Traffic Conflicts at Urban Junctions

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Abstract
The Traffic Conflicts Technique is a device for indirect safety measurement. The basis for the definition of conflicts is a sequence of events which has a finite probability of developing into an accident.

The investigation of TCT in Germany was performed in three stages:
- Development of a standardized traffic observation technique for most kinds of traffic locations and a standardization of observation areas
- Validity studies of conflicts showed for all conflict types a rather close relationship (correlation) to accident types in particular traffic locations
- Successful practical applications of the method depend on the standardization and facility of the technique, on available guidelines for the training of observation personnel and on statistical aids for the interpretation of the results.

1. Introduction
The Traffic Conflicts Technique (TCT) is a device for indirect safety measurement and applicable to a variety of situations, especially as a
- diagnostic instrument for in-depth analysis of locations with a concentration of accidents. The aim is to identify and localize hazards and to investigate effectiveness of devices, layouts, designs, procedures etc. This should also be possible at locations with low accident potential.
- basis for before and after studies or generally speaking, evaluation studies. In this context, one usually wishes to ascertain whether some treatment, e.g. the installation of automatic traffic control is effective in increasing traffic safety.

- method to forecast accident risks for special groups of road users e.g. pedestrians, drivers, children etc.

It has been pointed out (Amundsen & Hyden 1977) that conflicts are generally considered as a substitute for accidents, because of the drawbacks of accident analysis: accidents are rare events compared with the number of situations involving accident risks, accident records may be distorted, incorrect and incomplete and only a small part of all accidents is recorded.

The time needed to collect adequate numbers of conflicts for statistical processing is relatively small, the reliability is much higher and it is possible to define conflict types in correspondence to accident types.

The basis for the definition of conflicts is a situation or sequence of events which has a finite probability of developing into an accident. Conflicts are related to the chain of events preceding a possible accident. From the road user's point of view the chronological events can be expressed in the following diagram:

![Diagram of conflict types]

- E = Encounter
- C = Conflict
- S = Safe Encounter
- A = Accident
All occurrences in the diagram are observable events. The rare event of accidents preceded by no observable evasive action is excluded as well as single vehicle accidents in this diagram. A traffic conflict will be defined as follows:

"A traffic conflict is an observable situation in which two or more road users approach each other in space or time to such an extent that there is an increased risk of collision if their movements remain unchanged". (Amundsen & Hyden 1977, P. 135).

Traffic conflicts are described by a small set of variables, all of which are combinations of a certain kind of manoeuvres and proximity in time and distance. The level of severity is strongly related to the continuous variable 'time to collision' and is classified in our studies by three levels from slight to serious.

Training of human observers with video recordings, training manuals and in field-studies improves the reliability of measuring conflict types and levels of severity. In spite of the subjectivity of the measurement the internal and external reliability of observers proved to be rather good. According to our own results, observers agreed in 80 - 90% of observed events.

2. The development of Traffic Conflicts Technique

Traffic observations under standardized conditions have a proved tradition. Herwig & Sprotte (1965) registered regular and irregular behavior of pedestrians and drivers at urban junctions and marked crosswalks in order to discover proposals for constructional measures. The observation techniques used in these and other studies do not qualify for general application. They were not sufficiently standardized and the relation between observations and accidents was not investigated thoroughly.

The standardization and generalisation of traffic observation techniques was improved by the development of the TCT (Perkins & Harris 1968)
In many countries the technique has been investigated and applied practically. Recent applications are described by Cooper 1974, Hyden 1975, Amundsen & Hyden 1977).

The investigation of TCT in Germany started in 1976 and was performed in three stages:
- Development of a standardized traffic observation technique for most kinds of traffic locations
- Practical applications and guidelines for users.

3. Development of a standardized observation technique

The first aim was to develop an observation technique adaptable for most kinds of locations: urban and residential junctions, signalized and nonsignalized intersections, approach roads with more than one lane etc.

Based on the conflict description of the General Motors Manual the conflict types were defined according to the German official accident causes catalogue to guarantee a detailed investigation of the relationship between accident and conflict types. It was necessary to define new unequal categories to account for many actual causes of conflicts observed in approach roads and nonsignalized junctions.

The majority of hitherto existing studies concentrated on junctions that can hardly be compared with big signalized junctions in urban areas as far as traffic guidance systems, lanes and traffic volume are concerned.

Our pilot studies showed that these junctions could not be covered by the usual 2 person team. The observation of the total entrance or the inner area from one angle was impossible.

