14. Relationship between accidents and road user behaviour: an integral research programme

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The analysis of accident statistics and the study of road user behaviour are the traditional methods of road safety research. Neither of these involve direct observation of accidents. A research programme has been designed to gain insight in the generation process of traffic accidents as well as to compare the traditional methods of road safety research. The first goal asks for long term day and night video recordings at a number of locations. In view of the second goal other methods of research have to be applied at the same locations. This kind of research has been called the integral approach.

The design of the programme will be presented and the value of video recordings will be illustrated by three recordings of actual accidents.

14.1. TRADITIONAL APPROACHES OF RESEARCH ON TRAFFIC SAFETY

Research on traffic safety takes the form of analyses of accident data or the study of road user behaviour. Both approaches have their advantages and disadvantages. The registration of accidents is limited in number as well as in the type of information. Many accidents (the less serious ones in particular) are not recorded. Circumstances, the sequence of events and the behaviour of road users in accidents are recorded in general terms only. Accident data can be complemented with observations at the spot or interviews with eye witnesses. This can only be done on a small scale and necessarily only some time after the facts. In summary, this approach is more concerned with the consequences of accidents than with the accidents themselves. The behaviour of road users can be studied in a number of ways. The most serious limitation lies in the fact that all this behaviour does not result in real accidents. The aim of research on traffic safety, however, is to gain insight in the occurrence of accidents as a result of the behaviour of road users in their actual traffic situation. This limitation is only partly resolved by choosing the conditions of behavioral studies in accordance with accident statistics. In summary, this second approach is directed at events that have at best a tendency to result in accidents. Knowledge about the generation of accidents is obtained by combining the results of both approaches, neither of which involves direct observation of accidents.

14.2. THE INTEGRAL APPROACH

In this situation there is a need for research in which accidents are studied in a direct way. Together with other institutes SWOV has elaborated the design of such a research programme. The goal of this research is to gain insight in the generation of traffic accidents as well as to compare the traditional methods of road safety research. The first goal asks for long-term video recordings during day and night at a number of locations. In view of the second goal other methods of research have to be applied at the same locations. This kind of research has been called the integral approach.

14.2.1. Selection of locations

The design of the proposed research programme has to meet a number of requirements, the first of which concerns the selection of locations. A number of locations is needed with a high number of accidents per time unit. Furthermore, these accidents should resemble each other in some ways and be different in other ways. Preferably, these accidents should represent a large proportion of all traffic accidents. Based on these considerations a choice has been made of urban intersections with high traffic volumes, partly with traffic lights, partly with priority signs. 20% of all serious traffic accidents occur at such locations. It has been estimated that in one year time ten of these intersections will have about hundred accidents, about thirty of which serious enough to be recorded by the police.

14.2.2. Selection of methods

The research methods to be applied in this programme have to be already proven in practice. They should also have a wide range of application. Finally they have to show essentially differing elements between them. Based on these criteria, a small number of methods has been selected. Traffic counts will be made from video tapes. Video recordings will also be analysed by measuring the Time-To-Collision (TTC): the time that is still available before two road users will meet at the same time at the same spot (provided neither of them takes evasive action). The length of this time period differentiates between encounters and conflicts. This method also measures the exact position, speed, change of speed, direction of movement and change of direction at successive moments in time (van der Horst, 1990). Additional video recordings will be made for the analysis of head movement data. Two other methods of conflict analysis will be applied based on human observations at the road side. One of these is DOCTOR (Dutch Objective Conflict Technique for Operation and Research), a method which can be seen as the 'subjective' counterpart of the video-based TTC method (Kraay, van der Horst & Oppe, 1986). The other method is a completely subjective judgement of the danger of an encounter in traffic (Kruysse, 1990). A totally different method is the reconstruction of accidents by means of road side inspections and interviews with eye witnesses some time after the accidents: the in-depth accident investigation (Stoop, 1991). Finally, all accidents and serious conflicts which are going to be recorded will be analysed by a team of traffic safety experts. This analysis includes an interpretation of the behaviour of the road users in terms of motivation, information seeking, decision-making and internal representation of the traffic situations. This, of course is not a standard method of safety research since such recordings have not been available before (with a few exceptions).

14.2.3. Selection of observation periods

Apart from the latter two methods, the application of all the other methods must be restricted in time to one or more relatively short periods of observation. These periods must have a high number of observable events per unit of time. This requirement has been translated as a high number of accidents per unit of time. Again, these accidents should preferably represent a large proportion of all traffic accidents (at this kind of locations). Accident statistics show that a first choice consists of the afternoon hours of weekdays during daylight. 40% of all serious accidents at urban intersections occur during these hours. To obtain a sufficient number of conflicts at each location, observations should last four days as a minimum.

