5. TRAFFIC CONFLICTS AS INDICATORS OF PEDESTRIAN SAFETY IN A *DRIVE* PROJECT

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5.1 THE PYRAMID OF TRAFFIC EVENTS AND THE ACCIDENT - CONFLICT RELATIONSHIP

Interactions between road users can be described by different elementary events, from undisturbed passage through encounters and conflicts of different seriousness to accidents. The probability and by that the frequency of the different kind of events is different. Simplified the relations it can be presented as the well known pyramid (Hydén, 1987).

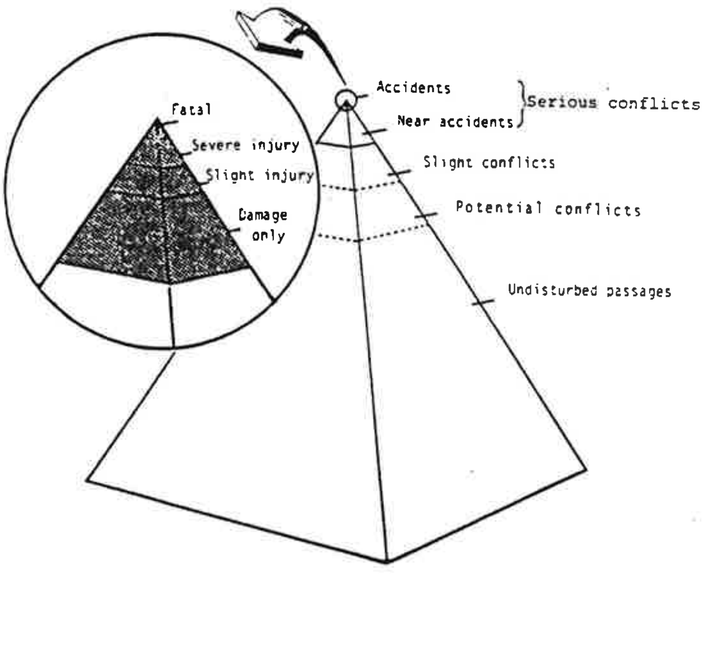


Figure 1. The relation between the different types of elementary events in traffic

Serious traffic conflicts which are the closest to accidents are usually observed in order to define the dangerousness of a place or traffic situation. The most important and the most debated aspect in this respect is how much do traffic conflicts correlate with accidents both as far as the number and type of serious traffic conflicts and accidents are concerned.

While several statistical studies supported arguments for and against the traffic conflict techniques as a tool to predict accidents, the most important theoretical contribution to the topic of the validity of indirect safety measures came from Hauer and Gårder (1986). Defining the safety of an entity (e.g. intersection) they introduce the term "expected number of accidents" occurring on the entity per unit of time. According to them, not the number of future accidents but the expected number of accidents should be predicted by any predictive tool (e.g. by the traffic conflicts techniques). "The number of accidents to occur in the future can no more be predicted than can the roll of a die. The proper question to ask is: how good is the TCT in estimating the expected number of accidents?" They state that a technique is valid if it produces unbiased estimates and if the variance of those estimates is deemed to be "satisfactory". This means that a method should not be classified as simply valid or not valid. It's a matter of degree and what one considers to be a satisfactory variance of the estimate.

The main result of a study carried out at 115 intersections, using 7 years accident data in Sweden (Hydén et al. 1978) was, that at low accident frequencies, up to a couple of accidents a year and intersection, it turned out to be more preferable to use conflicts instead of accidents when estimating the expected number of accidents. Using conflicts proved to give smaller variance than accidents did. The product validity of the traffic conflicts technique seems, therefore, to be satisfactory.

The other indicator of validity, process validity, means to what extent conflicts may be used for defining the process that leads to accidents, i.e. to what extent are conflicts and accidents describing the same process in the pre-crash phase. Hydén's studies (1987) have shown that there is a high degree of similarity between serious conflicts and accidents regarding the type of evasive manoeuvre, the category of road user executing the evasive manoeuvre, speed at the moment when the evasive action started, etc.

5.2 RELATIONSHIP BETWEEN CONFLICTS AND COMMON TRAFFIC BEHAVIOUR

If both product- and process validity of serious traffic conflicts seem to be satisfactory, one can move further down on the pyramid where 'common' traffic events, i.e. conflict-free encounters or common traffic behaviour can be found and ask how much can those elementary events be used as indirect safety measures. The quality of those events is supposed to be in close connection with the safety outcome, i.e. traffic conflicts and accidents. That notion is supported not only by the common sense but also by the results of accident analyses which show that the vast majority of accidents are caused by some mistaken human behaviour.

