GUIDELINES FOR THE CONDUCT OF

TRAFFIC CONFLICTS STUDIES

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Contributors:

Foreword

This document was prepared by the International Committee for Traffic Conflict Techniques (ICTCT) for safety professional interested in the subject of traffic conflicts. It describes the background, need and conditions for the conduct of a conflict study. It provides also some insight into the considerations prior to the adoption or development of a specific Traffic Conflict Technique (TCT). Once such a decision is taken one would normally need much more detailed material about such a technique and various aspects of its application. Such detail is generally found in the manuals developed by various national agencies describing their TCT.

In the preparation of this document extensive use was made of existing articles and publications on the subject. Especially useful were the contributions of the various ICTCT members in the proceedings of the international TCT Workshops and seminars. Use was also made of various parts of an uncompleted document prepared by W.D. Glauz, E. Hauer, A. Lightburn, J.H. Kraay and J. Older.

The various contributions are generally acknowledged in the references or mentioned otherwise.

This document is at present a draft which should be corrected and amended by the ICTCT members.

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Editor

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1. THE TRAFFIC CONFLICTS TECHNIQUE

The Traffic Conflicts Technique (TCT) is a tool used to deal with various tasks and problems in the field of road safety. This chapter will introduce the range of issues and problems which managers and researchers of road safety have to face. It is within this context that the use, usefulness, advantages and limitations of the TCT need to be discussed.

1.1. The Road Safety Context

Three problems have to be faced by mangers of road safety (OECD, 1979):
1. Which areas, locations, designs or standards are characterized by poor road safety performance?
2. What are the contributory causes of poor road safety?
3. What are the safety effects of countermeasures?

In this context the questions as to what safety is and how it should be measured arise naturally.

Safety can be defined to mean:

The expected number of accidents for each severity class occurring on a system per unit of time (Hauer, 1982)

While defining safety is relatively easy, its measurement, assessment and characterization are difficult problems. The following criteria are often used to assess safety.

1. The recorded number of fatal, injury and property damage accidents occurring on a system per unit of time.
2. The number of near-accidents (or traffic conflicts), also sometimes termed incidents (OECD, 1984)
3. The number of encounters arising within the traffic milieu and causing concern to the participants or local residents although not normally resulting in accidents or near-misses.
4. The degree of awareness of local residents and road users of the traffic safety problem and their feelings of being safe or unsafe, which reflects their subjective perception of the dangers on the road.

Criteria 3 and 4 relate to experiences, perceptions and feelings. In this sense they are an index of subjective road safety. A certain feeling of danger, however, does not necessarily mean that a traffic situation is indeed unsafe. A sense of danger, however, can be important in view of its potential influence on the drivers' behaviour. Moreover, it can reach an intensity which has to be taken seriously into consideration.

Up till now road safety analysis is predominantly based on accident records (criterion 1). The use of accident records for this purpose has several well known limitations. There is therefore a desire to substitute or complement accident data with an alternative safety related phenomenon.

Conflicts occur more frequently than accidents and they seem to relate to the road safety problem. They also provide a vehicle for deeper insight into it. Although the relationship between conflicts and accidents is not yet universally understood and always clear, conflict observations give a direct insight into the traffic behaviour on the system observed.

The method of road safety investigation based on conflict observation will be referred to as the Traffic Conflicts Technique (TCT). This method comprises the field observation of conflicts and the analysis thereof, with the aid of adequate techniques.

It is hoped that in due time it will prove possible to use the TCT as a general operational tool to assess the safety of various locations, traffic situations or road conditions, when there is insufficient information about accidents or when the available information cannot be relied upon.

1.2 Systematic observation of human behaviour in traffic

Road accidents are generally considered as symptoms of a failure in the proper functioning of the man-vehicle-road-environment transportation system. To diagnose the "causes" for such a failure is a difficult task.

Apart from psychological and physiological characteristics of the participants, other interactions with the social and physical environment should be considered. It is therefore essential to learn more about the traffic behaviour of road users in a variety of conditions in time, location and circumstances. Both normal and abnormal behaviour should be understood.

Behavioural studies of road users are well suited to contribute to the increase of our knowledge and understanding of the traffic process. Not necessarily always will the observed behaviour correspond with the actual knowledge and experience of the road user. Other factors such as attitudes, environmental characteristics and other factors may account for the discrepancy. Behavioural studies provide us with an insight into the normal behaviour of road users under specific circumstances. They can be undertaken for a variety of reasons. They can provide quantitative information on behavioural variables which can be linked with accident characteristics. They provide a deeper understanding of our traffic behaviour. They may provide insight into the changes in behaviour as a result of certain traffic and safety countermeasures.

In each of these cases it is important to conduct the observations in a systematic and well organized manner. One type of behavioural study is the observation of traffic under near-accident situations, i.e. conflict studies. When applying the TCT it is generally sought to explore those aspects of behaviour which are thought to be relevant to road safety.

A diagrammatic description of the safety process is given in Fig. 1.

In this context it is assumed that our understanding of road safety should be examined within the framework of the traffic process. Failure of the process provides us with the required insight and understanding. Conflicts are considered as an approximation to the total failure of the process and can be regarded as partial failures. Investigation of accidents, which always occurs after the event is insufficient for these purposes.

Studies concerned with the intermediate processes as shown in Fig. 1 and in particular conflict studies may provide an essential contribution to an increase in our understanding of such processes. Similarly countermeasures can be compared and evaluated in terms of the intermediate processes, or compared with the before situation, until such time when accident data may provide more definitive answers.

It is within this wide context that one should conduct and evaluate conflict studies and other behavioural studies. The systematic and pre-defined manner of observation are essential to their successful application.

Appendix 1 provides a brief history of the TCT from its origins in 1967 until recent years. It is not meant as an all-inclusive and comprehensive review and critique but includes most of the major studies on the subject and refers to further reviews, critiques and discussions.

1.3 The TCT - its Uses, Strengths and Weaknesses

From the review of published accounts on the uses of the TCT emerge three principal applications.

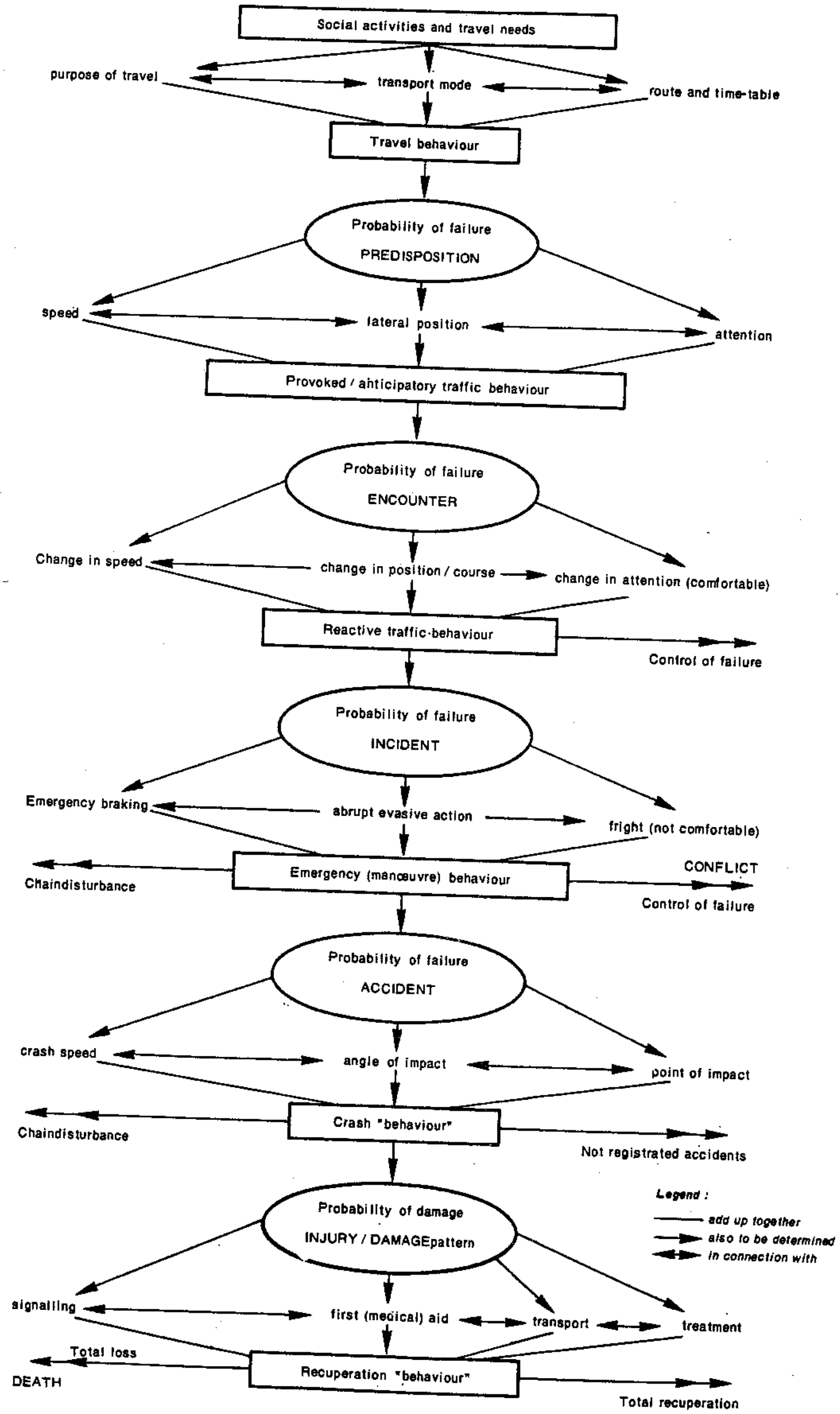
First there is an assumption of a direct relationship between conflict and accident occurrence. The belief is that the more frequently conflicts occur the larger the number of accidents must be. Thus, conflicts serve as an indirect measure of safety.

