Gerald. R. BROWN
Department of Civil Engineering,
University of British Columbia
and
Peter. J. COOPER
Safety Research manager,
Insurance Corporation of British Columbia

ROLE OF CONFLICTS IN TRAFFIC ANALYSIS

Introduction

While traffic conflicts have been advocated for about two decades as a quantitative measure of roadway hazard, traffic engineers have been slow to adopt the traffic conflicts technique as a means to analyze roadway safety. Because traffic engineers have been trained to associate roadway hazard with accidents, much of the research into traffic conflicts has sought to find a correlation between accidents and conflicts; in which conflicts provide a more numerous, less randomized surrogate for accidents. One elegant expression of this role for traffic conflicts is by Hauer and Garder (1986) who relate conflicts to expected accidents through an accident + conflict parameter which provides a ratio of accidents to conflicts for the entity under investigation. It is still too early to determine if a set of parameters exists, and if so, the functional relationship between traffic conflicts and traffic crashes (Williams, 1981; Glauz et al, 1984). In addition to this research thrust, it appears appropriate to view traffic conflicts as unique indicators of roadway hazard within the traffic flow process. In 1984 the authors undertook a research project designed primarily to develop an approach and a technique which would be accepted by traffic engineers as a useful means to evaluate roadway safety. This is a brief report on the approach taken to traffic conflicts vis-a-vis accidents, and some preliminary conclusions derived from the conflict studies done to date by traffic engineers.

Approach

The approach is to look into the driver behaviour process for evidence of hazard as proposed by Oppe (1985), rather than to look to the accident record as an exclusive indicator of roadway hazard. Two models of the process are extant: van der Horst and Riemersma (1981) view the traffic process as a continuum of events from encounters through different levels of conflict severity to actual accidents; and Hydén (1987) postulated a pyramid of events made up of undisturbed passages at the base to fatal accidents at the apex. In both the continuum and pyramid models accidents are a sub-set of conflicts and are connected by conditional probabilities, with probabilities likely influenced by fewer external factors and more by chance toward the accident end of the model (Grayson and Hakkert, 1987). A conflict is viewed as a critical event on the modeled dimension.

The authors view the traffic conflict as a traffic situation which may or may not be the pre-condition associated with an accident. The object of conflict is defined in driver behaviour terms as the successful avoidance of contact. The driver behaviour process is perceived to consist of two safety dimensions: one leading to accidents and one leading to conflicts. We can observe the latter process but not the former. The information content of the conflict situation is relevant only for the conflict, but we suggest this information should be used for engineering design. Conversely, the information contained in the accident event, which in any case we cannot observe, is not necessarily relevant to the driver behaviour leading to the accident. A description of the process is given in the Appendix.

An illustration of the soundness of the approach outlined here is given by Figure 1 on which the observed evasive actions are close to the mid-point of the acceleration ramp (2b) while the accidents occurred at the gore (2a). The information contained in the accident record indicates a headway problem while the information in the conflict situation indicates a weaving problem. This is clearly seen on 2c where the minimum time to collision, taken as 1.5 s occurs almost .75 of the distance along the acceleration lane ramp.

Of course, by defining conflict as an observed successful avoidance of contact situation it is possible to overlook accidents that contain little or no information about the driving process. Therefore, for a complete analysis of safety both conflicts and accidents should be analyzed.

The quantitative measure of conflict used is the time to collision (TTC) or the time from an evasive action (to avoid contact) to the hypothetical point of contact. A second, non-observable criterion for conflict is the minimum time to collision, being the minimum time distance a driver will leave between his vehicle and potential contact. These concepts are shown on Figure 2. Threshold values for TTC and TTC_{min} which appear reasonable at this time are 1.5 second and 1.0 second respectively; values confirmed by a field experiment on braking in 1989 which gave a TTC_{br} of 1.6 second at a speed of 50 km/hr, and a TTC_{min} of 1.1 second (van der Horst and Brown, 1989).

