FROM ACCIDENTS TO CONFLICTS: ALTERNATIVE SAFETY MEASUREMENT

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ABSTRACT

The danger of traffic is commonly determined by the occurence of accidents. This paper presents some of the history of alternative measures for describing traffic unsafety (measurement of so-called conflicts). It also gives the results of a series of research projects aimed at the development of a conflits observation technique for the estimation of the safety of child pedestrians in residential areas.
The reliability, practical applicability and validity of the developed technique prove to be satisfying.
It is concluded that the use of this technique seems to be justified for those situations in which accident rates are relatively low, e.g., in residential areas. This is not only because of the strong relationship between serious conflicts and accidents but also because other potential alternative indicators for the estimation of traffic unsafety often used in practice, such as traffic volumes and subjective estimation of risk by residents, had little success in predicting accidents.

Introduction

When speaking about the dangers of traffic, most of us think of accidents. The extent of traffic unsafeness is usually described by the occurence of accidents.
However, recorded accidents are rather unsatisfactory indicators for traffic unsafety.

a) The registration of accidents is limited and not always reliable or complete. With respect to the first, the extent of limitation of the registration depends on the definition of accidents.
If one defines an accident as "a collision which results in the death of one (ore more) of the participants", all accidents in Holland are recorded. If one chooses, as we do, a definition of an accident as "a collision between an traffic participant and another participant or an object regardless of the results of that accident in terms of victims or material damage", only a small, unknown fraction of all accidents is recorded.

b) Although (even if one only speaks about recorded accidents) accidents happen frequently and qualifications such as "a modern epidemic" (1979) seem to be quite apt, they are still relatively rare events. It is, e.g., hardly possible to trace, within a short time, unsafe locations or to evaluate traffic safety measures.

c) The fact that accidents must take place before one can determine the risk of locations is, from an ethical point of view, a basic disadvantage.

There is a need for a more frequently occuring and measurable phenomenon than the accident as a criterion for traffic safety.

Conflict observation

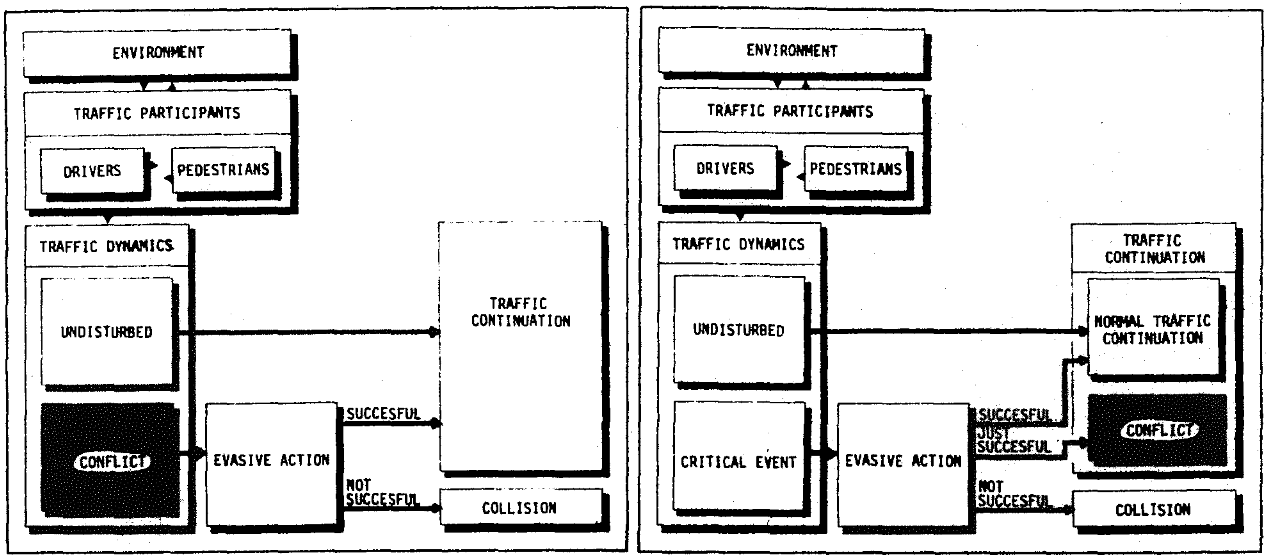
To gain some insight into the effect of safety measures in a relatively small area, we decided to follow a trend in the research that concentrates on finding an alternative indicator for safety that, in its origin, started back in the nineteen forties. In aviation, "pilot errors" or "critical incidents" were then used as measures of safety performance (Fits & Jones, 1947; Flanagan, 1954).
The term "conflict" in traffic safety resarch was introduced by Perkins and Harris (1967). All research in this area originates from their work, although it must be mentioned that it was Spicer (1971) who, by means of introducing a new concept (severity grade), did much to promote the conflict observation technique.
There is agreement among the research workers in this area on the use of the term "conflict" and even on the main aspects of the operational definitions of conflicts (namely, evasive or avoidance actions).
However, there seems to be some confusion regarding the place of the conflict in the traffic process, as illustred in figure 1.