14.3. ANALYSIS OF VIDEO-TAPED COLLISIONS

To demonstrate the approach of analysing the sequence of events that finally results in an accident directly from video, in this section three examples of video-taped collisions will be discussed. Collisions 1 and 2 were accidentally recorded during video-observations of road user behaviour in The Netherlands. The third collision was registered during an accident-recording study by the City of Helsinki with similar objectives as our proposed integral approach. In a period of 11 months they collected 9 accidents on tape. At another intersection 2 accidents were recorded within a one month period. The procedure in Helsinki to collect accidents required that there was made reference of an accident to the police. We anticipate a selection procedure that also enables the storing of minor collisions without the involvement by the police.

14.3.1. Rear-end collision at roundabout

The first example consists of a rear-end collision between two cars at a leg of a large-scale roundabout with roundabout traffic having right of way (Figure 1).

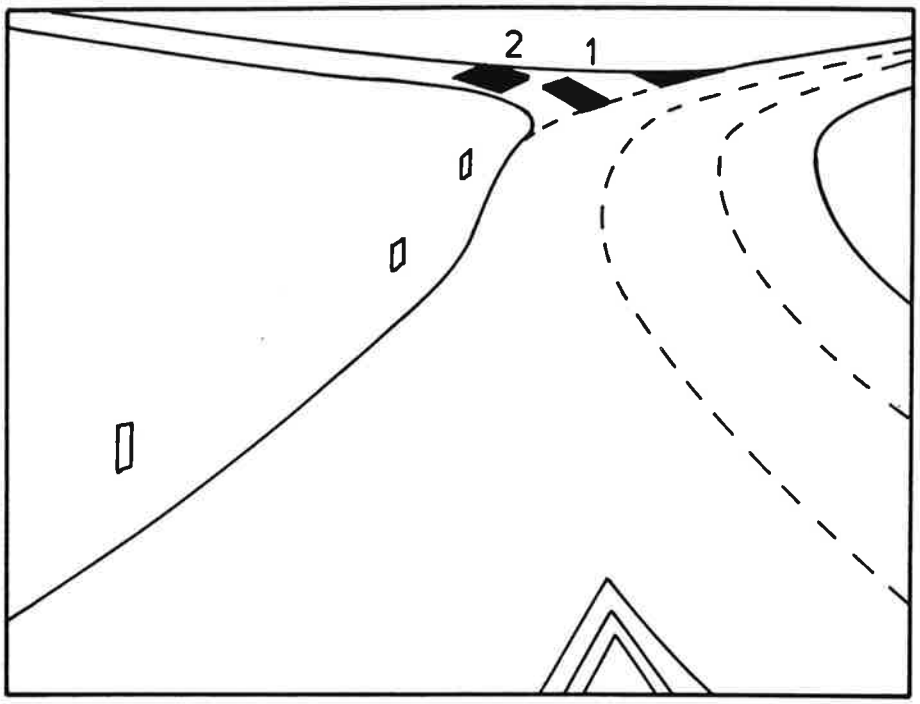

Figure 1:
Collision 1, rear-end car-car at a roundabout.

14.3.1.1. Accident registration

The information that most likely is available from the accident statistics (if registered at all!) is very limited and will probably only include: rear-end collision, car-car, at roundabout, some information on road and light conditions, damage-only accident.

14.3.1.2. Police report

If the original police report is accessible, some additional information may be available, such as a rough situational drawing, the direction the vehicles involved are coming from and going to, and as the reason why the accident occurred 'insufficient distance keeping'.

14.3.1.3. Event description from video

The vehicle in question (VEH1) is approaching the roundabout at a low speed, while the second vehicle (VEH2) is nearing VEH1. VEH1 is preceded by three vehicles that enter the roundabout in front of him. VEH1 stops (as does VEH2) for a vehicle at the roundabout, gives way to six other roundabout vehicles, accelerates for a very brief moment, but then waits for a seventh vehicle. VEH2 starts to accelerate at the moment VEH1 makes his small movement, and runs into VEH1 that stopped again. VEH2 pushes VEH1 several meters forward.

14.3.1.4. Subjective interpretation

VEH2 is nearing VEH1 with a relatively high speed. From the rather abrupt slowing down one may conclude that the driver of VEH2 is in a hurry (or is an aggressive type of driver). Apparently, VEH2 orientates himself towards the seventh vehicle on the roundabout, once he got the 'go' signal from the small movement of VEH1. VEH2 is missing the second stop by VEH1. The obtuse connection to the roundabout may well be contributing to the occurrence of this collision.