The Procedure

The research program aimed to develop a practical procedure to use conflicts as a method of complementing other information in the analysis of road intersections. Because the conflict situation itself is the object of study we tried to avoid the tendency to worry too much about association with accidents; but since we thought we would need to relate conflicts to accidents to market the procedure, we evaluated the 5 year accident records against 16 hour conflict counts for 13 intersections. As well, seven of these intersections were used to assess the reliability of traffic conflicts to evaluate the effect of intersection improvements. This work has been reported elsewhere (Brown and Cooper, 1986) and in general shows that (1) severe conflicts have some correlation with accidents for some movements and (2) conflicts decrease with the installation of signals at 3 out of 4 intersections. Weaving and rear end conflicts showed no correlation with accidents (as you would expect from Figure 1).

The observation procedure which evolved from these studies has two features which are worth noting. The procedure establishes time to collision zones on the roadway approach under investigation to facilitate an observer's ability to record the time-to-collision value based on the zone the vehicle occupies when the evasive action takes place. A second feature of the technique is an evaluation of risk of collision (ROC) being the observer's judgement of risk based on physical proximity, speed, and other factors associated with the conflict being recorded. A composite severity score from two 3 point TTC and ROC scales is used, with TTC 1.5 seconds and moderate ROC taken as the threshold for a severe conflict. This converts to a score value of 4.0 on the composite severity scale.

Monitoring and documenting observer reliability indicated that 3-5 days' training, using video feedback with 5 cycles of field observation and de-briefing produced about 75% reliability, both for identifying conflicts and estimating the severity. To transfer the procedure to the professional community, a training film was produced along with an observer's instruction manual. This training program has been carried out over two summers with consulting engineering firms.

The overall result of our training produces the following reliabilities: recognition of a conflict event 73%; correctly scoring ROC = 85%; and correctly scoring the TTC = 76%. Problems found in training have been minimal. It is difficult to find the number of conflicts one would wish to observe in the limited time for training; and too many observers and video cameras at an intersection will change drivers' behaviour, with fewer conflicts recorded than normal.

Applications

The traffic conflicts procedure has now been applied to some 20 intersections as part of municipal traffic engineering studies. These studies are being conducted by traffic engineering consultants trained in traffic conflicts observations and include capacity analysis, accident analysis, and conflicts analysis. Some intersections had very few accidents, but nevertheless studies were done because of public complaints or a concern with safety, even in the absence of a large number of accidents.

In a review of five of the completed studies, listed under References, the following conclusions emerge. First, it is evident that conflicts are a valuable (and perhaps necessary) component of the tripartite analysis to understand how poor operation of traffic at the intersection causes safety problems. Conflicts were used in these studies to find unsafe practices with regard to signing and traffic signal control; even though these practices were not creating a great number of accidents. A second, unexpected, finding from the studies was that a number of problems were evident during the noon-time period. It appears that traffic control systems and signal splits are by and large designed for peak periods, and are operating inefficiently during the mid-day period. Drivers are observed to be impatient with the operation of the intersection and take risks, resulting in conflicts; particularly, left turn movements. Sometimes the problem could be revealed by the accident record, sometimes not. Thirdly, it appears from these studies that conflicts are recording a different dimension of hazard than accidents, although the reports were cautious in interpreting results which would lead to recommendations based only on traffic conflict counts. Four of the five studies had no conflicts with severity as much as 4.0; nevertheless, improvements were recommended (particularly signal timing changes). In addition, the authorities charged with the responsibilities for the safety of roadways appear to believe the conflict analysis is producing useful results for decision making.

