An analysis of the traffic safety phenomenon

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AN ANALYSIS OF THE TRAFFIC SAFETY PHENOMENON

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1. INTRODUCTION

> "One accident with one death is a tragedy for those concerned; one accident with ten or more deaths is a disaster; one million accidents a year with 2,000 deaths and 60,000 injured is a statistic".

In 1980 about 2,000 fatalities occurred and about 60,000 persons were injured in the road transport system of The Netherlands. This most tragic part of the traffic unsafety system was still further enhanced by several hundred thousands of traffic accidents involving exclusively material damages and incidents (near-accidents), whereby the persons involved just "got off with fright".
This image of traffic unsafety does not yet include the number of permanently disabled persons, a number which is added to that of the preceding years, since not all of the injured are ever recovering completely.
However, this bleak image only partly covers the definition of the concept of traffic unsafety for 1980.
Traffic unsafety is a combination of the critical coincidence of circumstances in the traffic of incidents (near-accidents) and accidents with unwanted (permanent) consequences, such as fatalities, injured and disabled persons and material damage.
This definition covers the whole of the critical coincidence of circumstances in traffic. Traffic accidents cannot be always attributed to certain unique circumstances or characteristics of a traffic situation or of persons. There are no specific places one never can pass through without an accident; there are no specific vehicles that are always involved in accidents; there are no persons who always cause accidents nor are there any weather conditions that always lead to accidents. Yet accidents happen, certainly not in each locomotion, but there is undoubtedly a certain critical coincidence of circumstances (so-called situation characteristics) which are the necessary and sufficient conditions that lead to traffic accidents.

2. THE MODEL OF THE ACCIDENT PROCESS

In order to elucidate the phenomenon of traffic (un)safety, accidents and incidents can be analysed. This, as a rule, takes place by statistical methods and techniques, which are focused to establish relationships between the characteristics of the elements of the transport system (road, vehicle, traffic and man) and the risk of accidents. Such analyses also require an insight into sub-processes. This can be explained by the following example.

The characteristics: wide carriageways and sharp road bends are correlated with a high risk of accidents and injuries of the drivers (passengers) mainly at night on a wet road surface. This correlation, however, gives no indication in view of the required measures, nor in view of a possible success, in the change of the characteristics involved in the relationship.

The intermediary processes mentioned in this example, which also play an important part in general, are shown in Figure 1, representing the model of an accident process that takes place at manoeuvre level.

The "provoked" traffic behaviour on the road sector preceding the bend, where evidently a critical coincidence of circumstances can occur, concerns in this case the driving on the road at a given speed and the attention level of the driver. On wide roads the driver will be tempted to drive at high speed. On long straight roads the attention level of the driver is, as a rule, rather low. Motivation of the aim of travel, the choice of vehicle, the choice of route and first of all the travel scheme, have also effect on the traffic behaviour of the driver.

The perception of a critical coincidence of circumstances in case of a sharp bend not only depends on various perception factors like visibility, conspicuousness, recognisability and localisability; the general and specific expectation of the driver plays a part here as well. The general expectation in the given example is, whether there will be many sharp bends in the road the driver travels on. The specific expectation, however, is based on characteristics of the preceding road sector, which can give indications as to the further part of the road. On a carriageway in general no sharp bends are expected. One does not expect a bend on a straight dike road because the major part of the road was straight and not because there are never sharp bends on dike roads.