Second, the conflict event is a precursor to the accident event. However, unlike the accident about which only second hand and incomplete information is collected after the event, the conflict is observed at the time of its occurrence. Therefore it enables the observer to trace some visible aspects of the causal chain of events. The identification of causal factors leads to fruitful speculation about appropriate countermeasures and remedies.

Third, the occurence of most traffic conflicts is a source of annoyance, fright and sensation of insecurity adversely affecting the well being of road users. Thus, measures which reduce the rate of conflict occurrence increase the perceived quality of the road traffic environment and vice versa.

Fig. 1

PHASE-MODEL OF THE TRANSPORT AND TRAFFIC (UNSAFETY) PROCESS



from OECD (1984)

The advantages of the TCT can be summarized as follows:

- It is possible to obtain a statistically sufficient number of observations in a relatively short time. Therby facilitating the safety evaluation even at locations of low traffic intensity.

- It is possible to taylor the data collection to specific requirements of the investigation, with regard to vehicle type, environmental conditions, type of manoeuvre, etc.

- Compementary information (visibility, pavement friction, traffic flow, etc) can be collected simultaneously, so that all data refer to the same period of time.

- The technique can be used to provide a measure of unsafe driving thereby identifying possible accident generating problems and suggests possible countermeasures at high accident locations.

- Measures that have been implemented can be evaluated more quickly rather than having to wait for an accident history to evolve.

- The method of data collection is objective in the sense that it is carried out by trained, impartial observers, without questions of "blame" arising.

- It is possible to use a process of video or time-lapse film so that events can be recorded for later analysis or for training purposes.

These advantages are mainly in comparison to accident data. It is aften impossible to attain statistical reliability using accident records. More likely than not the accident report form will not contain information about the factor of interest (vehicle size, type of manouevres, etc.); nor will it be possible to obtain complimentary information about, say, visibility, friction or traffic flows prevailing at the time of the accident.

Having listed the main advantages of this method, a discussion of its weaknesses and limitations is in order.

- The field observations are expensive and ordinarily rely on the use of manpower or photography. In consequence, they are carried out for relatively short periods of time, during daytime, usually in summer. As a result, these observations may not be representative for, say, nightime accidents or winter accidents.

- In most cases the identification of a conflict and the assessment of its severity are a matter of judgement. Thus the conduct of field observations requires adequate training and a permanent observation team in order to be able to collect comparable observation data in a consistent manner.

- What constitutes a conflict is not always defined in the same way. This interferes with the comparability of results from different studies.

- All accidents need not necessarily be preceded by some form of evasive manoeuvre. Therefore a TCT technique based on evasive manoeuvres can only be dealing with a certain proportion of the expected number of accidents.

- The TCT is based on an assumed relationship with safety. Such relationship has to be present to the required extent. The question of how well conflicts correlate with accidents and are therefore likely to accurately predict accidents has not yet been answered satisfactorily for many situations. More on this topic in the section on conflict validity and the Appendix on the history and developments of conflict studies.

The first two shortcomings effect the reliability of the method. Statistical reliability can be attained by counting long enough; representativeness can be ensured by proper design of the field study; the adverse effect of the judgemental element can be minimized by clear definitions and adequate training.

The last shortcoming affects the validity of the TCT and will be discussed in a later section.

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2. DEFINITION AND CLASSIFICATION OF CONFLICTS

2.1 Definition of a Conflict

The driver's task can be seen as a continuum of events ranging from those with no danger of a collision through events where the possibility of an accident increases but is successfully avoided, to those where an actual accident occurs. Conflicts are those events where there is a possibility of an accident but where a collision does not occur because one or other of the involved parties takes avoiding action. There is now a general consensus of opinion that a traffic conflict can be defined as

> "...an observable situation in which two or more road users approach each other in space and time to such an extent that a collision is imminent if their movements remain unchanged." 1st International Workshop on the Traffic Conflicts Technique, Oslo, 1977.

This definition excludes traffic violations, situations involving parked vehicles and single vehicle incidents. Included in the term "road users" are two wheeled vehicles, (motor cycles, mopeds and pedal cycles) and pedestrians. Although the definition seems equally applicable to pedestrian-vehicle conflicts, some modification to a conflict recording technique for vehicles would be needed to make it appropriate for pedestrians.

The event of a traffic conflict is indicated by a critical manoeuvre of at least one of the involved road users. Critical manoevres are:

- braking
- accelerating
- swerving
- stopping
- running, jumping
- combinations of these manoeuvres.

Excluded are safe encounters where time and space are sufficient to coordinate the behaviour in a controlled manner.

The observation area is defined according to the roadway geometry, the task of the road users observed and the capacity of the observer. A conflict is counted when the corresponding accident would be located inside the observed area, the conflict can be initiated outside the area.

A conflict study involves two or more trained observers monitoring a junction usually from opposing directions along the priority road, and recording all relevant details of each conflict that occurs as well as subjective judgments of the evasive action taken. It has been established that four factors are used by experienced observers in assessing the grade of a conflict. These factors are:

i) The TIME before the possible collision that evasive action is commenced.
ii) The SEVERITY or rapidity of the evasive action.
iii) The TYPE of evasive action i.e. whether it involves more than one action.
iv) The PROXIMITY of the vehicles involved at the instant evasive action is terminated.

A relationship between judgments of the levels of these factors and conflict grades has also been established by most techniques so that observers can quickly assess and record the level of each factor associated with a particular conflict and these can subsequently be applied to obtain conflict grade. This approach has proved helpful in training new observers and has also resulted in a more consistent recording of conflicts and their severity grades. This may be due to the fact that the method promotes careful observation of several aspects of the evasive action involved in a conflict.

2.2 Conflict severity

The degree of severity of a conflict is determined

- by the distance between the two road users
- by the different speeds
- by the strength of the acceleration and deceleration

The severity of a conflict is determined by the estimated time span which is available to perform a critical driving manoeuvre. The shorter the time, the more dangerous the conflict, and the higher is the conflict degree of severity.

In order to be better able to grade the available time, driver reactions which still could be carried out in the given time are specified. Important is that this time is available and not whether the driver actually carried out these reactions.

Observed reactions:

- reaction to the conflict partner
- orientation to the overall situation and reaction to the other road users
- indication of own intention

Conflict severity is defined differently by the various conflict techniques. Some techniques have only few severity grades (West-Germany has three grades), some techniques have more (France and Great Britain define five grades). Conflict severity is of great importance in the determination of conflict relevance to safety on the assumption that severity is proportional to the probability of an accident (or injury). Severity therefore depends also on various conflict characteristics such as type of road user, type of location, etc.