Human behaviour in traffic, and especially driver behaviour is one of the central topics of traffic safety research, and there exist a lot of theoretical models describing and analyzing the correct and erroneous traffic behaviour. These models are based partly on different psychological theories of human behaviour, motivation, learning, etc., partly on a more empirical base, i.e. traffic accident analysis. Accidents are, however, non-observable events. This is exactly what made indirect safety measures basically necessary.

Traffic conflicts and common traffic behaviour, which are two different levels on the aforementioned pyramid, are both events that are relatively easy to observe and study empirically. There is plenty of literature registering traffic conflicts as well as registering and analyzing different aspects of traffic behaviour (Chaloupka, 1990, Draskóczy, 1990). There is, however, practically no study - at least regarding pedestrians - which would be based on the simultaneous observation of traffic behaviour and conflicts, i.e. traffic behaviour in traffic conflicts and in conflict-free encounters. Traffic conflict studies usually are based on the observation of all kind of conflicts occurring within the area of observation - the majority of which is usually car-car conflicts. Behavioural observations can be carried out from the roadside as well as in-car, using pre-defined lists of variables as well as video-registration and ad hoc variables emerging from the situation observed.

The characteristics of our study are that traffic conflicts and pedestrian behaviour are observed at the same time, and behavioural characteristics of encounters leading to a traffic conflict and that of conflict-free encounters are compared.

5.3 VULNERABLE ROAD USERS WITHIN *DRIVE*

Vulnerable road users are in general quite neglected as far as their traffic safety is concerned. This is even more true for projects like PROMETHEUS and DRIVE which are concerned with advanced technology applied in the road network and within cars. Our present DRIVE project on vulnerable road users (V2005 - Vulnerable Road User Traffic Observation and Optimization - VRU-TOO) is the only project on vulnerable road users in DRIVE II and is a continuation of a DRIVE I project (V1031 - An Intelligent Traffic System for Vulnerable Road Users). Its aim is to enhance the safety and comfort of vulnerable road users (first of all pedestrians) and integrates both pilot project work and further research.

The project consists of three main parts:

* a relatively small scale pilot project carried out in England, Greece and Portugal, by installing intelligent pedestrian crossing facilities in urban environments, using localized signal control to reduce delay and increase safety for pedestrians,

* a behavioural study and formulation of behavioural rules for a pedestrian behavioural model, and

* computer modelling activity which contains an application of the pedestrian model (VULCAN) in Greece and Portugal, and the development of a more behaviourally intelligent version of VULCAN.

5.4 DATA COLLECTION ON PEDESTRIAN BEHAVIOUR PRECEDING CONFLICTS AND CONFLICT-FREE ENCOUNTERS

The behavioural studies are carried out by a team headed by TRC University of Groningen and consisting ITS, University of Leeds, University of Porto and Coimbra in Portugal and us. Its aim is to define and quantify behavioural variables that are related to the safety of pedestrians. Those quantified behaviour-safety relationships will serve as a basis for the safety model and for the development of tools to evaluate the safety effects of the pilot projects.

Conflicts and pedestrian behaviour are observed in urban intersections in Britain, The Netherlands, Portugal and Sweden. Observations are carried out in each country in one signalized and one non-signalized intersection, the characteristics of which are as similar as possible (Euro-intersection). The difficulties of the comparative study started when we defined the so-called Euro-intersections as a crossing of two urban roads, two-way driving direction with one driving lane per direction, with zebra crossing at each leg without refuge, priority of one of the roads regulated by 'give way' signs, major road width 7-11 meters, no parking on the driving lane and no cycle lanes. We expected relatively high vehicle (300-600 vehicles/hour both directions together on the major road) and pedestrian flows and relatively low bicycle flows. It seemed to be the most common type of intersection in every country, but it turned out that it was almost impossible to find it in practice. There were always smaller deviations (one-way road, turning lane, refuge, different kinds of pedestrian crossings, different kinds of traffic lights, etc.) We had to find compromises to fulfil the common demands.

Events which are analyzed by using the same variables are serious traffic conflicts and conflict-free encounters between pedestrians and motorized traffic. Conflicts are defined and observed according the Swedish traffic conflict technique. An encounter between a pedestrian and a motorized vehicle is defined as follows: At least one of the traffic participants obviously adapts his behaviour to the other by changing speed or swerving to give way or to avoid a conflict. According to this definition, a pedestrian can have more than one encounter while crossing the road.