A critical coincidence of circumstances at a sharp road bend depends on:

- the type of vehicle, the movement characteristics of the vehicle (road holding, braking capacity, steering parameters);
- the characteristics of the road user, such as fatigue, stress, influence of alcohol, sight and age;

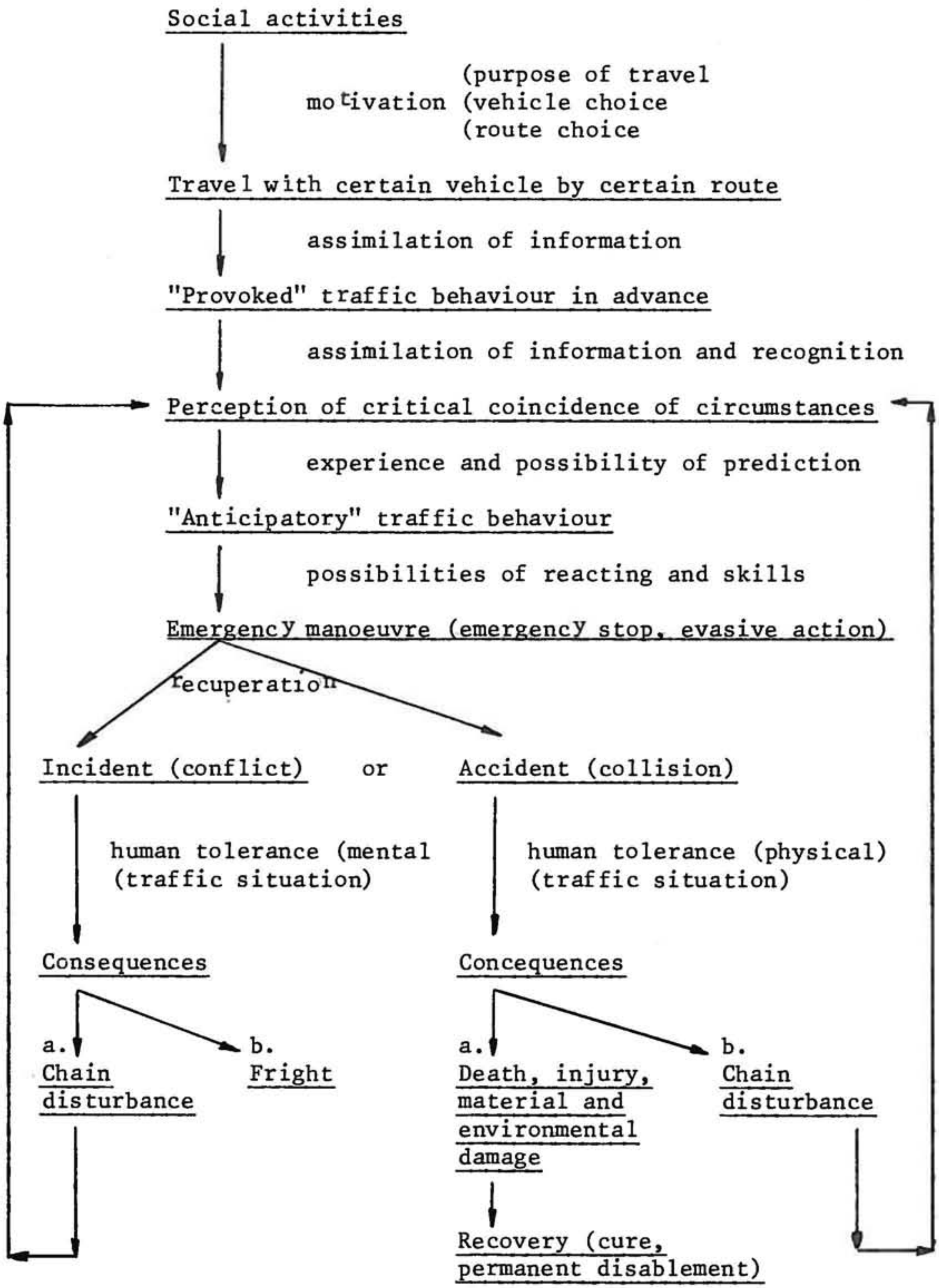

Figure 1. Model of the accident process.

- the "provoked" traffic behaviour on the road sector preceding the bend, such as driving speed and alertness of the driver;
- road characteristics at the place of the bend, such as the bend radius, the width of the road, superelevation and the level of illumination;
- road surface characteristics at the place of the bend, such as skidding resistance, trace forming, drainage and dirt;
- the presence of other vehicles, etc.