2.3 Types of conflicts

Most conflict studies conducted were concerned with safety at intersections. For this reason most conflict techniques were designed to observe driving patterns at intersections. Another application of the conflict technique is concerned with the observation of pedestrians. The types of conflicts to be defined will depend on the situation to be analysed and on the specific purposes of the study, research vs. operational mode. The following general types of conflicts are frequently used:

- motor vehicle-motor vehicle conflict. A further classification relates to type of vehicle, type of manoeuvre (angle, rear-end or turning)
- motor vehicle-bicycle conflict
- motor vehicle-pedestrian conflict

Various other types and categorization are possible, including those related to the type of road location, such as: signalized intersections, non-signalized intersections, pedestrian crossings, etc.

3. OPERATIONAL CONFLICT TECHNIQUES

During the past fifteen years various countries developed their own conflict technique. At first it was believed that one technique might prove to be better than the others and might be selected as a universally accepted superior technique. Further work and development in this field showed that this is unlikely to happen. Techniques are developed according to specific needs and requirements. The U.S. technique applied only to intersection situations and is mostly adapted to motor vehicles. In the Netherlands the technique specifically applies to pedestrians in low volume situations.

It would seem that each potential user must study the various techniques available, select the one most suited to his needs, or compose one on the basis of various elements taken from different techniques.

3.1 Description of national conflict techniques

The various national conflict techniques are described in brief in the Appendix to this report. More detailed descriptions exist in the literature. Several countries have developed manuals describing their techniques including Sweden, Finland, Great Britain, West Germany and the Netherlands.

Each technique normally consists of detailed procedures and definitions dealing with the following aspects:

- description of the ways a conflict arises and evolves
- selection of critical (conflict) situations
- definition of conflict types
- detailed instructions about conflict recording and coding
- data collection and recording procedures
- data analysis
- observer training and testing
- field study procedures

Each of these aspects will be discussed briefly.

3.2 Designing a traffic conflicts study

The design stage is crucial to the success of a conflict study. Its importance cannot be overemphasized, since if the design of the study is inadequate or incomplete in any way then it is a waste of time and resources conducting any observations as they would be of questionable reliability and validity.

3.2.1. Selecting the Site(s)

In theory the conflict technique can be used at any type of site. The majority of accidents involving personal injury occur at junctions, therefore conflict research has focused on these types of site. There are no restrictions upon the type of junction at which the technique can be applied. However it is advisable, when embarking on a conflict study for the first time, to at least begin with a more straight forward site. Either an uncontrolled T-junction or crossroads would be suitable, especially since these types of site will be used to illustrate examples of conflicts during training. Otherwise potential sites should be selected as they would be for any other type of junction investigation, on the basis of their accident histories or because problems have been encountered by drivers using them regularly etc.

3.2.2 Examining the Accident Data

In the case of safety or countermeasure evaluation, the accident history (if there is any) of the potential site should be studied to determine the type of accidents occurring and the manoeuvres involved. Three to five years accident data should give sufficient information depending upon the number of accidents per year at the site concerned. A check should be made to determine whether any significant changes in road layout or land use have occurred during this period as they may have affected the accident type and/or number occurring in each year.

Results of the accident analysis can then be used to help decide whether all or only some of the potential conflict manoeuvres should be observed. As mentioned earlier there are several uses of conflict studies. If the aim of the study is to supplement existing accident data in the identification of safety deficiencies and suggest possible remedial measures, it may only be necessary to study conflicts involving those manoeuvres found to have been involved in the accidents. This approach should only be taken if specific, dominant accident types have been identified at the site, otherwise all potential conflict manoeuvres should be studied. Where remedial measures taken are to be evaluated than all conflict manoeuvres should be studied since a modification made to a site may alleviate the original problem but might also generate a few conflicts not originally present. Similarly if there is an absence of an accident history at a site and the aim of the study is to assess it's safety standard then all potential conflict manoeuvres should be observed.

3.2.3 Timing of the Conflict Study

The choice of the observation period and its duration are important. For a guide, the accident history should be consulted. Where there is a predominant pattern of accidents occurring during a particular period in the day, or month of the year or day of the week, then where ever possible the conflict study should be conducted around the same times. If no clear picture emerges as regards time of day then it is sufficient to carry out the study within convenient daylight hours, so long as at least some of the accidents occurred within the proposed observation periods. Most conflict studies have been based on an observation period of ten hours per day, from 08.00 - 18.00. This period is satisfactory since it includes most of the morning and evening rush hours together with sections of relatively low flow conditions in between.

The daily conflict rate will vary due to random fluctuation, but when the data across days is averaged there is some stability. Accuracy of the daily estimate increases with the number of daily counts, but beyond a certain point not much greater accuracy is gained by further counts. Three days is now considered to be the optimal length of study at one site, since Spicer et al (1980) and Hauer (1978) have shown that there is only a marginal increase beyond this. These three days are normally weekdays since the pattern of accidents and traffic flows are different at weekends.

3.2.4 Number of Observers Required

The number of observers required will depend upon the type of site and traffic volume there. Considering the type of site first. If it is an unsignalized T-junction or crossroads then two observers will be required to monitor the junction from opposing directions along the priority road. For signalized junctions, one observer should be situated at each arm of the junction, therefore three observers for T-junctions and four for crossroads would be required. If however conflicts occurring on the approaches are also to be recorded then one extra observer per arm will be required.

These numbers of observers are based on the assumption that one observer will be able to cope with one stream of traffic. If the total inflows are high then more than one observer will be required for each arm/stream of traffic. In this situation it must be specified to each observer which conflicting manoeuvres they should observe in order to avoid over counting. The numbers of observers quoted in this section are the number required at a site at any one time. Previous studies have shown that one person can carry out accurate and reliable observations for a maximum of three to five hours continuously depending on conditions. Ideally the observation period should be shorter particularly if an observer is required to return for a second period during the day. Breaks between one person's observation periods should be related to the length of observations, the longer the observations the longer the break. An example would be one hour observing and one hour break etc.

3.2.5 Inspecting the Site

All potential sites should be inspected before finally being included in the study. A diagram of the layout of the site should be made showing all the manoeuvres possible through the site. Notes regarding the feasibility of positioning observers to record conflicts will also be required, since if there are no suitable observation points then the site should be excluded. Some time should be spent at each site to determine the volume of traffic passing through. These details concerning layout and traffic volumes are essential in order to be able to decide on the numbers of observers required at each site.

3.3 How to conduct a conflict study

Having decided that a conflict study might be beneficial, having selected the sites to be studied and having selected a particular TCT to suit our needs the question now arises: How does one conduct a conflict study? Again, generally at this stage a country, or agency, will have developed a detailed manual describing the required procedure but for the novice it might be helpful to have some idea of the concepts and procedures involved.

3.3.1 The evolution of a conflict

Road user behaviour in a conflict situation can normally be divided into two parts. The first phase is the evolvement of a conflict due to the existence of a collision course and up to the onset of the collision evasion manoeuvre. The second phase concerns the dissolvement of the conflict situation due to the evasive action.

The characteristics that play a role in the creation of a conflict situation are type of road user, speed, a collision course and type of manoeuvre.

Details of the traffic process during the manoeuvre, such as strength of deceleration, severity of swerving, proximity and speeds all form part of the determination of the conflict severity.

A collision course exists if the two road users are going to collide unless at least one of them changes some aspect of his approach, i.e. speed or direction.

3.3.2 Registration of conflicts

The observation and registration of conflicts is a highly structured process. Observers will normally have been trained how to observe traffic, how to detect a conflict and how to register it on specially prepared forms. Some idea of the information to be observed and registered can be obtained from the sample conflict form attached in Appendix 3.

3.3.3 Data collection procedure

Previous experience has shown that it is necessary to give observers very explicit instructions to ensure that they carry out the types of observations that will be useful in the study. Each observer should be given the following written information:

LOCATION of the site to be studied
DAY and DATE on which the observations are to be carried out
PRECISE TIME PERIODS for which he/she is expected to observe
POSITION AT THE SITE from which they should carry out their

observations
TYPES OF CONFLICTS they should record

Information regarding position at the site and types of conflicts to be recorded can be included on the diagram of the site given to the observers along with the recording sheets. The position from which the observations should be carried out can be marked on the site diagram. Conflicts to be recorded can also be indicated by showing the manoeuvres of interest only on this diagram.

Trained observers, usually teams, are positioned at the location under observation to be able to detect the conflicts with a perspective as close as possible to that of the road users involved.

For registration the observer uses the appropriate recording sheet. The traffic volumes are recorded in an analogous way.

For conflicts with left-turning vehicles involved encounters can be registered in addition to the volumes.

