, Ladies and Gentlemen,

The first thing one does when preparing a lecture is of course to look at the topics included in the programme. While doing this I could not escape the impression that it would take at least three or four hours to sum up and comment on the enormous range of topics dealt with here. I should not like to inflict that upon you, especially at the end of the afternoon.

The advantage of such a wide-ranging programme is that each speaker can select what subjects he wishes to single out for in-depth treatment and precisely how to deal with them, and this is just what the previous speakers have done. Inevitably, there has been some overlapping of subject matter.

What I should like to do is to give you a condensed account of the experience and knowledge I have gained over 23 years at SWOV - a bird's-eye view, as it were. This will enable me to sketch out some lines of development for the future.

When I began work at SWOV 23 years ago - myself and a secretary on one small floor of a house on Nassaukade in The Hague - I had no real idea of how to start such an organization. However, I did have clear ideas on how to tackle road safety, by bringing about a rational system of decision-making based, for instance, on cost-benefit analysis.
When I aired this opinion in an interview it was poorly received in some quarters. There were even questions asked in Parliament about the choice of director; some people would rather have had a pedagogue than a technocratically-minded engineer. Safety, it was thought, is a question of mentality: once you have improved that, the road safety problem is solved.
Luckily a concrete technical problem was immediately brought in: a roadside safety structure was needed. I am still proud of the fact that after about a year of research, in collaboration with TNO-Iweco and Delft University of Technology, a system was devised that is essentially the same as the one used today. The Netherlands was in fact the first country in Europe to use these effective safety devices on any large scale.

Our second major project was to provide contributions to the Road Safety Memorandum. This was a summary of the entire field of road safety, and furthermore a first attempt to dispose of the simple but impractical idea of "improving mentalities" - the moralistic approach.
I should never have managed to complete the project and the contributions without the help of Dick Griep, psychologist and SWOV's first research assistant. We lost him, sadly, in a car accident. I don't think I have ever learnt more from anyone, certainly in the scientific field, than I did from Dick.

Our official counterparts at the Ministry of Transport and Public Works were Mr. Quist and Mr. Tops, who later become Director General of the Public Works Department. At that time I also had direct access to the Minister, Mr. Bakker, which enabled a lot of misunderstandings to be avoid. These arose because in those days the Department did not shield independent organizations entirely from the world of politics.

That first Road Safety Memorandum, incidentally, was based on the idea that behavioural research techniques would enable us to determine the effects of isolated measures fairly precisely, i.e. to isolate them from other, simultaneous, influences. The more one goes into the phenomenon of road safety, however, the clearer it becomes how complex it all is. Every time one has the feeling, "now I have found a successful way of preventing accidents", but then, after a while, the
effect disappears, or turns out to be an illusion caused, for instance, by autonomous changes in the system, chance or regression to the mean. In other words, it is virtually impossible to determine the effects of single measures.

To disentangle a phenomenon of such awe-inspiring complexity one has to establish some kind of structure in it. This can only be done with knowledge. We can identify five types of knowledge which can help us to control problems and phenomena:

1. Concepts and conceptual frameworks at a high level of abstraction: these are usually paradigms, philosophies, etc.
2. Methods and techniques for analysing problems, making adaptations and thus finding solutions.

3. Patterns or complex conditional statements, which can be represented in a multiple context.
4. Parameters or conditional statements: if x is the problem under y conditions, then z is the solution; different conditions require a different solution.
5. Rules and guidelines: if x is the problem, then we always take solution z - a kind of recipe, as it were.

Let me give you an example of some of these conceptual frameworks or philosophies which are still applied by some authorities and have a strong influence on their decisions and actions.

Many recent articles and studies try to show that accidents are the result of the combination of a large number of circumstances and contributory factors. Despite this, many authorities and individuals continue in the belief that each accident has a single principal cause (the "monocausal approach") and that measures must consequently be directed at that single main cause. This principle is still applied in accident records, for instance: these still state a single "main cause". The causes are then divided up among the human, vehicle and road components, and - inevitably - the human element turns out to be the cause about 80% of the time. Measures must therefore be directed at people. The behaviour of road users, then, is almost entirely the cause of road accidents. The question of liability is central; "inappropriate behaviour" is a term often heard.

Nor is this the end of the argument. Being involved in an accident once may be chance, but causing several accidents cannot be mere chance. Such "accident-prone" drivers must be kept off the roads or forced, by punishment or reeducation, to better themselves and become "gentlemen of the road". This divides the road user population intwo two categories, the good drivers and the accident-prone. Behind the "accident-prone-driver" philosophy lies the "Just world hypothesis" (Melvin Lerner), which is based on the idea of work being rewarded: you get what you deserve.