14.3.2. Right-angle collision at priority intersection

The second collision is of the right-angle type at a priority intersection (Figure 2).

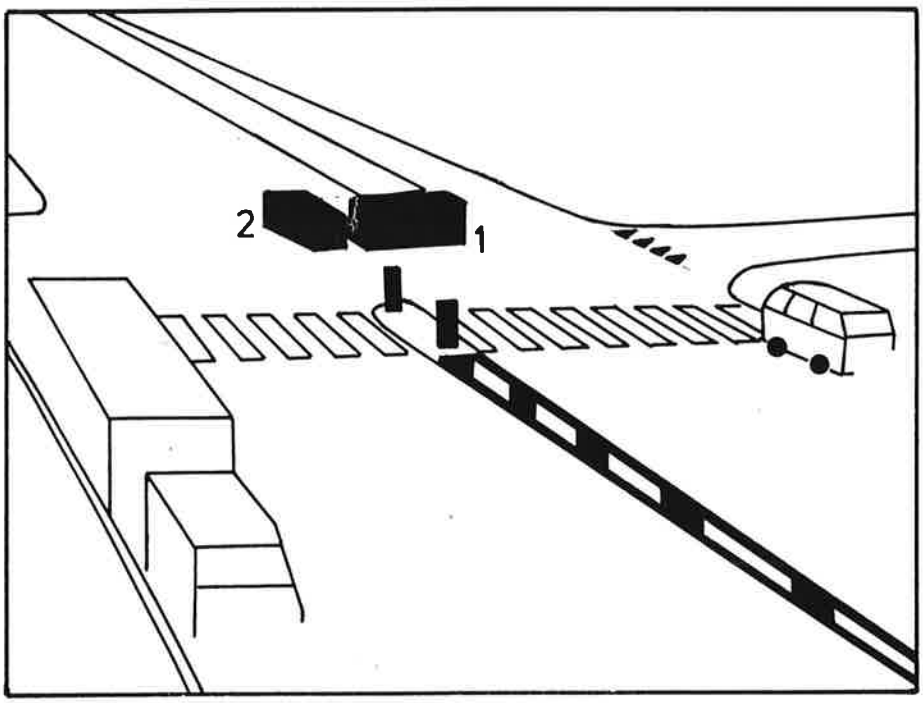

Figure 2:
Collision 2, right-angle accident at a priority intersection.

14.3.2.1. Accident registration

Information from the accident statistics on this accident comprises probably only the following items: car-car, right-angle collision, failure of giving right of way, damage only.

14.3.2.2. Police report

A raw situational sketch that is often included in the police report, may indicate the directions the vehicles involved are coming from, who was failing to give right of way, and sometimes the type of intersection is mentioned.

14.3.2.3. Event description from video

The vehicle from the minor road (VEH1) is approaching the intersection with a normal speed, comes almost to a full stop at a place beyond the yield markings on the road pavement. A vehicle from the left (VEH2) starts braking for about 1 s at 3 s away before the actual collision occurs, but accelerates again after VEH1 has reached a very low speed. At the moment VEH2 is just in front of VEH1 (and a third vehicle coming from the right is just entering VEH1's viewing area), VEH1 accelerates and runs into the right side of VEH2. VEH1's view to the left is restricted by a van that is parked at the corner for about 10 minutes.

14.3.2.4. Subjective interpretation

The reason why VEH2 starts braking may well be that he is probably anticipating a potential right of way error by VEH1. He concludes from the near stop by VEH1 that he has been noticed and decides it is safe to proceed. The driver of VEH1 is displaying behaviour that is rather typical for a normal right-hand-rule intersection, viz. that one only is looking to the right in search for other vehicles (Janssen et al., 1988). So he may have missed VEH2 completely either because he was not aware of the vigorous priority regime at this particular intersection, or because he looked at the left too early. It seems as if VEH1 decides that it is safe to accept the gap in front of the vehicle from the right, while completely overlooking VEH2. From this event it is clear that several measures for improving the intersection lay-out can be proposed.

14.3.3. Car-pedestrian collision at zebra crossing

The third example deals with a car-pedestrian accident at a signalised intersection (Figure 3).