For studies with special emphasis on pedestrian and cyclist conflicts it seems useful to note encounters and violations of traffic laws. At locations with low traffic volumes and few conflicts the observer has to register traffic volumes, encounters, violations and other critical incidents in addition to the conflicts.

The exact position of observation should be pointed out to each observer as should be the exact area of observation, which should also be marked on the observation sheets on which the observer marks the conflicts.

3.3.4 Observation periods

As road accidents can occur at any time of day, conflicts should, perhaps, ideally be observed for the full 24 hours in order to reflect all normally occurring traffic and lighting conditions. However, this is obviously impractical and a good compromise, on which validation studies have been based, is an observation period of 10 hours per day from 08.00 to 18.00 hours. This period spans most of the morning and evening rush hours, any minor peaks which normally occur around the lunch period, and also relatively low flow conditions.

It has been found that as long as observers can be accommodated in relative comfort, preferably in a vehicle parked in a suitable viewing position off the carriageway, then satisfactory concentration can be maintained for 5-hour periods on site per day.

The aim of site observations is, of course, to obtain reliable mean daily conflict counts and, although day-to-day variation does appear to depend on type of site, in most cases three days of observation is the normal period used. Spicer et al (1980) and Hauer (1978) have shown that the increase in accuracy per additional day diminished rapidly and there is not much to be gained by counting for longer than three days.

Observation periods also depend on traffic flows and types of conflicts. Glauz and Migletz (1980) showed that observation periods needed to obtain reliable counts varied from 3 1/2 hours for single direction conflicts to 10 hours for cross traffic from right.

The Swedish technique requires a standard observation period of three days, i.e. 10 hours (Mattson, 1983). The German technique states that 12 hours of observation during one day leads to a coefficient of reliability of 0.83 (Erke and Gestalter, 1983). This can be increased to 0.91 for 24 hours and 0.95 for 60 hours of observation.

3.4 Data analysis and diagnosis

When the recording sheets are received from a conflict study they should be arranged in chronological order and checked whether they have been correctly filled in. A diagrammatic representation of the data collected should then be made showing the number of conflicts observed classified by the manoeuvres involved. Some distinction should be made between the numbers of Slight and Serious conflicts observed, since researchers have found higher correlation coefficients between Serious conflicts and Injury accidents than between Slight conflicts and Accidents. A large number of rear end conflicts are often recorded particularly at sites where the flows are high. If an accident did occur in this type of situation, at low speeds, it would probably be minor, involving damage only. Therefore it has been suggested that analysis should concentrate on conflicts where the paths of the vehicles involved crossed and merged. FIgure 2 shows an example of the sort of diagram resulting from data collected at a T-junction. Such diagrams can then be used to determine where within a junction the problems are occurring. All relevant conflicts can then be studied in more detail by referring back to the original record sheets.

It is assumed that the purpose of the study will come under one or more of the headings below:

- To supplement existing accident data and suggest possible remedial measures.
- To evaluate proposed remedial measures, without waiting for an accident history to evolve.
- To provide a means of assessment in the absence of an accident history.

It is usual when correlating numbers of accidents with conflicts to use all reported accidents but only serious conflicts.

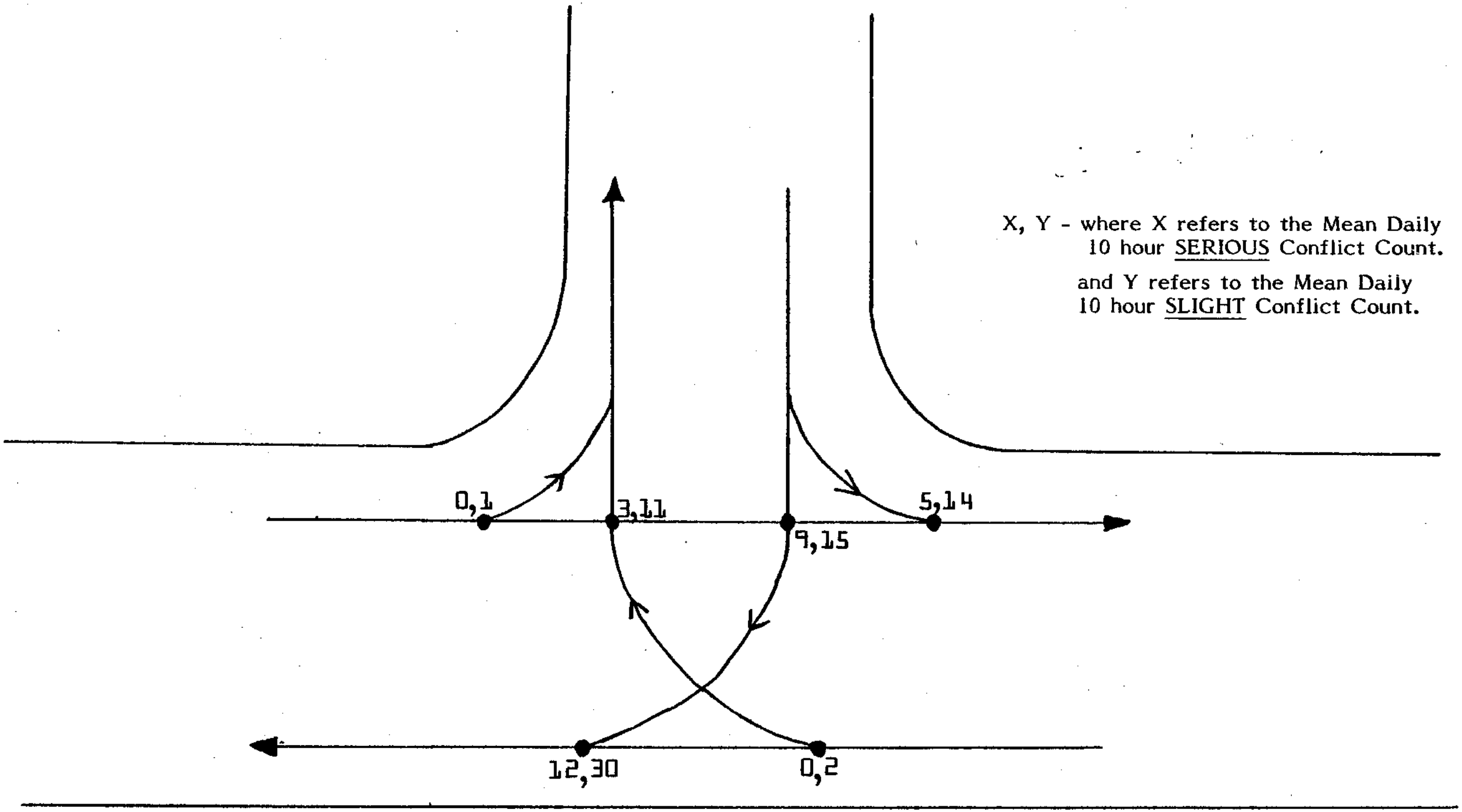

FIGURE 2. A Diagrammatic Representation of Conflicts Observed by Manoeuvres.

The use of the results from each type of study are discussed below.

- To Supplement Existing Accident Data

Often most of the serious conflicts found to occur at a site are caused by vehicles making one particular manoeuvre. If on examining the accident data it is found that most of the accidents also involve vehicles making this manoeuvre, then any remedial measures taken should be aimed at reducing this particular conflict type.

- To Evaluate Remedial Measures

Conflict studies can also be used to evaluate the effectiveness of remedial measures without waiting for an accident history to evolve. Ideally conflict studies should be conducted both before and after remedial work is carried out at a site. The data collected can then by analysed to try to answer the following questions:

1) Have the remedial measures successfully alleviated the problem identified in the before study?
2) Have re remedial measures introduced had any undesirable secondary effects on manoeuvres other than the one they were designed to improve?

Care must be taken when carrying out before and after studies that they are both conducted under the same environmental conditions wherever possible.

- To Provide an Assessment in the absence of an Accident History

In some authorities, there are very few sites with a high accident record. Most locations have an infrequent accident history and there are insufficient numbers to analyze for a dominant accident pattern to emerge. In these instances, conflict studies can indicate those aspects that may need modifying.

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4. TRAINING OF OBSERVERS

Conflict observation is a skilled activity and observers should be appropriately selected, trained and tested before they are sent out into the field for conflict registration. It is for this reason that observer training forms a central and crucial part of any conflict technique and is described in detail in the various manuals. Training packages are generally developed for this purpose.