If there is such a thing as chance, which can strike at any time - in the form of an accident, for example - people cannot be sure that this can be avoided through their own merrits and skills, that they have control of their own destiny. They start to feel threatened. Aside from the empirical fact that this hypothesis of a just world in fact preserves injustice, there are various harmful consequences:

1. A selective, human-oriented approach to road safety, ignoring the interactions with other elements.
2. Those who have never been involved in an accident derive confirmation from the "accident-prone driver" philosophy that they can regard themselves as way above average road users. Self-overestimation of this kind can make them more likely to take risks and less alert to critical situations.
3. Gentle threat, or subjective risk perception, is seen as one of the main mechanisms resulting in safer roads.

A pendant to this philosophy is the monocausal chance phenomena approach. Accidents were considered to be solely a matter of chance and could not thus be prevented. It was recognised, of course, that there were fluctuations in the number of accidents, but this was eventually expected to stabilize around a certain mean accident rate. This philosophy, which implies that little can be done about accidents, caused almost complete concentration on the consequences of accidents, on their severity. Crash-proof cars (albeit only to the occupants) and breakaway lighting columns are examples of this way of thinking. Pedestrians and cyclists dressed as Michelin men or with crash helmets fit into the same picture. The effects of measures to reduce the severity of accidents should not be underestimated, even without the Michelin costume. Since 1973 there has been a dramatic decrease in the death rate in most countries, but there are strong indications that there has been hardly any drop in the accident rate.

The limitations of the monocausal approach came to be felt more and more strongly, particularly in research circles, and even among road safety professionals. The multicausal approach made its entrance some fifteen years ago. This is based on the idea that everyone who participates in traffic runs the risk of being involved in an accident, and a large number of factors play a part in combination with one another. Research

looks at the interactions between these factors in a static black-box model, i.e. the statistical relationships between input magnitudes, relevant contributory factors and output magnitudes, accident indicators.

The process itself, i.e. the transformations that take place between input and output, are not considered. Advanced multivariable techniques are being devised and applied to bring some order into the factors. The result is a strong concentration on the effectiveness of the environmental factors since, being static, (e.g. the road and infrastructure, or the average traffic intensity) these are the simplest to measure. The motto is "adapt the environment to the road user", to his capabilities and limitations.

Despite the high expectations, the results have been disappointing, especially when set against the enormous quantities of detailed data which have had to be collected for the analysis. The approach has not produced a true understanding of the relationships between the relevant variables. It has become increasingly clear that if analyses are to be successful the process itself cannot be ignored but must in fact be the basis of every analysis.

As a result the dynamic system approach was developed. A system approach is based on the assumption that everything is connected with everything else and that the interconnections are more important than the isolated components of the system - a holistic approach, in other words. Applied consistently, a conception where everything is connected with everything else results in the scale becoming larger and lager, until finally it becomes the universe. Moreover, if we try to take account of all aspects we discover that their number is infinite; consequently the phenomena become so complex that they cannot be analysed.
The system as a whole must therefore be divided into subsystems and sub-subsystems, with the aim of identifying more or less homogeneous groups. The choice of subsystem boundaries is thus crucial, and in particular the principles and strategies on the basis of which the boundaries are determined.

Let me mention a few principles. The first is the system's control mechanism. Because of the large number of freedoms enjoyed by road users, the course of the traffic process is determined largely by the perception, decision-making and action of individual road users in or on their vehicles. We refer to the road user in or on his vehicle as the elementary system. This is a system with primarily internal control. How fault-free the control is depends on how well the road user, the actor in the elementary system, is able to perform his perception, decision-making and action tasks within the context of the facilities and circumstances with which he is presented.
The system boundaries are thus determined by the nature of the tasks performed by the road user in the traffic process. The nature of these tasks differs, in particular as regards possible disturbance of the process, which could eventually lead to accidents and damage.

Thinking along these lines I and my colleagues at SWOV developed the phase model of the accident process. The phases differ not only in relation to tasks and circumstances but also in relation to behaviour alternatives open to the road user. External control is provided by the collective authorities. The alternatives open to them (e.g. as regards measures) also differ from one phase to the next, and they are designed mainly to influence, directly or indirectly, the context of facilities and thus the environment in which the road user has to perform his tasks.