In case the bend is perceived in time or in case road signs sufficiently indicate the (sharpness of) bend, the driver will anticipate accordingly, for example by lowering the speed or by raising his attention level ("anticipatory" traffic behaviour).
Whether the driver will anticipate or anticipates to the required extent, depends on the experience about anticipation possibilities with regard to the required behaviour in "negotiating" a sharp bend. These anticipation possibilities depend, in turn, on the information the driver receives from the characteristics of road, road surfaces and traffic in the bend and on the degree to which he can digest this information, among other, in connection with his general and specific expectations.

In case the driver does not anticipate or does not anticipate to the required extent, an emergency manoeuvre will have to be carried out in order not to be "thrown out" from the bend. Such an emergency manoeuvre can be carried out by a slip correction, an extreme steering correction or an emergency braking just before the bend.
The success of the emergency manoeuvre depends on the following factors:
- the steering characteristics of the vehicle, both before negotiating the bend and before the slip correction;
- the road holding and the brake characteristics of the vehicle;
- the reaction capacity and manoeuvring skill of the driver;
- the road and road surface characteristics, such as moisture, skidding resistance, trace forming, superelevation, dirt;
- the presence of sufficient space for the emergency manoeuvre, for example hard shoulder, etc.

If the emergency manoeuvre succeeds, i.e. the vehicle does not skid off the road and does not hit an object on or beside the road, we have to do with an incident (near-accident), which gives the driver only a fright. However, in case the vehicle gets onto the other half of the road, a chain disturbance can develop if there is oncoming traffic thereon. In this way, a critical coincidence of circumstances occurs for this traffic and the entire process begins anew.
If the emergency manoeuvre did not succeed, the vehicle skids off the road or turns over or hits a collision object (obstacles along or on the road, road bank, steep slope or water) and in this case we have to do with an accident (collision).

The outcome of the accident (death, injury, material damage) depends on the following factors:
- the collision characteristics of the vehicle involved (impact safety) and of the obstacle (aggressivity);
- the resilience (human tolerance of the driver and passenger(s);
- in case of lorries still another factor has to be considered: the "behaviour" of the cargo during the sudden slow-down in the collision; the "tolerance" of the packing of the cargo and the effects caused by the cargo falling off or released from the lorry (environmental damage).

The "repair" of the outcome of accidents consists of first aid "in situ", transportation of the injured persons, treatment and cure of injuries, the removal of damaged vehicles and repair of material damages.
A chain disturbance can develop both with oncoming and with following traffic, in both cases a critical coincidence of circumstances will be created.

The theories concerning the intermediary processes can form a stable background for the statistical relationships established and it will be possible to compare the possible countermeasures on the basis of the expectable effects they will have on the intermediary processes. The analysis of these intermediary processes can also be utilised in case there are no statistical relationships at disposal, for example in the investigation of locations and small areas.
In such places there is no sufficient number of fatalities and injured, which would permit assessments based on the usual statistical and technical methods.