Most TCT's use film or video as part of the training procedure. In those techniques where conflicts are scored on an explicit time-base (Sweden, Finland, Holland) part of the training is devoted to acquiring this skill. Other parts of the training to the reliable estimation of speeds, distances and conflict evolution, i.e. selecting those incidents that evolve into a conflict.

In order to obtain a reliable mean conflict count it is, of course, essential to minimize any variability in the assessments made by observers. Studies by Older and Spicer (1976) and Older and Shippey (1977) showed that good agreement could be attained between trained observers for both slight and serious grades of conflicts.

It is considered that conflict studies could be carried out more cheaply and would be more widely used if an easy and effective training package is available such that part-time workers could be trained to carry out conflict data collection reliably. Although time-lapse film has been used extensively for development of the conflict technique, on-site observers are again cheaper overall and results are obtained much more quickly than with film methods.

A pilot study in England employing a group of students and housewives who were asked to identify and grade conflicts from film (Lightburn and Howarth, 1980) showed that subjects could produce reliable results which could be improved by increasing the length of training period. By the third day of this study (a total of 9 hours training) the correlation coefficient between subjects was 0.68 and the mean correlation coefficient for within-subject reliability was 0.75. However, this latter figure showed considerable variance, and poor quality subjects were shown to greatly influence the reliability of results. It was therefore recommended that trainers should be discriminating in their final selection of observers to be used for field studies.

4.1 The training manual

A training package normally comprises a manual and 16 mm time-lapse film or video containing examples of conflicts taken from real-life situations. The first part of the manual is generally concerned with the rationale for conflict studies and advice on study design. The need to use conflict data as a supplement and not a replacement for accident investigations is stressed and limitations of the technique are outlined. These include the subjectivity of data collected and the fact that conflicts cannot be expected to identify all accident types (e.g. single vehicle accidents) or to reflect accidents occurring at times of day outside the periods of conflicts observation. Conflict studies are often most useful at low traffic volume, low accident density sites.

The remaining section of the manual is used in conjunction with the training film. Each of the elements used in assessing conflicts is introduced with appropriate film examples and exercises for trainees to gain experience of identifying conflicts using the standard recording sheet.

Finally, trainees are taken to one or two sites with relatively high rates of conflict occurrence where further practice of conflict recording is carried out with an experienced observer. Satisfactory levels of performance must be attained by all trainees and if there is any doubt as to the suitability of a potential observer then such a person should not be used for field studies.

Even after completing the training package further reliability checks should occasionally be made on observers by experienced observers either on-site or from film.

4.2 Testing of observers

Observers have to be selected and trained. In many cases local authorities would want to employ part-time personnel for conflict studies. Upon completion of a training course observers will normally be tested for proficiency. Because practice is such a large part of conflict observation it will generally be advantageous to establish a permanent TCT observer team, which should be periodically retrained and tested.

Tests are normally undertaken with the aid of a video tape or film from which a variety of conflict situations can be scored. The tests should be devised in such a way as to identify a number of observer traits.

- Observer bias, where an observer is obviously scoring events differently from the norm due to a personal bias, such an observer should be removed.
- observer reliability should be tested. It is possible to differentiate between two types:
  Inter-observer reliability - the reliability between different observers grading the same event. This is sometimes called external reliability.
  Intra-observer reliability - the reliability of the same observer to grade consistently. This is sometimes called internal reliability.

Glauz and Migletz (1980) have suggested that inter-observer reliability may not be a great problem, and variance due to this source represents only a very small percentage of the total variation in the conflict counts.

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5. VALIDATION OF CONFLICT STUDIES

5.1 Summary of evaluation research

Of the various possible uses for conflict studies, as described earlier in the report (Section 1.1), only when used as safety indicators or predictors is it that the question of validity arises.

Early pilot studies by Spicer at two relatively high accident rate sites showed good rank correlations between serious conflicts and 3-year accident records classified both by time of day and manoeuvres involved. However, no statistically significant correlation between slight conflicts and accidents was found. Evaluation studies were extended to six (Spicer, 1973) and eventually fourteen sites (TRRL, 1980) having 3-year injury accident histories which ranged from 2 to 24 accidents. The overall correlation coefficient between serious conflicts and accidents was again high ($r = 0.87$). At sites where there were sufficient numbers of accidents, the types of conflicting manoeuvres were ranked in order of accident and conflict rates for each site. Spearman rank correlation coefficients ranged from 0.88 to 0.97, statistically significant at the 1 per cent level, demonstrating that serious conflicts are a good indicator of the vehicle manoeuvres most frequently resulting in accidents. Again, no relation between either slight conflicts and accidents or traffic flow and accidents was found.

Recently completed work by Swain and Howarth (1983) has provided further evidence of the relationship of serious conflicts with accidents. Their results indicated that the relationship varied with type of site but comparing data from the most common type of junction used in the study (i.e. 8 unsignalized T-junctions), a Spearman rank correlation coefficient of 0.87 was obtained between serious conflicts per vehicle and accidents per vehicle. Total inflow was found to have non significant correlations with accidents and serious conflicts.

Williams (1981) in a review of conflict studies questions their validity in predicting accidents and concludes that ..."A review of evaluation studies fails to confirm that the method can perform these tasks..." (i.e. estimating accident potential or indicating methods of reducing hazardous conditions).

Further critical reviews were mentioned earlier in the report (Chapter 1) Glennon (1977), Engel (1985a).

5.2 A theoretical framework

A detailed framework for the consideration of conflict techniques validity was presented by Hauer and Garder, (1983). Having defined safety of a traffic system as "the expected number of accidents by severity occurring on the system per unit of time.", he then presents an operational definition of validity as

"A technique for the estimation of system safety is 'valid' if it produces unbiased estimates the variance of which is deemed to be satisfactory".

It thus becomes a question of the accuracy of safety estimates from conflict studies. The rate of conflict occurrence and the expected rate of accident occurrence must be related in the following manner.

$$\left\{\begin{matrix}\text{The number of accidents}\\ \text{expected to occur on a}\\ \text{system during a certain}\\ \text{period of time}\end{matrix}\right\} = \left\{\begin{matrix}\text{Number of conflicts}\\ \text{occurring on the}\\ \text{system in that time}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Accident to}\\ \text{conflict}\\ \text{ratio for}\\ \text{that system}\end{matrix}\right\}$$

or in symbols $\lambda = c \cdot \pi$

Thus, to obtain an estimate $(\hat{\lambda})$ of the expected number of accidents (λ), an estimate $(\hat{c})$ is used being the number of conflicts (c) and multiply that by an estimate $(\hat{\pi})$ of the accident-to-conflict ratio (π).

It appears that most doubts about the validity of the TCT center on the issue: is the accident-to-conflict ratio a stable and reliable property of the conflict event and therefore common to all systems or does it fluctuate unpredictably from system to system?

Hauer presents a framework for discussion, develops reliable unbiased estimators and examines their performance in a simulation study.

One recent large-scale study in which conflict observations were validated on the basis of Hauer's method was conducted by Migletz and Glauz (1985). Accident/conflict ratios were statistically determined for several types of collisions for each of four types of intersections (signalized-high volume, signalized medium volume, unsignalized medium volume, unsignalized low volume). These ratios, which vary greatly by type of conflict can be applied to comparable locations to obtain an expected accident rate of a specific type. Overall, traffic conflicts were found to be good surrogates of accidents in that they produce estimates of average accident rates nearly as accurate, and just as precise, as those produced from historical accident data.

In view of conflict's additional advantages in terms of diagnosis and understanding and for those locations where reliable accident data are not available, conflict studies therefore seem a promising tool.

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6. APPLICATIONS AND INTERNATIONAL COOPERATION

Having traced the evolution of the Traffic Conflicts Technique and examined its uses, strengths and weaknesses it is in order to briefly review the manner of its application in few countries and describe recent attempts for international cooperation.

Local TCT's were developed in many countries, including the U.S.A., Canada, Great Britain, France, the Federal Rebpublic of Germany, Sweden, Finland, Norway, Austria, the Netherlands and Israel.

In Germany, Sweden, Finland and the Netherlands the technique is in operational use; in France, Great Britain and the U.S.A. the technique has been developed to a stage where it can be put into operational use. In the other countries the technique is mostly applied and developed for research purposes.

Developments and uses of the TCT in some of the countries are described below.