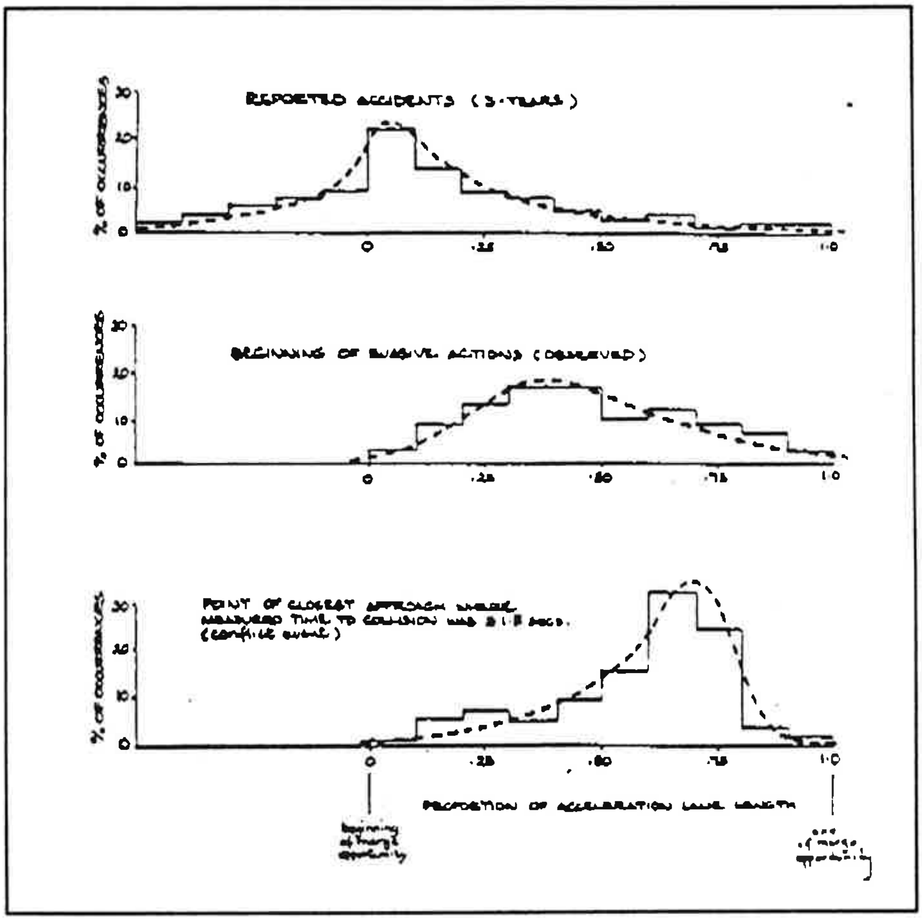


Figure 1: Comparison of Accident, Evasive Action and Conflict Distributions by Position Relative to End of Acceleration Lane. [Unpublished Data from Transport Canada Studies During 1974-77]