3. RELATIONSHIP BETWEEN RESEARCH AND POLICY MAKING CONCERNING ROAD TRAFFIC SYSTEMS

The scientific traffic safety research received a really strong impetus only at the beginning of the sixties.
From this time on, both social and political interest in traffic safety increased steadily. Such intensified interest has two reasons: in the first place, there is a general trend to increase not only prosperity, but well-being of society as well. In the second place, life and well-being are threatened to an ever increasing extent by the systems, which become more and more complex and extended and which surround us and which we all are integrated parts of, like for example the road traffic system. The development of damaging consequences is not under a sufficiently effective control. And this is not at all surprising.
The transportation system, in it present form and in its functioning, is, in fact, the work of monodisciplinarily operating scientists and decision makers. Town and transportation planners decide which roads should be built and where; traffic experts decide how the roads should be designed, road builders decide how these roads should be constructed and of which material. Vehicle experts decide how vehicles should be designed and function; behaviour scientists and legal experts decide how the roads and vehicles should be used. Strictly speaking, everybody operates independently from the other, more or less without understanding the coherence of the system. And the road users, who - as it will be slowly known at last - has only limited possibilities of perception, decision making and acting and has to live in a road transport system, which clearly displays the traces of the fact that the responsible decision makers did not take into consideration the interaction between all the factors involved, i.e. the road, the vehicle, the traffic, the man and environment.
For a long time the aforementioned researchers and decision makers did not take into account that the road traffic system is defined as the whole of elements or entities, which mutually influence one another and which are arranged according to a plan in order to achieve a certain goal.
It is evident that not everybody can be engaged in the entire traffic system and that sub-systems will have to be distinguished in study and control. However, with regard to the aforementioned interactions between the factors, it is of great importance to make clear distinction between the sub-systems.
Before starting investigations and establishing possible measures, a structural analysis of the problems has to be carried out and the following questions must be answered:

a. What is the problem or the process to be controlled?

b. What for and why should it be controlled?

c. How and where should it be controlled?
d. Who controls what and where?

The decision maker, as a rule, is inclined to start with "how". Also, people, politicians bear pressure on the decision makers in order to come to measures, but not in order to solve problematic situations. As a result, it often happens that solutions are sought for problems which, actually, are not sufficiently known and most certainly not from the social view point.
And yet, finally it is the society which pass judgement whether certain developments are acceptable or not.
The question arises, whether traffic unsafety can be attributed alone to the lack of coordination between planners of towns and transport systems, traffic experts, road construction engineers, car experts, behaviourists and legal authorities. Or, is not the insufficient realisation of the interactions between man, vehicle, road, traffic and environment in the first place responsible for the present traffic unsafety?
Both aspects play a certain part, but they are not the only and main conditions of traffic unsafety; there are other "mechanisms" which must be taken into account as regard traffic unsafety and we shall discuss them in a simplified form. These mechanisms are related to the "control" of the transport and traffic system on the one hand and to the decision making and learning strategies of men on the other hand. It must be evident that these mechanisms influence one another. A lack of knowledge concerning the decision making and learning strategies of man can have a most unfavourable effect on transport and traffic without this being still "visible".

4. CONTROL OF THE TRANSPORT AND TRAFFIC SYSTEMS

The "control" of each complex system of a high order of magnitude, such as the road transport system, proceeds in fact very slowly. Michon compares the control of the road transport system with the steering of a fully loaded mammoth tanker. If the wheel of such a vessel is radically swung around, the effect (change of course) will not become noticeable for a long time!

1. The slow response of the steering system, the causal lag, whereby the reaction of the mammoth tanker will become noticeable only after a certain period of time (cf the limitations of statistical registration of developments in the traffic system, like the registration of accidents);
2. The limitations of human perception ability, whereby slow, small changes are not signalled or are signalled only incompletely (cf limitations of statistical analysis for disclosing changes in the pattern of accidents).

The moment the output changes can be perceived, it is already too late both on the mammoth tanker and on the road to take effective corrective action. Ships' captains therefore do not respond so much to changes in the ship's course (output variable; cf of accident statistics) but anticipate changes in output by responding to data on intermediate processes (process variables, such as speed, position of helm, direction and speed of currents, etc.). This is possible because they have sufficient knowledge and comprehension of the relationship between changes of the steering wheel (control variable) and the process variables and the influence thereof on the change of course (output variable). Thus, they do not wait until the moment the change in course completely manifests itself, but they always act on the basis of changes in process variables.
Ships' captains have acquired this knowledge from experiments or simulations in which real situations were examined or simulated. This form of control does also require regular "position finding" in order to verify and adjust that from "dead reckoning". In terms of the transportation system this means that output variables (accident data) have to be measured in order to verify the predicted relationship between process variables and output variables (increase of knowledge).
The steering mechanism is focused on control variables of the road transport system (characteristics of the road, vehicle, man, traffic, environment, etc.). In the same way as described above, the control can be focused on input variables, for example changes in the need or demand for journeys in general or with a specific mode of transport.