6.1 Applications

In the U.S. the conflicts method is applied to the study of intersections which are deemed dangerous, and to design measures which could alleviate risky situations. Specially trained observation teams are used for this purpose and also for evaluating the measures already taken. The emphasis seems to be not on traffic safety, but on the elimination of operational deficiencies in the traffic system.

The Transport and Road Research Laboratory (TRRL) in England applies the traffic conflicts technique to the identification of layout-related problems and rapid evaluation of the effect of any change in design on safety. The results from site studies show the identification of hazards at certain "at grade" junctions on dual carriageway roads and the effect of traffic signal installations at these intersections; the short-term effects of introducing a mini-roundabout at a simple priority intersection; an evaluation of the effect of a traffic signal installation at an urban intersection; and the effect of increasing the entry lanes at an intersection possessing a small island-miniroundabout.

In recent years observer training procedures have been improved and a training package has been developed.

In Sweden the conflicts method is used in the evaluation of safety countermeasures. For example, measuring the effect of speed limits in the neighbourhood of schools and in the reconstruction of intersections. In recent years attempts are being made to better adapt the TCT to high speed locations. Previously it had been mostly used for safety evaluation in urban areas.

In Austria, researchers from the Kuratorium fur Verkehrssicherheit used the conflicts method in the practical study of the functioning of novel patterns of zebra crossings. Video-tape recordings of conflicts are also employed for educational purposes. The behaviour of children who had been exposed to training was video-taped for behaviour analysis. Recently the TCT was used in an evaluation of the safety of interurban intersections.

Most investigators (France, Germany, Norway, U.S.A.) deploy observers on site for identification, severity assessment and counting of conflicts. In some cases (Sweden, Finland), hard copy film or video taping is used to supplement information recorded by observers. Denmark and England explored the use of automatic detection techniques, but have since abandoned these efforts.

All these techniques and studies investigate specific locations (sites). One technique (Guttinger, 1980) focuses on pedestrians in various layouts of residential neighbourhoods. The observation of encounters and conflicts involving children (as pedestrians) is carried out by following them or by sector observations. Trained observers follow randomly selected children in a residential district for a given period of time, while the entrance to and exit from the district and schools are observed as well. In this way it is possible to compare residential neighbourhoods of different layout.

Similarly in Austria, drivers are being observed while following a certain route and conflicts are marked.

6.2 International Cooperation

In recent years international contacts led to fruitful cooperation. In 1977 the first international meeting on conflict studies convened in Oslo, Norway. The aim of this meeting was to bring together research workers for the purpose of exchange of experience and the discussion of methodological and practical developments in this field. A report of proceedings of this meeting has been published by Amundsen and Hyden (1977).

At that meeting agreement was reached on a common definition of a conflict. Also in Oslo the participants established the International Committee on Traffic Conflicts Technique, (ICTCT). The main tasks of ICTCT were seen as the determination of research aims, the development of research plans and methodologies and the stimulation of international cooperation in research.

Following this meeting the international consultations and cooperation were considerably enhanced and extended. As a result an international TCT experiment was carried out in 1979 in Rouen (France). The objective of the experiment ("calibration study") was to examine the similarities and differences between the various conflict definitions and field study practices of five countries. The participant research teams came from England, West Germany, Sweden, France and the U.S.A. In Rouen two intersections were selected with different environmental characteristics and traffic situations. The results of this calibration study are described by Malaterre & Muhlrad (1980).

According to the participants the Rouen-experiment was successful, mainly by fostering a mutual understanding of the various techniques as practiced in the different countries. However, the modes of detecting a conflict varied quite considerably from team to team. On the day of the experiment, a video-tape was analysed as well, proving that in several cases no agreement could be arrived at. More specifically differences of opinion arose when: the conflict was a slight one, just on the borderline of normal traffic manoeuvre; in case of evasive manoeuvres, when a conflict was scored, while it was not clear that two cars were on a collision course; in some cases, when it was doubtful whether an "evasive manoeuvre" was being carried out; in case of a controlled but belated evasive manoeuvre; when two conflicts occurred in close succession (while recording the data of the first conflict, the observers omitted the recording of a second one); sometimes the conflict situation was hidden from the view of the observers.

Generally it was accepted that some differences in the identification of a conflict situation are caused by differences between the driving habits in France and the teams own country. The "calibration study" undoubtedly had some shortcomings. The layout of the observed intersection was complicated, with high traffic flows. Most countries sent teams consisting of less observers than is usual in their own country. In addition, it was difficult to find suitable observation posts. Not all the teams were working simultaneously and consequently not all the obtained data were comparable. In the end, only general comparisons were made and no detailed comparative analyses between the various teams were possible.

The Second International Workshop on the Traffic Conflicts Technique was conducted in Paris (1979) after the conclusion of the Rouen study. At its conclusion a steering committee was established so as to continue to foster international cooperation and promote the further development of the TCT. The proceedings of this workshop were published by the Transport and Road Research Laboratory, (Older & Shippey, 1980). During the Second Workshop it was also decided to conduct a further calibration study, to be designed in more detail by the steering committee, with the following aims:

- to design guidelines for the conduct of an international calibration study to establish the relationships between conflicts detected by different methods, as applied by teams from various countries.
- to specify a research outline for an international validation study of conflicts to establish functional relationships between

accidents and conflicts.

These proposals and the detailed design of the calibration study were further discussed at the third International Conflict seminar held in Leidschendam, Holland and reported in Kraay (1982).

Prior to the conduct of the calibration study in Malmo (Sweden) an international seminar was held in Kopenhagen (1983). Latest developments were discussed, each country described its conflicts technique and details of the Malmo experiments were explained and discussed. Proceedings of the seminar are reported in (Asmussen, Ed. (1984)).

6.3 The Malmo Calibration Study

The study was aimed at a detailed comparison of the various techniques to establish similarities and differences. Special attention was given to the agreement between teams on the identification of conflicts as influenced by location, type of manoeuvre and traffic participant. A longer term aim was to establish ways to and criteria by which data collected by various techniques could be interpreted and compared. Such results would be very promising in terms of international cooperation and comparability. Results from the Malmo experiment are described in Grayson (1984).

The Malmo experiment was conducted at three intersections. Observations at each intersection lasted three days, 6 hours per day, during 0700 and 1800. A uniform observation protocol was applied. Eight teams participated in the experiment: Austria, Canada, Finland, France, the Federal Republic of Germany, Great Britain, Sweden and the U.S.A. Israel and Belgium participated as observers. The Dutch team, apart from its organizational input, also recorded all conflicts on video and provided a quantitative analysis of each conflict including speeds, distances, deceleration and time-to-collision (TTC). The detailed analysis was conducted by the Dutch Institute for Perception IZF-TNO. A statistical analysis of all collected conflicts and a comparison with the objective video analysis was conducted by SWOV.

An overview of the conflict definitions and severities used by the teams is given in Table 1.

Table 1. Overview of Conflict definitions and severities used by the 8 teams participating in the Malmo experiment.

	Conflict definitions			Severity	
	Estimate of		Interpretation of avoidance action	Based on proximity to	
	TTC	PET		Collision (all)	Injury Accident
Sweden 1	fixed step-value			X	
Finland	fixed step-value				
Sweden 2	fixed value				av'g spd & type of user
Sweden 4	step value depending on speed			X	
Canada		fixed step-value	X		
England			intensity & result		X
France 2			intensity & result		
France 1			intensity & result	X	
U.S.A.			intensity & result		
Sweden 3			intensity & result		
F.R.G.			intensity & result	X	
Austria			intensity & result		
Holland	minimum value			X	

In total about a thousand conflicts were scored by at least one team in nine days of observation.

Large differences were found in the number of scored conflicts by each team, depending on conflict type. The team with the largest number of conflicts recorded almost four times as many conflicts as the team that scored least.

A multivariate analysis of the subjective scores shows that the data possess a one-dimensional structure which can be defined as a severity scale. On average, conflicts are scored correctly on this scale by all teams. This means that the degree of severity is a common concept among the teams even though definitions and methods of observation differ.

Additional differences between team scores exist. The variability in scoring applies mostly to the level of detection of conflicts but less to the rating of severity.

A comparison of the subjective team scores with the objective video analysis shows that the most important variable is time-to-collision (TTC). Other important aspects of the conflict situation are minimum distance, conflict type and to a lesser extent type of manoeuvre.

Results indicate that in scoring severity observers also use a subjective dimension which depends on various aspects of the traffic situation s.a. chance of serious injury.