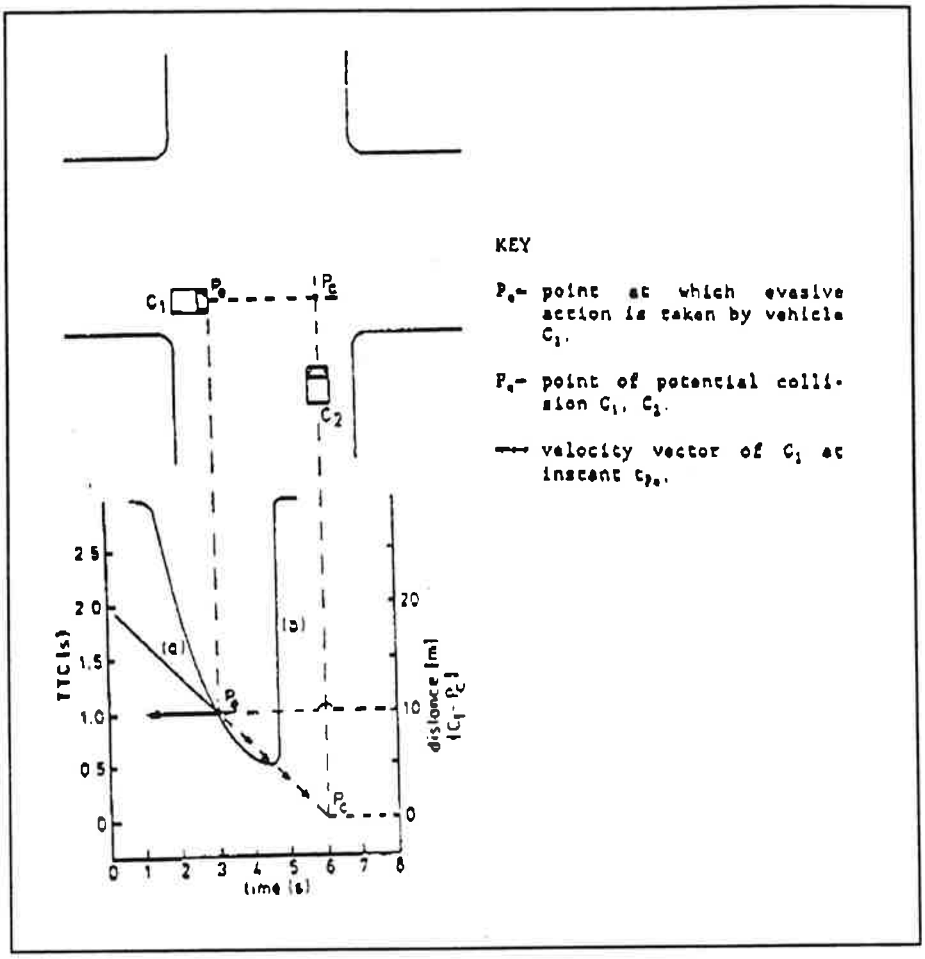


Figure 2. Concept of Time to Collision (TTC) as a Quantitative Measure of Traffic Conflict