The crossing behaviour is described in three stages:

* approaching phase: starting at a distance of 3 meters away from the point where the pedestrian leaves the kerb and ending at the kerb,

* first half crossing phase: staring at the point where the pedestrian leaves the kerb and ending at the middle of the road,

* second half crossing phase: starting at the middle of the road and ending at the point where the pedestrian reaches the opposite kerb.

For each of these phases the following variables are scored:

Independent variables:

* Course: walking tempo, tempo changes, stopping, waiting

* Visual orientation - head movements

* Safety margins - rejected/accepted

* Traffic variables: type of encounter, speed and type of approaching vehicle, phase of pedestrian traffic light, evasive action of the driver

* Use of the zebra

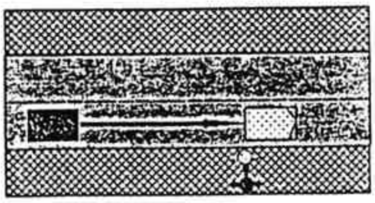
The different types of encounters distinguished can be seen in Figure 2.

Dependent variables

* The main variable is the existence and seriousness of a conflict

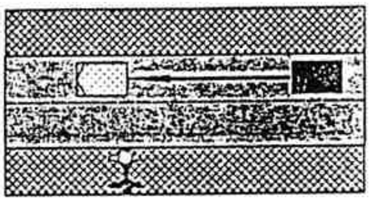
* Additional variables: country, date, day, time of the day, weather conditions, personal variables of the pedestrian (age, sex). social variables (social group size, secondary characteristics of the pedestrian).

Encounter type A:



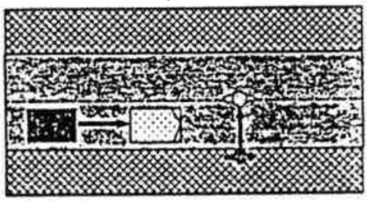
The pedestrian stops or slows down at the curb for a vehicle coming from the left; the vehicle crosses in front of the pedestrian

Encounter type B:



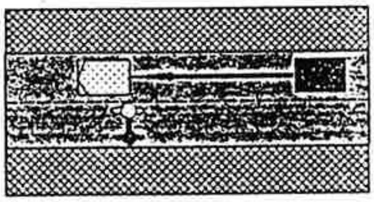
The pedestrian stops or solws down at the curb for a vehicle coming from the right; the vehicle crosses in front of the pedestrian

Encounter type C:



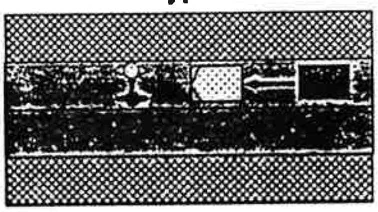
The pedestrian, leaving the curb, crosses in front of a vehicle coming from the left; the vehicle decelerates or swerves around and passes behind the pedestrian

Encounter type D:



The pedestrian, walking on the first half of the road, stops or slows down for a vehicle coming from the right; the vehicle crosses in front of the pedestrian

Encounter type E:



The pedestrian, entering the second half of the road, crosses in front of a vehicle coming from the right; the vehicle decelerates or swerves around and passes behind the pedestrian

Figure 2. Encounter types

Our original plan was to collect 100 conflicts between pedestrians and motorized vehicles at each location and compare them with 100 randomly selected encounters without conflict during the same period and at the same location. The first periods of observation revealed, however, that conflicts between pedestrians and cars are so seldom, especially at signalized intersections, both in Britain, the Netherlands and Sweden that to collect 100 serious car-pedestrian conflicts would take more time than we can afford. It was, therefore, decided that 50 hours of conflict observation and video-recording per location is the necessary and sufficient amount of observation, whatever is the number of serious conflicts during that period. It seems now, that the number of conflicts reaches the originally planned level only in Portugal.

We are at present in the last phase of the data collection period, therefore real conclusions can not yet be drawn from the observations. Some preliminary, more general results can, however, be already drawn:

1. Our research being carried out within DRIVE by an international research team - outside ICTCT - reveals that there is a readiness to move from a strictly accident-based approach of traffic safety toward a wider base, taking different levels of the pyramid of encounters into account and considering serious traffic conflicts as indicators of traffic safety.

2. The Traffic Conflicts Techniques based on human observation on the spot were developed first of all for busy urban intersections. There is, however, a need for such a technique also in situations where traffic conflicts are less frequent - even if still much more frequent than accidents. Such situations can be road sections, or interactions of specific road users, as our case was. Long-range video-recording and image-processing might be a promising direction of development to design a method which is efficient in such situations.

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