For some, the conflict is an event that precedes an evasive action that can be either succesful or not succesful (collision). For others, it is the same as a near-miss situation after an evasive action. In this last view, a conflict cannot lead to collision but is an event parallel with a collision.

At the time that we started our research in this area, three main conflict techniques existed, each with their advantages and shortcomings (table 1):

a) the traffic conflicts technique of Perkins and Harris (1967, 1968, 1969);

Figure 1. Place of the conflict in the traffic process



a) Conflict as potential accident. Evasive action - sometimes combined with distance between participants - indicates previous conflict.

b) Conflict as near-miss situation. Just succesful evasive action (see text) - sometimes combined with distance between participants - indicates conflict.

Table 1. Positive and negative aspects of the three conflicts techniques

technique	advantages	disadvantages
Perkins and Harris (1967, 1968, 1969)	- objective definitions in terms of evasive actions and traffic violations - easy applicable (direct observation at spots)	- reliability not tested - no substantial and stable relationship with accidents (validity)
Spicer (1971, 1972, 1973)	- introduction of severity grade: distinction of serious and less serious conflicts (5 levels) - strong association between serious conflicts and accidents	- subjective operational definitions of conflicts - reliability not tested*
Hayward (1972)	- objective registration of the time-measured-to-collision by means of video- and computer equipment	- validity not tested - expensive equipment - practical application not always possible

* Given the estabilished relationship between conflicts and accidents, a reasonable amount of reliability (in this case intra-rater-reliability) must exist.

b) the traffic conflicts technique of Spicer (1971, 1972, 1973);

c) the time - measured - to collision technique* of Hayward (1972).

In terms of our interest - the safety of pedestrians, especially children - a general disadvantage was that none of the above-mentioned techniques took pedistrians into account.

The development of a conflict observation technique

Despite the mentioned disadvantages of the conflict techniques, this approach seemed to be the most promising with regard to the problem we faced: the estimation of the safety of (child) pedestrians in situations where accident data are very scarce. Especially the results of the work of Spicer (1971, 1972, 1973) seemed to be encouraging enough to justify attemps in this direction.
Our work which was aimed at developing a reliable and valid conflict observation technique that could be used for the prediction of the safety of children as pedestrians consisted of four steps:

1) operationalisation of the concept "conflict". Operational definitions of conflicts have to be objective. If strict objectivity is not possible, intersubjective agreement between expert observers can replace objectivity (de Groot, 1966);
2) a test of the reliability: do observers using the operational criteria for conflicts reach agreement in the judgement of situations (inter-rater-reliability) and are individual observers stable in their judgements (intra-rater-reliability);
3) a test of the practical applicability of the conflict observation technique in field situations;
4) a test of the validity of the conflict technique

Operationalisation

Following the work of others (particulary Spicer, 1971), we defined a serious conflict as: "a sudden motor reaction by a party or both of the parties involved in a traffic situation towards the other to avoid a collision, with a distance of about one metre or less between those involved".

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* The time-measured-to-collision (TMTC): "The time required for two vehicles to collide if they continue at their present speeds and on the same path" (Hayward, 1972, p. 9).

The criterion of "sudden" was determined empirically: observers had to judge reactions of participants in traffic situations to see whether they used certain common criteria in their judgements (the traffic situations were recorded on videotape). A discussion afterwards resulted in a detailed list of criteria that could be used to indentify four types of reactions (from "no reaction", scale value 0, up to "sudden reaction", scale value 3) of different kinds of road users.