Clearly, collective control has to be applied to the internal control mechanisms in the traffic system and to strengthen them. The collective decision-makers must climb into the road user's skin, as it were. Critical combinations of circumstances occur where the environment and the road user's behaviour are not matched. The question is, which road user should the collective decision-makers select, and where and when? Road users are highly heterogeneous group. The traffic population consists of a large number of minority groups, each of which has different features relevant to the accident process in different problem situations.

Let me take two sections of the population as an example: the elderly and the young. The main features of the elderly are, on the one hand, loss of vision and motor skills, but on the other hand a good idea of their limitations, even a tendency to underrate their capabilities. They will try to compensate for these limitations as far as possible in their traffic behaviour, choosing off-peak times and quiet, well-known routes for travel and a relatively low speed (anticipatory behaviour).
Because of this overcompensation the elderly are not often involved in unilateral crashes. In complex encounter situations, e.g. when turning left (hampered by a stiff neck) or at complex intersections, their visual and motor skills are inadequate. They are not able to compensate (reactive traffic behaviour) by adopting a low speed or high level of attention, since they have already done this. Obviously it is in complex situations of this kind that the elderly tend to become involved in accidents.

The elderly also have very low resilience: the severity factor is much higher among them than among the young. If we look only at the fatal accident figures there is a risk of overestimating the accident risk.

Measures for the elderly needed to be designed to help them avoid complex situations, e.g. by indicating special routes for them on which complex situations are absent or scarce. If this cannot be done, certain traffic situations must be simplified.
As regards education, they should above all be taught how to cope with difficult situations, given tailor-made strategies, not told how to improve their acceptance of risks, as many educational programmes wrongly try to do.

If we compare the elderly with young road users, we find a completely different picture. They have good visual and motor skills but are particularly deficient at the cognitive level (they are inexperienced) and in acceptance of risks, the latter mainly because they overestimate their capability to react quickly or perform emergency manoeuvres. This means that they make little if any compensation for deficiencies in their behaviour (speed, level of attention, choice of route, travel timetable etc). Consequently they tend to become involved in unilateral accidents more than in accidents in complex traffic situations.

In their case measures need to be designed above all to reduce speeds (e.g. "sleeping policemen", road narrowing or realignment, even a ban on driving in fast cars).

They are very resilient, so the severity factor is relatively low. In terms of fatal accidents only this produces and underestimate of the accident rate.

I have tried to show with these examples that it is necessary to identify homogeneous problem groups in similar problem situations on the basis of functional factors relevant to the accident process. This can be achieved by using the theories relating to each phase of the accident process to collect and classify selected data on reality. We have to realise that observed facts and theories are inseparably linked. A theory acts like a lens, selecting facts from reality and distorting them. Even the police, who collect accident data, use theories just as much as do highways administrators or researchers. Clearly, if every authority applies different conceptions and theories to observation the result cannot be ideal.

I trust that you will have gathered from my argument that knowledge of conceptions determines the subsequent knowledge levels. The conception determines what methods and techniques have to be used, what data collected. In the monocausal approach the emphasis was on "before" and "after" studies, case-controlled or otherwise, and in-depth studies; also on the listing of "principal causes".
The conception chosen determines knowledge level 4 (parameters or conditional statements), and the extent to which, and form in which, pronouncements can be made at level 5 (the rules and recipes).

It will be realized from the foregoing how important it is for all the authorities that have an influence on road safety - and there are many - to apply the same conception. It is the lack of coherence between all the decision-makers that has become a critical issue, pointing to the need for a common conceptual framework for the control of road safety so that all the efforts directed to improving safety can be integrated.
I am convinced that the dynamic system approach, as introduced by me in

the OECD Working Group on Integrated Road Safety Programmes, can provide a solution, albeit the method needs to be developed. I am particularly pleased, therefore, that SWOV has asked me to do this, in my capacity of research fellow at Delft University of Technology.

If we take now a critical look at the "state of the art" of the pre-crash phase, i.e. accident prevention, we have to admit that our knowledge is still very paltry and that research has not yet been very successful. most field studies and experiments (epidemiological research) employ what is known as a macrostrategy, i.e. they are concerned with group behaviour or the consequences of group behaviour, e.g. accidents at certain locations or on certain roads. the advantage of this approach is that the reality value is high (we are dealing with the real world) and that the results can often be extended. the drawback is that the conclusions resulting from a macrostrategy are often conditional, i.e. of little practical value in terms of control strategies: very little understanding of the traffic process and the role of the actors in it, the individual road users, is provided.