Because of the limited nature of the study it was not a major aim to correlate conflicts with accidents. However on the basis of their observed conflicts, each team also prepared a diagnosis of the safety problems at the three junctions. These diagnoses were in fair agreement with the accident analysis. results from the Malmo-calibration study were presented and discussed at a fourth international workshop held in Leuven, Belgium in 1984.

A second calibration experiment was also undertaken recently in Trautenfels, Austria (September, 1985). Teams from Austria, France, the Netherlands, Sweden, Israel, the U.S.A. and Finland participated in a calibration study and safety diagnosis of a rural intersection in Austria. The study was conducted along lines similar to the Malmo-study. Results from this study should be published during 1986-87.

6.4 Future developments and cooperation

These calibration experiments can be regarded as significant steps towards a more systematic and methodologically justified application of conflict techniques. From these experiments similarities among the different techniques were established , as were those aspects of the techniques of importance in determining a conflict's severity. A large amount of variation was found in the selection of situations which were included as "dangerous" but, once selected, a great deal of agreement was found in the scoring of those situations and in the use of objective criteria of assistance in scoring.

An important next step, after the calibration studies, is to see in what way the various situations selected are related to safety, i.e. validation studies. With the aid of these calibration studies it should be possible to check the amount of agreement and overlap in previous, limited, validation studies carried out in various countries.

ICTCT sees three areas of development as important in further international cooperation.

- The preparation of a set of guidelines on the conduct of conflict-studies of use for potential users of a conflict method. The current document should go part way to fulfil this need. Results so far, with the knowledge obtained in the calibration studies, are seen as promising enough to assist potential users in the selection of a method suited to their purposes.
- Validation of conflict methods. Again the calibration studies have facilitated the transfer and comparability of results from different countries. This knowledge should increase the extent of international cooperation.
- The flexibility of conflict methods, with the various techniques that have now been developed as a means of systematic observation should enhance our understanding of road user behaviour. It should be possible to explore and develop new applications in fields such as traffic education, driver rehabilitation, in-depth accident investigation and other subjects.

Thus it appears that, at present, the TCT in its many variants seems to be applied to the following diverse uses:

a) detection of operational deficiencies in traffic systems.
b) identification of proper corrective measures for the rectification of operational deficiencies.
c) evaluation of the effects of corrective measures on operational deficiencies.
d) detection of safety problems and shortcomings.
e) evaluation of the safety effect of countermeasures.

The question of validity which has been mentioned briefly earlier and which was discussed in Chapter 5 can now be posed with clarity. For uses a, b and c the existence of a relationship between conflicts and safety is of little concern. In these cases the question is whether the rate of conflict occurrence is an appropriate surrogate for road user irritation, discomfort and whatever is contained in the term "operational deficiency".

It is only for uses d and e that the problem of validity (are conflicts indicators of safety) arises. The use of the TCT for safety estimation depends on the existence of a stable relationship between the rate of which conflicts occur and the rate at which accidents occur.

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APPENDIX 1

SHORT HISTORICAL SURVEY OF TRAFFIC CONFLICT TECHNIQUES

This appendix contains a short historical survey of the evolution of the conflict observation techniques in various countries. Only the most significant developments are discussed.

Observations on conflictive behaviour between motor vehicles were carried out as early as 1954 (McFarland & Moseley, 1954; Forbes, 1957). However, the systematic development of a method for measuring conflictive traffic behaviour started only in 1966.

In one of the first studies, Perkins & Harris (1967) considered two categories of conflicts: sudden actions by the drivers in order to prevent a collision (braking and changing of lanes), and traffic offences. Perkins & Harris investigated five types of conflicts at intersections: left turn, change of lane, crossing traffic, driving through red light and insufficient distance between vehicles. For the intersections at which conflict counts were conducted accident data were available for a period of one year only. Therefore it was not possible to examine the relationship of conflicts to accidents. Nevertheless, the reliability of the method seemed satisfactory.

Campbell & Ellis King (1970) carried out an investigation using the same technique and conflict types as Perkins & Harris with similar results. The only difference being that they used two years of accident data instead of one. Baker (1972) evaluated the conflict technique developed in the General Motors Research Laboratories. Based on results of several field studies the statistical relationship between accidents and conflicts was investigated. The data collected in this study verified the hypothesis that conflicts and accidents are correlated. However, the coefficient of correlation was in most cases disappointingly low.

Spicer (1971) considered as "conflict" a sudden action such as braking or changing the lane, involving one or more vehicles, in order to prevent a collision. However, such a broad definition of the conflict event did not indicate existence of a close relationship with accidents. Subsequently five classes of severity were established to distinguish serious conflicts from the less serious ones. A serious conflict was said to occur when, in order to prevent an accident, the driver of a vehicle has to apply the brakes suddenly or has to swerve or come to a sudden stop, all these actions taking place in close proximity to another car and with no time to carry out the normal, controlled crash-preventing manoeuvres. The association between acidents and serious conflicts, established according to the hour of the day and the place on the road, seemed to be strong and statistically significant. In 1972 Spicer verified the findings of the investigation of 1971. Later Spicer (1973) repeated his 1971 investigation and extended it to five more intersections.

In this case it was also possible to establish a relationship between serious conflicts and accidents, which was quite close regarding manoeuvering and positioning on the road as well. These results seem to validate the use of the traffic conflicts technique as a relatively rapid method of studying the traffic safety at intersections.

In recent years (Baguley, 1984) studied fourteen sites having three years injury accident histories. Using the method developed at the TRRL for conflict observation he obtained a high overall correlation coefficient between serious conflicts and accidents ($r = 0.87$).

At sites where there were sufficient numbers of accidents, the types of conflicting manoeuvres were ranked in order of accident and conflict rates for each site. The correlation coefficients ranged from $r = 0.88$ and $r = 0.97$; statistically significant at the 1 percent level.

A study of the variation in daily conflict counts has been extended to include a further 17 sites each observed for 6 days (Baguley, 1982). Results from this study has not yet been documented.

Paddock (1974) surveyed the General Motors method as applied in many field investigations. He conludes that: the hypothesis that serious conflicts are correlated with accidents is verified; on the basis of experience in various states of the U.S.A. it appears that traffic safety problems at intersections can be identified quickly and in a reliable manner; the TCT is particularly suitable for use at low volume intersections; the technique leads to identification of low cost countermeasures; the effects of countermeasures at intersections can be evaluated within a short period of time; in addition to intersections, the technique can be applied to other traffic situations as well.

In Sweden PLANFOR (1972) developed a technique, which was tested in Uppsala in 1972. Here, the risk of injuries varies in accordance with the type of the traffic environment, the traffic situation and the vehicle. All these factors constitute conflict categories. Conflict categories with specific risks of injury are selected by means of accident analyses. Within each conflict category the risk of being injured varies in relation to the volume of the traffic flows which may cause conflicts. A conflict situation can be characterized as an uncontrolled manoeuvre carried out in order to prevent a collision or a dangerous manoeuvre resulting in an uncontrolled situation with the drivers missing each other closely. These definitions are essentially in accordance with those of Spicer (1971).

To eliminate the subjective character of conflict identification, Hayward (1972) recommends to measure the time to the moment of potential collision between two cars, were their speed and course to remain unaltered. Hayward's analysis indicates that a "time-to-collision" of one second or less is a reliable criterion for identification of near-misses. The obvious drawback of this method is its tedium and expense. A TV camera has to be continuously in operation. Relevant events have to be identified and the time to collision measured for each.

Hayward's basic idea was further explored by several other researchers. Thus, for example Hyden (1975 and 1978) based his research on the "time-to-collision" concept. His purpose was the estimation of risks to pedestrians and cyclists under varying environmental conditions and varying exposure to car traffic. In contrast to Hayward's labourious method, Hyden estimates time-to-collision in the field with the aid of trained observers. After years of work and development with this technique Hyden (1984) developed conversion factors from conflicts to accidents. Data from a total of 115 intersections were collected. At each intersection, conflicts were recorded during approximately seven hours and compared with injury-accidents during the proceeding 7-8 years. Average ratios were established between the number of serious conflicts and accidents, segregated by type of road-user (car-car, car bicycle or pedestrian) and type of intersection (low speed, high speed). Other variants of this idea can be found in the works of Hakkert et al. (1977) and Van der Horst & Riemersma (1981). This technique permits an objective definition of course and course changes, speed and speed changes, minimum distance and minimum time between road users. Van der Horst & Symonsma did not work with observers in field situations, but made video films, followed by quantitative read-out and analysis. Van der Horst et. al. at the IZF.JNO significantly developed the objective analysis of the TTC concept.