5. DECISION AND LEARNING STRATEGIES OF MAN

The second mechanism concerns the decision and learning strategies of man.
Unfortunately we still can observe that technical experts display much too optimistic stereotype opinions with regard to human behaviour. These experts only find that man's behaviour is not "adjusted" to the surrounding they have created in a satisfactory manner. They simply hope that others will be able to improve the "mentality" of road users.
The design of a complete picture of the decision and learning of man as road user/traffic participant would take us much too far.
We have to confine ourselves to some salient points, which up till now were neglected in the shaping and establishing of circumstances within which man has to function in a given system.

1. Man is an adaptive, information absorbing being, who can adapt himself more or less flexibly to his surrounding and who is characterised by a (very) limited, not entirely constant, ability. This will be explained by the following examples.
On a winding narrow country road outside the built-up area, drivers, as a rule, will drive at high speed only seldom. On the contrary, on a wide, straight asphalt road the drivers will drive at high speed, even if the road leads through a residential area and in spite of the 50 km/hr speed limit.
The question now arises, whether in this case the car drivers behave themselves irresponsibly (irresponsible behaviour) or whether the designers of the road acted in an irresponsible manner. Obviously, the circumstances prevailing on the country road promote the behaviour adapted to the circumstances, while the circumstances on the asphalt road fail to do so.
After accidents one can often hear remarks like "I have not seen the bend" or "I saw the pedestrian too late".
Information over the presence of a bend or of a pedestrian is more or less always available. And yet, this information does not penetrate the human brain or not to the required extent.
If something is <u>not</u> expected, the certain information will sometimes not be received which means that the picture received by the retina is not transmitted via the nerve system to the brains. This phenomenon may also occur under the effect of temporary physiological conditions, motivation, etc.
Subsequently, there is a selection in the brain from all "penetrated" information. In this event earlier collected memory content plays an important part, for example specific "stored" experience with identical or similar situations. Information which does not

link up with memory and also information, which is opposed to motivation, will be discarded.
Only information which is really received, i.e. information which passed through cell "filters" of eye, brain and memory, will be processed into a decision.

2. Man bases his decisions on the principle of benefit, i.e. he weighs the advantages of a manoeuvre or activity against the drawbacks (risks) thereof. The context of this assessment is the motivation resulting from the aim of activity.
Investigations into the parking habits of business men proved that they are easily tempted to park illegally when they have to get to a meeting on time, ignoring the expected fine, while they will park correctly and even at considerable distance from their destination if necessary, when they do their shopping in their own time.
Quite often behaviour is prescribed by rules for situations wherein and unwanted behaviour is more attractive on account of created circumstances than the prescribed one.
If we take into consideration the fact that locomotion is some kind of sacrifice which has to be made in order to carry out somewhere a certain activity, it can be expected that all endeavours will be undertaken in order to mitigate this sacrifice as far as possible. This can concern both the time which one will save and the distance which one will reduce.

3. Man perceives the risk (phenomenon of chance) he is exposed to in traffic hardly or not at all. This means that traffic risks play, as a rule, only a small part in assessments, which are based on the benefit principle.
The risk per journey of getting involved in an accident (causing injuries) is 1 to 150,000, the risk of being killed in an accident being 1 to 5 million. The risk of being injured or killed per travel mileage is still lower.
Only specific experience gained in special risky situations will have influence on decision making in similar situations, provided the information about such situations is linked up with the memory content stored up earlier.

4. The aforementioned considerations will prove that the perception and, mainly, the recognition of a possible critical coincidence of circumstances, the adequate anticipation and reaction closely depend on the experience gained in real world traffic. We could call this a learning process in reality. Road users are often accused of being "slow learners", but the decision makers, technical experts can rightly be accused with this as well.
The question is whether the traffic system is established and controlled in such a way which permits optimum and efficient learning for the road users. Learning consists of action, repetition, making errors, but also of understanding. Learning may also mean "conditioning".