Many laboratory experiments and other simulation studies employ a microstrategy, i.e. they look at the behaviour of individual road users in performing certain tasks. It is not just a question of road users following the road, there is particularly the matter of interplay of, and interactions between, the various types of road user to be considered. Road users encountering one anotyher differ in age, experience and type of vehicle (car, bicycle, pedestrian). The conclusions resulting from a microstrategy have a fairly low reality value - they are difficult to verify in the real world - but they are of great practical value. Most measures, and certainly the form in which they are implemented, are in fact based on theories and assumptions on micro-level behaviour (i.e. influence on individual behaviour) which have been subjected to little if any verification.

Now the system approach is based on what I would call the context strategy. It first isolates homogeneous problem groups and situations step by step and then analyses - for instance in the encounter phase - the interaction between those homogeneous groups, e.g. between elderly

cyclists or pedestrians and, in their context, young motorists, given different types of environment (facilities). If this is done well it can be verified in the real world by systematic observation of behaviour or by analysis of accident data. Since this is based on a microstrategy, the applicability to control strategies and resulting packages of measures is great. This enables the enormous gap that currently exists between the results of research, usually based on macrostrategies, and the measures, which are based on theories which have not been verified in reality, to be bridged.

As I said earlier, the context of the elementary system, the individual in or on his vehicle, is largely determined by the administrative body. This is constituted by the large number of official bodies, each with its own purposes and interests, and the millions of road users. Perception, decision-making and action also take place in the administrative body. Here again we need first of all to identify homogeneous groups using a step-by-step strategy, as outlined in the OECD "Integrated Road Safety Programmes" report. Both Horn and Frybourg in their papers today have rightly urged an analysis of the administrative body, or as they call it, the management or policy authority.

This is another area where a kind of phase model needs to be developed, emphasizing the encounter phase, the encounter between the various groups of decision-makers with their different purposes, interests, preferences, capabilities and limitations. Here again emergency manoeuvre strategies will have to be devised, and the crash phase plays an important part. The feasibility - not only political feasibility - and practicality of an integrated programme of measures designed to optimalize well-defined problem situations is the ultimate aim. The various criteria, and thus the weight to be attached by the various groups of decision-makers to the various aspects, such as road safety, feasibility, smooth traffic flows, and also the economic aspects, will play an important role in the development of rational decision-making models. It is also important, of course, to formulate a clear system of objectives for any integrated programme.

In this context central government is only one of the many parts of the collective control mechanism: at civil service level alone there are many administrative strata. Central government should confine itself mainly to its role of creating the right conditions, providing information and coordinating.

A quantitative objective expressed in terms of a reduction in the total number of accidents, victims or fatalities could have a political significance. The actual significance is minor as long as these targets are not comparable with the "reference projection", i.e. the results that could be achieved if there were no intervention. The total number of victims or accidents is no more than a heterogeneous collection of various sub-collections. To what extent changes in the figures are attributable to the implementation of policy is impossible to say without first segmenting them into problem areas etc.
Furthermore, quantitative targets conflict with the spirit of the problem-oriented system approach. Of course, if the setting of a target demonstrably results in more money and efforts being made available to improve road safety, this is a good thing.

I should like to conclude with a few general comments on the nature of scientific research and the characteristics of researchers. Research is normally the fruit of collective brainwork. New ideas and discoveries, on the other hand, are usually produced by individuals. Any new development is usually preceded by a mutual fertilization period, a kind of cross-pollenation. A research organization is in some ways similar to a hothouse: how well things grow there depends to a large extent on the climate. I am convinced that a good deal of the rapid growth of SWOV and the scientific authority it has acquired, both nationally and internationally, have been due to the good climate and the freedom for the cross-pollenation of ideas to take place.

Naturally an organization also has to make sure that it has enough money. Although decisions on an organization like SWOV, whose main client is central government, ultimately rest with the political heads of the government departments, they are guided to a large extent by the civil servants. The organization must therefore satisfy the immediate demands

the help of the Board, in regaining the balance, which seems to have been lost at the moment; I have faith that they will.

I should like to end my remarks by thanking all those who have contributed to this occasion. I shall still see plenty of the Board and staff of SWOV in my capacity of advisor to, and Chairman of, the Scientific Advisory Council. I shall probably not have so much contact with my foreign friends and colleagues, so I should like to take this opportunity to express my thanks for the friendship I have enjoyed in the OECD Steering Committee, and wish you every success for the future. I have no doubt that the Committee will go on to do much good work, certainly as long as Burkhard Horn remains in charge of the secretariat; in my view he has produced work which has been consistently brilliant.