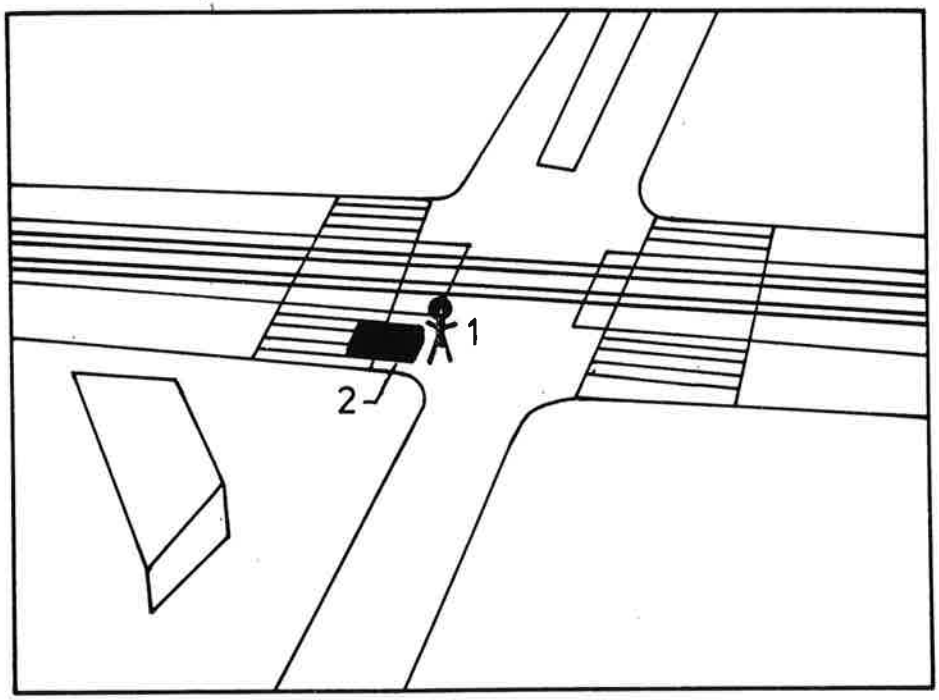

Figure 3:
Collision 3, car-pedestrian accident at zebra crossing of a signalised intersection.

14.3.3.1. Accident registration

Accident statistics would probably provide you with the following data: pedestrian-car collision, injury accident, zebra crossing involved, pedestrian from the left was running the red light, slippery road surface.

14.3.3.2. Police report

The police report would probably give some more details, such as at which zebra crossing the accident occurred, perhaps that the pedestrian started crossing all at a sudden, and, consequently, the car driver was not able to avoid a collision.

14.3.3.3. Event description from video

At a dual carriageway intersection with a wide median containing streetcar tracks, two pedestrians enter the first carriageway zebra near the end of green (that can be deducted from the behaviour of other road users). They also cross the median, but wait at the median curb of the second carriageway. A number of cars is waiting for making a left turn. For a relatively long time no straight-on traffic is present. All at a sudden one of the pedestrians starts running just at the moment a vehicle is approaching the zebra crossing on the left straight-on lane. The vehicle starts braking at a very late moment just before the frontal collision with the pedestrian occurs. A vehicle in the right lane is able to brake in time for the pedestrian lying on the road.

14.3.3.4. Subjective interpretation

While looking at this accident, one may wonder why the pedestrian starts running so suddenly. A plausible explanation is that he wants to catch the bus across the road. A careful inspection of the bus behaviour reveals that the bus moves forward a little bit just before the pedestrian starts running. Similar to collision 1, it seems as if relatively small movements in an expected direction people already trigger and focus on one particular sequence of actions that, once started, are difficult to interrupt. Moreover, the line of waiting left-turning cars together with the absence of straight-on traffic for a relatively long time may well have the pedestrian let come to the conclusion that the signal for the cars already had turned red.

14.4. CONCLUSIONS

The traditional approaches of traffic safety research (analysis of accident statistics, behavioural studies) do not involve direct observation of accidents. As a result the chain of events and the behaviour of road users resulting in an accident can only be hypothetically inferred. Long term video recordings open the possibility for direct observation of accidents. An integral research programme has been designed with long term video recordings, together with traditional methods.

The value of video recordings of accidents is illustrated with three cases, showing that the recordings:

- provide detailed information on circumstances and chain of events,
- can be analysed with quantitative measures (e.g. Time-To-Collision), and
- can be used for a detailed, subjective interpretation of the behaviour of road users.

The integral approach cannot be applied as a standard method, but will lead to a more appropriate application of traditional methods (such as conflict observations), based on a better theoretical understanding of the generation of accidents.

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