In the first place learning is based on experience gained in earlier or specific situations (action and repetition). Road users can only learn in case there are "specific" situations. Consequently, collective decision makers on various governmental levels and in various areas cannot give unlimited freedom to their own creativity.

It is necessary to coordinate various activities which must be suitably adjusted to one another. It is evident that road users move through all hierarchical governmental systems and control areas. Actually, in road and traffic situations only functional differences could be accepted, which can easily be recognised by the road users, for example in case the differences are in connection with a classification of the roads in clearly identifiable categories. In this case the road user can adjust his traffic behaviour to the road and traffic circumstances.

The learning process also includes experiments with novel traffic situations (like "woonerf"). We still don't know, how all this will develop. At the start of these experiments no hypotheses have been established with regard to the expected behaviour of the road user in all intermediary phases of the model of the accident process. Therefore it is also problematic, whether these experiments will provide information which could improve the learning process.

In the analysis of faults made we have to realise that the road user will recognise a certain decision and action as risky in case these provide a real feeling or experience of risk, for example getting frightened or fined. Rarely occurring events with various outcome will hardly - if at all - contribute to the learning process. An accident with serious outcome will also impede learning, because according to the popular jargon, "the memory is blocked by the shock".

The question now is how powerful the effect of a faulty action must be in order to teach something useful to the road user without all too much harm.

There are clear indications that incidents or conflicts have a strong effect on the learning process. The effect of faulty action is immediately fed back through getting frightened. A fine (if immediately imposed) can also positively contribute to the learning process. However, the fine (penalty) must be accepted as reasonable so that it does not aggravate the serious outcome of an accident.

A high priority must be given to measures focused on the limitation of the consequences of risky actions. This also means that possibilities must be created for emergency measures. These possibilities must be practically applicable. They require certain skill from the road users. Actually, all this involves the conditioning of the driver, to be able to carry out certain actions under threatening circumstances, simply as reflexes. For this purpose various types of emergency measures have to be regularly trained. This is already well known in the training of pilots.

Finally, understanding is an important factor of the learning process. Road users must know and understand the functioning of the traffic system. He must know why his car will skid, he must know what a

lorry can or cannot do, he must know that a bicyclist will sway at low speed. In the first place the simultaneous actions of various categories of road users need more knowledge and comprehension both with regard to the proper (vehicle) behaviour and to the (vehicle) behaviour of the other persons involved. Such increased knowledge and comprehension would favourably contribute to the improvement of traffic safety.
The control mechanism of the traffic system (as mentioned before) acts slowly and brings about visible results (the final results: the output variables) only after a certain period of time.
If we realise that man in the traffic system enjoys several degrees of freedom but that he also is under many limitations, further, if we accept that opinions concerning human behaviour are much too optimistic, it will be evident that correcting manoeuvres are necessary already in a very early stage.
Therefore measures and indicators have to be developed to make this evident.

6. MEASURES AGAINST UNSAFETY

Indicators must be certain criteria for a given problem. The entire traffic system will be investigated only seldom. We investigate sub-systems and even aspects thereof, like traffic unsafety at intersections in bicycle traffic, etc. Therefore, the choice of sub-system limits is very important for the proper use of indicators. We shall elucidate this with the following example.
In the road net of a traffic controller there is an intersection, where accidents occur relatively frequently with many fatalities and injured (this is a problem formulation, based on output variables). Actually, there is no sufficient perception of the critical coincidence of circumstances. This is supported by the lack of "anticipating" traffic behaviour, since in several cases there was no braking before the intersection (this is a problem formulation based on process variables).
The road controller intends to solve the problem by installing traffic lights (measure).
In some cases this seems to improve traffic safety. Some times however the effect does not come up to expectations.