Reliability

With respect to the reliability, the following can be stated: even unselected, untrained observers were fairly capable (by using the developed list of criteria) of judging the reactions of traffic participants.
The mean coefficient for the intra-rater-reliability (10 observers jugded 54 evasive actions) varied from r = .85 (judgement of the reactions of wheeled traffic) to r = .95 (judgements of the reactions of pedestrians). The results of the test of the inter-rater-reliability were smaller: r = .75 (reactions, wheeled traffic) and r = .87 (reactions, pedestrians). Selection and training of observers yielded better results with respect to the inter-rater-reliability: r = .85 and r = .94 (a new team of 8 observers judged 54 reactions).

Some definitions

Besides "serious conflicts" (characterized by "sudden evasive actions with a distance of about one metre or less between those involved"; popular: "just succesful evasive actions"), we distinguish "conflicts", "intensive contact-conflicts", "contact-conflicts" and "contacts". These distinctions are based on 6 different combinations of "sudden", "less sudden" and "nonsudden" reactions with "short distance" (± one metre or less) and "less small distance" (± 2 - ± 20 metres). The covering concept is called "an encounter", which is defined as "a motor action by a party or both of the parties involved in a traffic situation towards the other to avoid a collision, with a distance of 20 metres or less between those involved".

Practical applicability

In two field studies (Güttinger, 1976; 1979) the practical applicability of the conflict observation technique by means of so-called sector and personal observation was found to be satisfactory.

The method of sector observation is especially suited for the determination of the risk of certain spots, e.g., an intersection or a part of a road.
In the case of personal observation, individual road users (in our situation, child pedestrians) are followed for a certain time. This method is suited for the comparison of larger environmental units (e.g., neighbourhoods), for the detection of high risk spots within large areas or to trace the relative risks for certain child pedestrians or groups of child pedestrians.
With both methods, an amount of information which gives a good idea of what happens between child pedestrians and wheeled traffic in residential areas can be collected within a fairly short time period.
If accident figures are used as criteria for road safety in the same situation, nothing can be said about traffic dangers for pedestrians in a comparable short time.
The possibility to use serious conflicts as an alternative measure of traffic safety, of course, depends on the relation between these serious conflicts and accidents.

Validity

A study of the predictive validity of serious conflicts constituted the fourth step in our research.
Such a study has its limitations. Those factors that were the motivations for our attempts to find alternatives for accidents as indicators of traffic safety (the fact that accidents are relatively rare and the poor accident recording) interfere with the validation of the conflict observation technique.
Some remarks must be made with respect to the statistical testing of the relationship between conflicts and accidents.
If a correlational model is chosen, it is necessary to take a random sample of locations from the population of all locations.
Here, we are faced with two problems:

1) we do not know the population of locations;
2) to assure that the sample contains locations where accidents have taken place, it has to be of rather large size (because accidents per location are rare).

If one chooses a regression model for testing the relationship between conflicts and accidents, where random samples of locations with 0,1,2,3,4, etc., accidents must be taken, one is confronted with a comparable problem: we do not know the populations of locations with 0,1,2,3,4, etc., accidents.

What was our solution?

Based on the accident records of 4 municipalities of 1972 up to and including 1976, we selected a total of 25 road sections (max. length = 100 metres). The number of accidents (involving child pedestrians) per location varied from 0 to 5 (in five years). Each section was observed for 34 hours (after school hours and not during the weekend).
We will present the relations between conflicts as we observed them and accidents that happened in the previously chosen years in terms of product-moment correlations (but note that, because our sample was selected, estimation of the correlation coefficient of the population is not possible). If we find a relationship between conflicts and accidents, how strong must it be to indicate a certain validity of our method?
We formulated two demands.

1) The relation must be stronger than between exposure variables (traffic volume, volume of pedestrians, products of both) and accidents. In other conflict studies (Baker, 1972; Paddock, 1974; Glennon & Thorson, 1974), exposure seemed to be the explanatory variable of estabilished relations between conflicts and accidents.
2) The relationship must be stronger than between subjective feelings of the residents regarding the safety of the locations under study and accidents. If this subjective safety is strongly correlated with accidents, the need for an instrument such as the conflict observation technique is doubtful.

Results: a) conflicts and accidents.

Of all types of encounters, serious conflicts correlated best with accidents: $r = .51$, $p < .01$ (see table 2).
It can be concluded from table 2 that the combination of the two variables distance and reaction is essential in defining the different types of encounters.
Encounters characterized by short distances do not correlate better with accidents than those characterized by greater distance, nor do encounters featuring sudden evasive actions show a better correlation with accidents than those characterized by nonsudden actions.

Although serious conflicts show the strongest relation with accidents (a confirmation of Spicer's findings (1971, 1972, 1973)), they explain only 25% ($r^2 \times 100$) of the variance in recorded accidents.