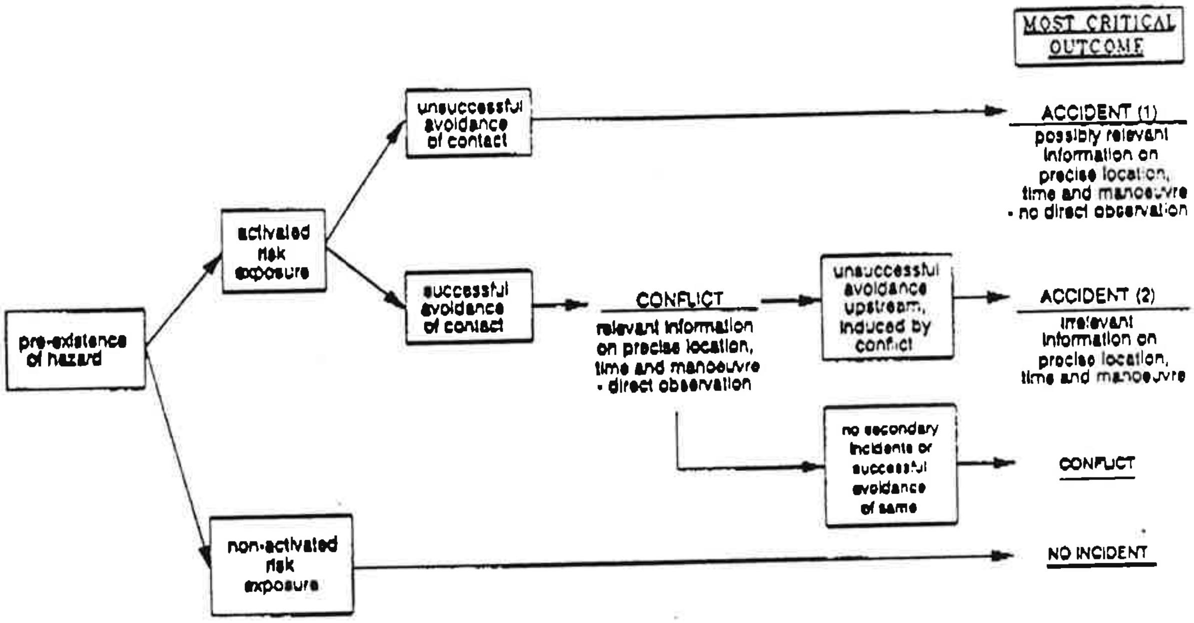
Appendix

by P.J. Cooper

The process which gives the relationship between exposure, conflicts and accidents is shown on Figure A1. This schematic represents the type of situation to which we are applying the TCT in British Columbia. That is, situations where some form of "hidden" geometric designed, traffic control or sight obstruction problem creates a hazard or contributes to driver confusion. The activation of risk exposure represents the opportunity for conflict or collision. For example, the lack of main road traffic at the time a sight-restricted minor road vehicle crosses an intersection means that no incident will occur in this instance, even though the potential for one always exists.

On the basis of such a postulated process we should not <u>necessarily</u> expect to find any direct correlation between individual conflicts and accidents. They are separate events which, nevertheless, are associated on the macro level through a common linkage with hazard and risk exposure. Thus, while such an association may lead to a statistical correlation between large numbers of conflicts and accidents, there are too many random and uncontrollable events which separate successful from unsuccessful collision avoidance for this correlation to be more than a modest one. But from the perspective of design or operational problem diagnosis, Figure A1 clearly indicates that both conflicts and Type 1 accidents should provide the same type of information since they are different only in terms of how successfully drivers react to the problem. The difficulty with using retrospective accident data is that they are often not accurate (Type 1 or 2) and sometimes not even relevant to the initiating situation (Type 2). Conflict data, however, are based on direct observation and measurement.

Figure A1: Postulated Traffic Conflict/Accident Process



References

Brown, G.R. and Cooper, P.J. (1986). Safety evaluation of intersection improvements using traffic conflicts. Proceedings of ITE Annual Meeting, Vancouver, 11-24.

Grayson, G.Grayson, G.B. and Hakkert, A.S. (1987). Accident Analysis and Conflict Behaviour. In: Rothengatter, J.A. and Bruin, R.A. de (eds.), Road Users and Traffic Safety, Van Gorcum, Assen, 27-59.

Hauer, E. and Garder, P. (1986). research into the validity of the traffic conflicts technique. Accid. Anal. & Prev. (18), 471-481.

Hydén, Ch. (1987). The development of a method for traffic safety evaluation: The Swedish Traffic Conflicts Technique. Bulletin 70, University of Lund, Lund Institute of Technology, Dept. of Traffic Planning and Engineering, Lund.

Oppe, S. (1985). Contribution to evaluation of intermediate variables: background paper. Proceedings paper. Proceedings of the International Meeting on the Evaluation of Local Traffic Safety Measures, Paris.

van der Horst, A.R.A., and Brown, G.R. (1989). Time-to-collection and driver decision-making in braking. Report 1ZF 1989 C-23, TNO Institute for Perception, Soesterberg.

Williams, M.J. (1981). Validity of the Traffic Conflicts Technique. Accid. Anal. & Prev. (13), 133-145.

Hamilton and Associates Reports,

(July 1989) Intersection Review, Lampson Street and Old Esquimalt Road, Esquimalt, B.C.

(Dec. 1989) Oak Bay Avenue and Rone Bay Road Intersection Study, Oak Bay, B.C.

(July 1990) 152nd St. and 16th Ave. Intersection Study, Surrey, B.C.

(Aug. 1990) 152nd St. and Fraser Highway Intersection Study, Surrey, B.C.

(Sept. 1990) 152nd St. and 20th Ave. Intersection Study, Surrey, B.C.