Most researchers continued to expand and develop the ideas of Perkings and Harris. Thus for example Erke & Zimolong (1978) studied three signalized high volume intersections in German cities. The conflict types to be identified were defined for both the intersection area and the approaches. In order to be able to analyse the relationship between accidents and conflicts, a systematic assignment system to link conflicts and their causes was developed. For some traffic situations the investigation demonstrated a relatively close relationship between the types of conflicts observed and the corresponding accidents recorded by the police. In France, Malaterre & Muhlrad (1976) came to the same conclusion in their studies, although using different conflict definitions. Comparing the accidents at eight urban intersections with the results of the conflict observation study they conclude that there exists a correlation between conflict and accident rates and also between conflict and accident types.

Automatic detection of the proximity of vehicles, using a complex array of sensors on the road for subsequent computer analysis was developed in the U.K. by the Transport and Road Research Laboratory (Older & Shippey, 1977), but has since been abandoned due to its complexity and unreliability. Based on detailed analysis of the relationships between conflicts and accidents, Cooper (1977) concludes that "post encroachment time" seems to perform best. Post encroachment time is defined as the time from the instant a turning vehicle encroaches on a through lane to the instant the through vehicle arrives at the potential collision point.

So far most studies described above applied a TCT to a specific location, generally intersections. TCT's were also adapted to situations wherein a road user is followed. Guttinger (1982) had observers follow child pedestrians in residential areas. 25 locations with a maximum length of 100 metres were selected. Each location was observed for 34 hours. Correlations between serious conflicts and 5 year accident records were generally good.

Risser (1984) observed 200 subject drivers while driving along a standardized route in Vienna. Two observers in the car recorded the conflicts. These conflicts were compared with the subject's previous accident record. Correlations for individual drivers were not high but aggregate correllations for the 37 route sections was quite high (r= 0.73 between conflicts and serios injuries).

Kulmala (1981) used a variation of the Swedish technique with the time to collision concept in a study of 13 pedestrian crossings. Conflicts observed over a 6 hour period were compared with 6 years of accidents at those locations.

Recently the U.S. completed a large scale validation study of their TCT. Relationships between accidents, conflicts and traffic volumes were studied at 46 intersections in Missouri. Accident to conflict ratios were established for various intersection types, road conditions and manoeuvres. Overall it was found that conflicts are a quite accurate predictor of the expected number of accidents.

In this brief review no attempt has been made to achieve comprehensive coverage. The intent was to give the reader an impression of the main concepts and ideas and some historical perspective. Several comprehensive surveys, reviews, bibliographies and critiques on this subject are available (eg Williams (1984) v.d. Hondel and Kraay (1979), Glennon et al (1977), Kraay (1983), Engels (1985) and Grayson (1984). Methodological discussions can also be found in Hauer (1983) and Oppe (1984).

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APPENDIX 2

STANDARD DESCRIPTION OF NATIONAL TCT

Definition of conflict:	2-3 lines
Special features of technique:	
Quantitative TTC estimate:	yes/no
Use of TTC or PET:	
Degrees of Conflict Severity:	
No. of conflict types:	
No. of vehicle manoeuvres:	
Estimate of approach speeds:	yes/no
Type of technique:	static/moving observer
Type of road users studied:	
Use of standard recording sheet:	yes/no
with sketch of location:	yes/no
Types of situations studied:	1-2 lines
Method of observation:	trained observers, film, video, combination
No. of observers:	
Training procedure:	3-4 lines
Use of film or video in training:	yes/no
Short description of applications:	2-3 lines
In operational use:	yes/no
Agency to contact for further details:	

Appendix 3 ICTCT - CONFLICTDATASHEET - AUSTRIA 1985

ID-code: ....

Intersection: Trautenfels B 308/B 145 .... Date: ....

Team: ☐ A ☐ ☐ D ☐ ☐ F ☐ ISR ☐ NL ☐ S ☐ SF ☐ USA

Observer: ....

Precise time of conflict: .... hour - min - sec | N:o

Road-users involved:

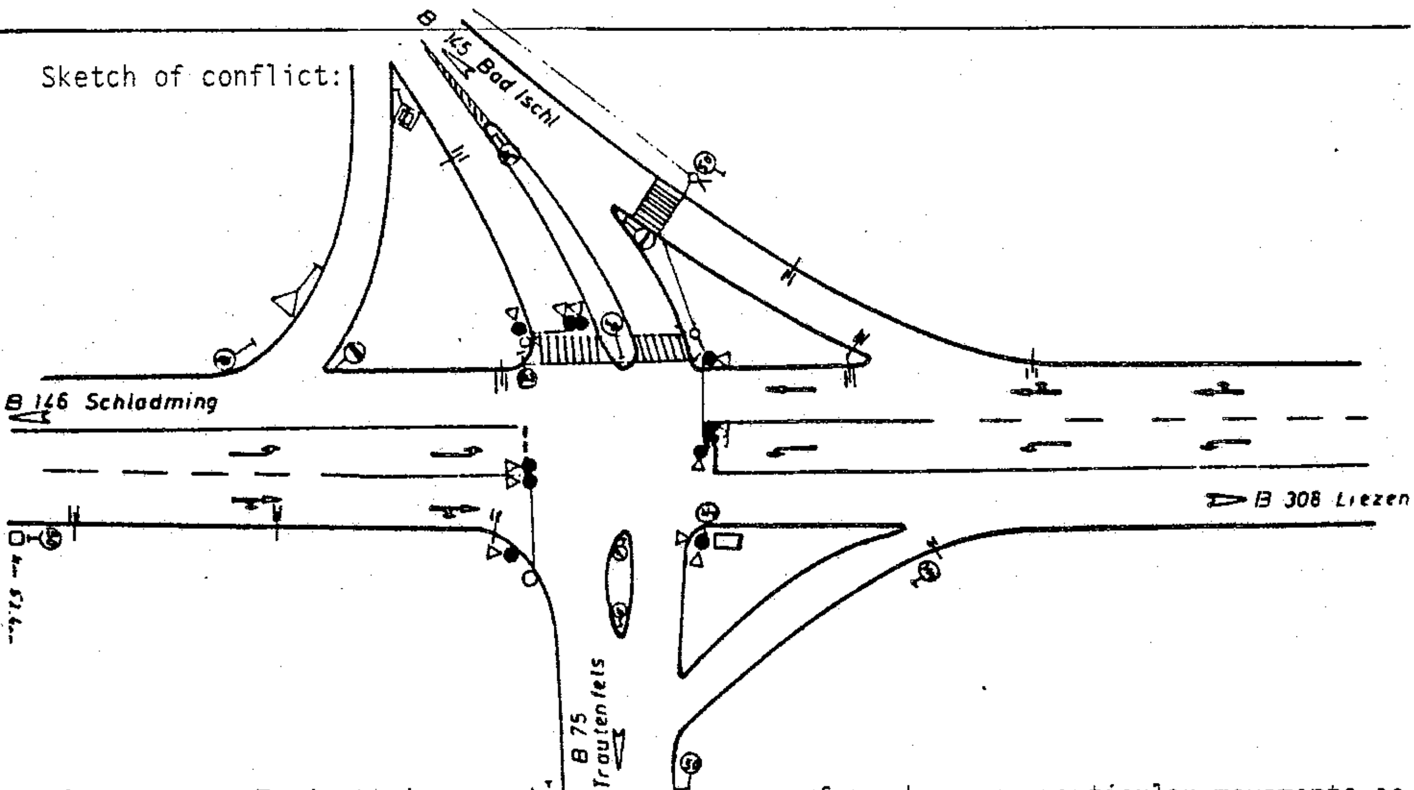
1) ___ ....
2) ___ ....
3) ___ ....
4) ___ ....

C = Car
T = Taxi
P = Pedestrian
B = Bicyclist
M = Moped
Mc = Motorbike
Bus= Public transport
L = Lorry
O = Others

Please note for,
Cars: colour,type
P/B/M/Mc: age,sex

Severity rating: ___ ___ ___ ....

Sketch of conflict:



Please note: Trajectories, number or reference of road-users, particular movements as breaking, stopping, skidding, falling etcetera.

Additional data/Comments (to be defined by each team)