Table 2. Matrix of correlations of the different types of encounters and reported accidents 1972 - 1976

	SC	C	ICC	CC	IC	C	E	A
serious conflict		.65 p<.001	.68 p<.001	.63 p<.001	.68 p<.001	.61 p<.001	.73 p<.001	.51 p<.01
conflict		1	.75 p<.001	.91 p<.001	.74 p<.001	.89 p<.001	.96 p<.001	.23 p>.05
intensive contact - conflict			1	.81 p<.001	.80 p<.001	.69 p<.001	.85 p<.001	.34 p<.05
contact - conflict				1	.65 p<.001	.90 p<.001	.96 p<.001	.37 p<.05
intensive contact					1	.64 p<.001	.80 p<.001	.15 p>.05
contact						1	.94 p<.001	.36 p<.05
total of encounters							1	.35 p<.05
accidents 1972 - 1976								1

This does not seem to be high enough to justify the use of serious conflicts as a criterion for traffic safety.

Addition of the other encounters as predictor variables (multiple correlation) yielded a correlation of $r = .68$, $p < .001$, which explains about 50% of the variance.

It must be noted, however, that recorded accidents do not include collisions between pedestrians and cyclists, because these collisions seldom result in injury (criterion for recording). In our observations, we also recorded encounters between pedestrians and cyclists.

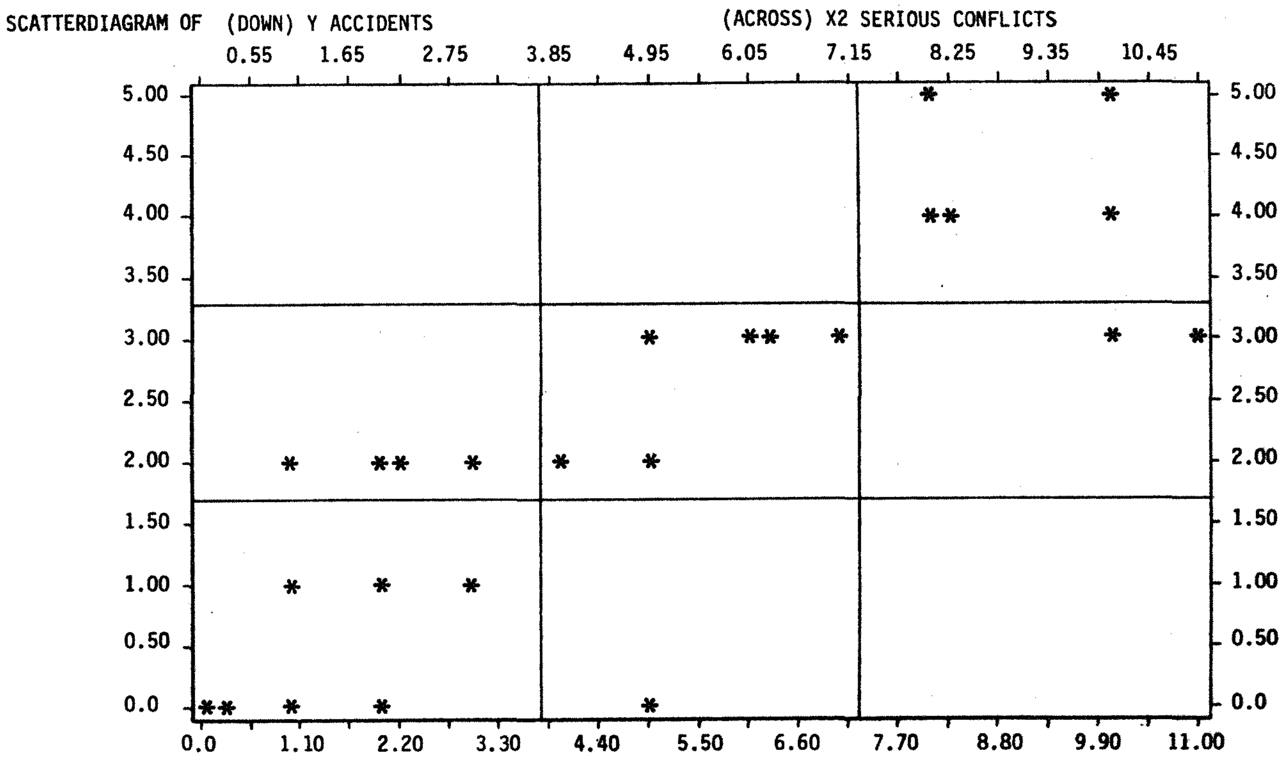
Leaving these kinds of encounters out of the calculations, we found a correlation of serious conflicts with accidents of $r = .82$, $p < .001$ (table 3). If all types of encounters are used as predictor variables, the multiple correlation is $r = .88$.