To guarantee a detailed investigation, a segmentation of the approach roads and the inner area of the junction was developed on the basis of constructional and behavioral criteria (see FIG 2).
FIG. 2 Segmentation of the approach road of a junction

Segment 1 from the advance guide sign to the beginning of the widening of the approach road

Segment 2 from that widening up to the point where all lanes of the approach road are fully built up

Segment 3 the area up to the shop line

Segment 4 defines the inner area of the intersection.
According to different tasks and behaviors of cardrivers crossing this area it was differentiated into travel directions: left turn, through and right turn. For detailed investigations the travel directions can be seperated in conflict areas as it is shown for the left turn direction in FIG 3

FIG. 3 Observation direction and conflict areas in a junction

This functional and behavioral segmentation of traffic locations has the advantage to be very flexible. It can be adapted unequivocally to the majority of signalized and non signalized intersections and does not depend on special geometric layouts and traffic volumes.
4. Validity studies of conflicts

An important aim of a conflict technique is to use conflicts as a measure of the deficiencies of the traffic system. It appears necessary to validate the technique on the basis of data at accident locations. But this is only possible for a part of urban or residential locations where accidents occur frequently and are concentrated on particular sites. In Braunschweig and Hannover, where investigations were performed, about 60% of all accidents are located at black spots, most of them being signalized junctions.

A remark on German accident statistics seems to be necessary: All injury accidents and collisions with damages over one thousand Marks are officially recorded. In addition, accident records of damages less than 1.000,- DM (A-accidents) are available if they have been reported to the police. The ratio between injury and damage accidents (including A-accidents) is about 1 : 10. All accidents occurring in the last three years were compiled on the basis of accident records and collision diagrams. The accident retest reliability proves to be good (r = .88) but depends on the accident types. Because of the great number of accidents it was possible to compute correlations between conflict and accident types in order to validate conflicts. This differential validity approach considers conflict types as a substitute for accident types at particular traffic locations. Simple and multiple regression functions are computed for different locations and conflict types.

Detailed investigations at 38 urban junctions and approach roads (all junctions signalized, at least three lanes in each approach road and heavy traffic volume) showed stable relationships between conflicts and accidents (Erke & Zimolong 1978). In general high correlation coefficients between Rear End (REA), Weaving (WEA) and all (ALL) conflicts and accidents were found in the approach roads (Table 1).
In the inner area of the junctions, separated into the travel directions Left, Through and Right, less accident variance could be accounted for by the conflicts. The correlation between left turn accidents and conflicts (LEF) proved to be significant statistically. By a weighted combination of the levels of severity and traffic volume much more variance of the criterion could be accounted for.

Table 1  Simple and multiple correlations of conflict and accident types

<table>
<thead>
<tr>
<th>Site</th>
<th>Conflict-types</th>
<th>Predictors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach road</td>
<td>K1</td>
<td>K2</td>
</tr>
<tr>
<td>Inner area of junction</td>
<td>REA</td>
<td>.74**</td>
</tr>
<tr>
<td></td>
<td>WEA</td>
<td>.80</td>
</tr>
<tr>
<td></td>
<td>ALL</td>
<td>.86**</td>
</tr>
<tr>
<td>Inner area of junction</td>
<td>Right</td>
<td>REA</td>
</tr>
<tr>
<td></td>
<td>ALL</td>
<td>.48</td>
</tr>
<tr>
<td></td>
<td>Through</td>
<td>REA</td>
</tr>
<tr>
<td></td>
<td>LEF</td>
<td>.51*</td>
</tr>
<tr>
<td></td>
<td>ALL</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>REA</td>
</tr>
<tr>
<td></td>
<td>LEF</td>
<td>.55</td>
</tr>
<tr>
<td></td>
<td>ALL</td>
<td>.51*</td>
</tr>
</tbody>
</table>

The different levels of severity of conflicts (K1 = slight, K2 = medium, K3 = serious) are generally recorded at a ratio of 80 to 19 to 1.

The relationship depends on the site and type of conflict. The best correlations between accidents and conflicts are generally found for the sum of all three levels of severity K1-3.
According to our results, traffic conflicts are valid predictors for different accident types at urban junctions. We assume, that the same valid relationship holds for other traffic locations, e.g. for low accident situations. Otherwise the numerical ratio of conflicts and accidents depends on the site and type of conflict. In order to forecast accidents from multiple regression functions, it is necessary to compute a different function for each type of conflict and for each type of traffic location.

5. Practical applications

Compared with other techniques, the TCT involves the advantage that practical aids for the evaluation of measures and the observation of traffic can be offered to the responsible bodies of communities and to the police.

A successful application of the method depends on the standardization and the facility of the technique, on available guidelines for the training of observation personnel and on statistical aids for the interpretation of the results.

The last topic includes the problem of conflict reliability measured over a couple of days and their theoretical distribution function. Hauer (1978) concludes that the expected conflict rate varies from day to day. He suggested a negative binomial distribution as appropriate for the representation of the distribution of conflict sample means. On this basis, confidence limits and error probabilities in testing hypotheses can be obtained, e.g. when treatment effectiveness in so called before and after studies is the main concern. Also the marginal increase in estimation accuracy in relationship to conflict counting time is of practical interest for field surveys. We are now studying the reliability problem to gain evidence for the distribution problems. One purpose of the current investigations is to examine the available empirical evidence in order to provide a general guideline for the standardized application of the TCT.
6. References


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Hauer, E. Traffic conflict surveys: some study design considerations. TRRL Supplementary Report 352.


Hydén, C. Relations between conflicts and traffic accidents. Lund Institute of Technology, 1975.