What is the effect of such measure on the accident process and the final outcome? (See again Figure 1).
Installing traffic lights at one intersection will not deter road users from making as many journeys nor will they change over to a different mode of transport. What they may do, is to select a different route to avoid the traffic lights. We must therefore know the input indicators for the intersection; for instance the number of approaching and passing vehicles. But we must also look beyond the intersection for other roads (extension of system boundaries) whether the input indicators increase there more traffic on this roads.
In the affected area the changes of process indicators and output indicators, caused by the measure, have to be investigated, furthermore the input variables increased thereby.
With regard to the intersection proper the effect of the measure (installing traffic lights) will manifest itself in the phase of route selection; the same number or fewer approaching vehicles.
The effect of fewer approaching vehicles in the phase of traffic behaviour "provoked" in advance may be: higher speeds.
The effect of higher speeds in advance may be: poorer observation of critical coincidences so that these are anticipated too late or not at all. An emergency manoeuvre (emergency stopping) may then still prevent a collision, provided the road surface there has sufficient skidding resistance. This implicates more accidents (for example through normal braking).

This is a rather pessimistic example of the possible effects of the measure taken.
There are actually hypotheses which can be tested realistically.
Other hypotheses are that
- fewer approaching vehicles, when traffic lights are inflexibly regulated, may even result in more people driving through the red lights, often with very serious consequences; all phases of the accident process then have a negative rating;
- higher speeds in advance without anticipatory behaviour influence negatively the success of the emergency manoeuvre;
- traffic lights may bring about a different kind of critical coincidence of circumstances, not because of the intersecting traffic but because of the queue at the traffic light that is being approached;
- in case the anticipation and emergency measure fail (emergency braking and/or evasive action), there will be another kind of collision, i.e. head-to-tail impacts instead of flank impacts at the intersection;
- the effects of head-to-tail impacts are often less serious than those of flank collisions (in connection with the place of crumple zones).

If we want to know the effects of such measures, we have to develop the following kinds of indicators: (both of the intersection and the influence area)
- input indicators, for instance approaching vehicles (whether or not per unit of time);
- process indicators for "provoked" traffic behaviour in advance (concerning speed), for observing critical coincidence of circumstances (concerning mental activation level), for "anticipatory" traffic behaviour (concerning changes in speed), for emergency manoeuvring (concerning deceleration and/or change of course), for crash behaviour (concerning impact decelerations);
- output indicators (concerning the number of vehicles in accidents, number of persons in accidents, number of fatalities and number of permanently disabled).

In case comparisons have to be made between other circumstances (places, conditions, categories of road users, etc.), and various periods of time (developments prior to and after the measures, etc.) and in case the indicators have to be linked up with theories over intermediary processes, the input, process and output variables have to be related to the characteristics which play a role in the comparison.

7. EXAMPLE OF A SET OF OUTPUT INDICATORS

Output indicators for traffic unsafety mostly express a kind of risk, that's to say a chance on an accident or a chance to be killed per inhabitant, per persons-kilometres of travel, etc. Thereby it has to be realised that not all of the possible output indicators are significant in view of the problem formulation, the choice of sub-system limits and the kind of the phenomenon in question.
An output indicator number of casulties/number of vehicle km comprises incompatible values and consequently it is actually useless. One vehicle may have more occupants and one accident may involve several vehicles. Such an output indicator gives hardly a clear picture of the accident.
An indicator number of fatal accidents/number of vehicle km can also give a badly distorted picture. For instance a bus has a comparatively large number of fatal accidents per vehicle kilometre (about 4 times higher than a private car), the victims mostly being the other parties, especially pedestrians. This does not mean, however, that replacing buses by cars would make the roads safer. The high occupancy of buses (an average of twenty persons) and the low occupancy of cars makes one bus equivalent to about ten cars. These cars together will cause more casualties than one bus.
There are always several indicators needed for the description of a phenomenon.
Figure 2 gives an example for a set of output indicators.
The indicator number of casualties/number of persons involved links up the traffic system with the social system and facilitates comparison with threats to society.
Each indicator has a certain significance, i.e. if properly selected it links up with certain theories and models.
The output indicator for the accident occupancy: number of accident persons/number of accident vehicles links up with the theory claiming that the number of occupants affects the driver's possibilities of perception and may even influence the "provoked" traffic behaviour in advance and the "anticipatory" traffic behaviour (in an adverse sense).
The indicator for the accident severity: number of casualties/number of accident persons links up with theories of human tolerance. If old people are involved in an accident this indicator will turn out very unfavourably (low human tolerance), since this age category displays, as a rule, a reduced tolerance.
The shown set of indicators provides the possibility of obtaining a clear interpretation of the unsafety of the whole traffic system on the basis of various problems and from various approaches, at the same time providing a framework and an incentive for the planned collection of data.
Mostly, specifications of these indicators are necessary and we have