If we plot the relation between serious conflicts and accidents, the regression shows a strong linear component (fig. 2).

Table 3. Matrix of correlations between the different types of encounters (leaving cyclists out of the calculations) and reported accidents (1972 - 1976)

	SC	C	ICC	CC	IC	C	E	A
serious conflict		.57 p<.001	.55 p<.001	.62 p<.001	.66 p<.001	.62 p<.001	.68 p<.001	.82 p<.001
conflict		1	.73 p<.001	.91 p<.001	.79 p<.001	.90 p<.001	.95 p<.001	.26 p>.05
intensive con-tact - conflict			1	.82 p<.001	.85 p<.001	.66 p<.001	.82 p<.001	.31 p<.05
contact - conflict				1	.77 p<.001	.91 p<.001	.97 p<.001	.38 p<.05
intensive contact					1	.71 p<.001	.85 p<.001	.34 p<.05
contact						1	.95 p<.001	.41 p<.05
total of encounters							1	.41 p<.05
accidents 1972 - 1976								1

Figure 2. Serious conflicts (X) versus accidents (Y)



CORRELATION (R)-	0.81525	R SQUARED -	0.66464	SIGNIFICANCE <	0.001
STD ERR OF EST -	0.91962	INTERCEPT (A) -	0.43776	SLOPE (B) -	0.36713
PLOTTED VALUES -	25	EXCLUDED VALUES -	0	MISSING VALUES -	0

b) exposure data and accidents.

Of all of the exposure variables we used, none yielded a better correlation with accidents, as can be seen in table 4.

If we add exposure variables to serious conflicts in our prediction of recorded accidents, we can see that they explain very little variance in addition (table 5).

Table 4. Matrix of correlations between exposure variables and recorded accidents (1972 - 1976)

exposure variable	r	p
traffic volume	.30	>.05
volume motor traffic*	.35	<.05
volume child pedestrians	.42	<.05
volume protected child pedestrians**	.31	>.05
volume unprotected child pedestrians	.44	<.01
product of 1 and 3 = exposure 1	.39	<.05
product of 2 and 3 = exposure 2	.40	<.05
product of 1 and 5 = exposure 3	.41	<.05
product of 2 and 5 = exposure 4	.41	<.05

Table 5.

	multiple corre-lation	partial correlation serious conflicts and accidents. Exposure constant	partial correlation exposure and accidents. Serious conflicts constant
serious conflicts + volume motor traffic	.82	.79	.14
serious conflicts + volume child pede-strians	.82	.77	-.12
serious conflicts + volume unaccompanied child pedestrians	.82	.77	.11
serious conflicts + vol.mot.traf. x vol. child pedestrians	.82	.78	.05
serious conflicts + vol.mot.traf. x vol. unacc. child pede-strians	.82	.77	.04

* Because of aforementioned reasons (collisions between cyclists and pedestrians do not result in recorded accidents), cyclists are left out of the calculation.

** Protection: presence of adults.

c) <u>subjective safety and accidents</u>.

Subjective feelings of the residents regarding the safety of the locations under study did not show much relation with the actual safety or hazards for children*.

Conclusion

Considering these results and considering also that

a) pedestrian accidents involving children in residential areas happen so infrequently that they cannot be used to arrive at statements about traffic safety; and

b) if after years of data collection there are "enough" accidents to make statements about the traffic safety, these statements are of little value because too much has changed,

we feel that serious conflicts (as we defined them) between child pedestrians and wheeled traffic can be used to arrive at statements about traffic safety. However, the conflict observation technique is not yet suited to predict accident rates. It can be used for comparing situations (areas, roads, intersections, etc.) and for arriving at statements in terms of relative safety.

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* Within a radius of 100 metres of each location, parents were asked questions like: "does your child play at that location";"has your child to cross that location";"if so, do you assist your child"; what is your opinion of the safety of that location", etc. Only one significant correlation was found: at locations where children of ages 0 - 4 years were allowed to play, more accidents had occurred ($r = .40$, $p < .05$)!

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