General set (tautology): $T = m \times o \times ac \times ao \times as$

$$T - \frac{\text{number of casualties}^{*}}{\text{number of persons involved}}$$

$$m = \frac{\text{number of traveller kms}}{\text{number of persons involved}} \quad \text{(mobility)}$$

$$o = \frac{\text{number of vehicle kms}}{\text{number of traveller kms}} \quad \text{(occupancy)}$$

$$ac = \frac{\text{number of accident vehicles}}{\text{number of vehicle kms}} \quad \text{(accident complexity)}$$

$$ao = \frac{\text{number of accident persons}}{\text{number of accident vehicles}} \quad \text{(accident occupancy)}$$

$$as = \frac{\text{number of casualties}}{\text{number of accident persons}} \quad \text{(accident severity)}$$

Specific set for car traffic:

$$T = \frac{\text{number of car casualties}}{\text{number of car users}}$$

$$m = \frac{\text{number of traveller kms of car users}}{\text{number of car users}}$$

$$o = \frac{\text{number of car kms}}{\text{number of traveller kms of car users}}$$

$$ac = \frac{\text{number of accident cars}}{\text{number of car kms}}$$

$$ao = \frac{\text{number of accident persons in car}}{\text{number of accident cars}}$$

$$as = \frac{\text{number of car casualties}}{\text{number accident persons in cars}}$$

*casualties: killed and injured; only killed or only injured.

Figure 2. Examples of a set of output indicators.

to break down the transportation system in sub-systems, such as the various modes of transport, different age groups, various smaller or bigger areas (localities, regions, etc.), and the various type of confrontation such as car/bicycle, bus/pedestrian, and so on. Practice proves that at present no sufficient data are collected for defining output indicators for certain situations.

8. COHERENT TRAFFIC SAFETY POLICY

A policy focused on the promotion of traffic safety becomes visible as the consequence of measures in areas related to traffic safety. As a result, traffic safety policy, with regard to execution, has hardly an independent character. Traffic (un)safety is first of all, the effect of means and instruments, shaping another policy. Nevertheless, traffic safety policy should be formulated as an independent policy in order to realise satisfactory coherence in other policies as regards the traffic safety effect. For this reason traffic safety policy should be based in the first place on starting points, aims, measures and fringe conditions, which have to be taken into account. In this way it can be achieved that policies referring to town and country planning, traffic and transportation, police, etc. are formulated and carried out so as to realise optimum traffic safety effects.
Furthermore, it should be clear by now, that permanent evaluation and feedback are inseparable factors of traffic safety policy. Traffic safety effects which are consequences of imposed measures in other policy areas should be permanently controlled, whether they have positive influence on traffic safety and if not, which measures have to be taken in order to evade or cancel negative effects.

Traffic safety policy has a normalising character. This means that traffic safety effects in other policy areas have to be systematically noted, while at the same time it has to be established which traffic situations are unacceptably unsafe, in order to apply the scarcely available means in the most appropriate manner. The starting point is that the road users have to be protected against accidents and for this reason an integrated approach must be made to the "man-vehicle-road" system.
Traffic safety policy should not only be aimed at the promotion of objective traffic safety; subjective traffic unsafety has to be taken into consideration as well. At present studies are made, how this can be achieved.

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