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Traffic conflicts technique - state of the art

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History of traffic conflicts

I will start with a short overview over the most significant steps in the development of traffic conflict techniques.

Starting point

The history of indirect traffic safety measures is short. The development of measures that were directly aiming at working as surrogates for accidents was starting with the development of a Traffic Conflicts Technique at *General Motors Research Laboratories* in the sixties. Perkins and Harris (1967) defined conflicts as events, where a vehicle had to brake. The brakelights were the operational criteria. The purpose of the technique was to use it to identify vehicle-related factors that contributed to safety problems. The technique was, however, only used for a fairly short period of time. The reason for this is not known by me.

The GM-technique did not include any severity grading of the conflicts. This was - with my interpretation, one of the reasons why the GM-technique did not make any big success. To record lots of events with obviously very different relation to accident risk must have produced a lot of frustration and uncertainty in interpreting the results of different studies.

Severity based definition of a conflict

The importance of severity grading of conflicts was appreciated by *English researchers at Transport and Road Research Laboratory (TRRL).* A five grade severity scale ranging from 1 = Precautionary braking to 4 = Emergency braking and 5 = Collision was established. The recording technique used by the English researchers was based on time-lapse filming, with analysis frame by frame in the laboratory. Even though it was based on a time-lapse technique, the filming and analysis was quite time consuming. The reliability and validity were quite carefully examined. The results were very promising. It was demonstrated that reliability issues - how precise conflicts could be recorded and classified with regard to the 5-grade scale -

were under good control. It was also demonstrated that the severe conflicts had a better correlation with accidents than all conflicts, i.e. including non-severe conflicts.

The English technique was extensively used for research purposes over a quite long period of time. Nowadays, however, it seems as if the use is very small. One of the main reasons is probably the time-consuming and expensive recording technique.

Time to Collision concept

In 1971 the U.S. researcher Hayward introduced a new severity concept. He based his definition of severity on the Time To Collision (TTC) - concept. The concept TTC was linked to accident situations, i.e. situations where a collision would have occurred if none of the road users involved had taken any evasive action. TTC is defined as the Time that remains till a Collision *would have* ocurred. It is a continuos value, defined and recorded as long as a collision course was at hand. Hayward was recording conflicts - and accidents - on film. The technique was, however, very expensive to use. It was therefore only used in a limited scale by Hayward himself for research purposes.

The Swedish technique

Our technique was developed in the seventies. It was first presented by me (Hydén 1976). The basis for the Swedish technique was the "Time to Accident (TA)"-concept. It was based on Hayward's TTC-concept, but was limited to one value of TTC, namely the TTC-value in the moment one of the road users involved started an evasive action. The main reason behind the simplified concept was to be able to record conflicts in a more cost effective way than Hayward could. That included to be able to record conflicts directly in the field. I will make a somewhat more comprehensive description of the Swedish technique. I do it because the Swedish technique is the traffic conflicts technique that - by far - is the most used one, both for research purposes and for practical use in traffic safety planning.

The basic idea behind our technique can be expressed as follows:

The interaction between road-users can be described through a large number of elementary events. (figure 1). These events occur with different probability and different degree of seriousness. One hypothesis is that serious conflicts are indicators of a break-down in the interaction between two road-users, i.e. the perceived accident-potential is so high that at least one of the road-users would not like to be involved in the creation of a similar event deliberately.

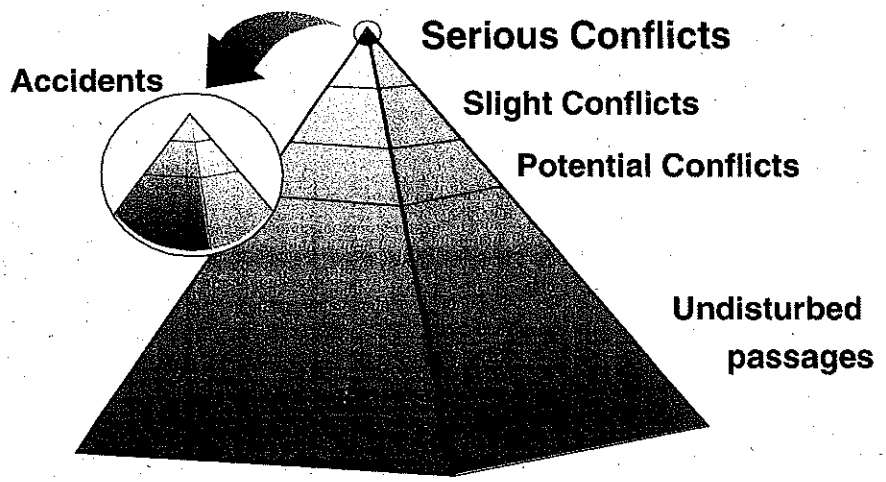

Figure 1: Elementary events in traffic

The severity grading of conflicts was based on Time to Accident (TA):
Time to Accident is the time that remains to an accident in the moment when evasive action has just been started, presupposed that the road-users continued with unchanged speeds and directions.

Originally the definition of a serious conflict was simply - and generally - a conflict where the TA-value was equal to or less than 1,5 seconds. The definition was generally applicable to all kinds of conflicts involving at least one motor vehicle, occuring in urban areas with a speed limit of 50 km/h or lower.

Fairly soon, however, we came to the conclusion that the definition had to be speed dependent in addition to being TA-dependent. After comparisons of different speed dependencies I came to the conclusion that the definition illustrated in figure 2 was the one that gave the most promising links to accidents. Conflict speed is the speed of the vehicle involved which takes evasive action, in the moment the action is started.

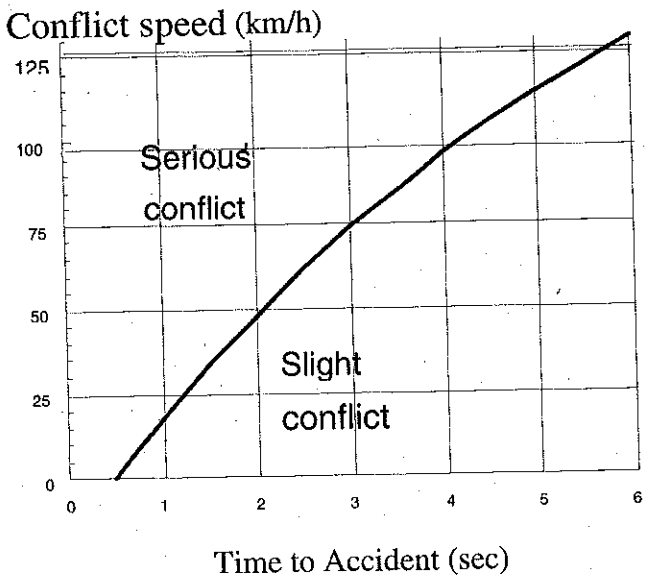

Figure 2: Definition of a serious conflict - the Swedish technique

Observers are trained for one week to do recordings in the field. Many different reliability studies are carried out in order to find out if observers manage to record conflicts in a reliable way. The general findings from these tests showed the following:

- On the whole, observers seem to miss very few serious conflicts, ranging from 10 % to 25 %.
- Very few events are scored as serious conflicts without being so. In the only major study of this the observers only scored 5 % more events as serious conflicts as they should have done.

At an international calibration study of different conflict techniques in Malmö - see below - a comparison was made between the Swedish observers' scorings and objectively assessed data via a semi-automatic, video-based,

recording technique developed by IZF-TNO in the Netherlands. The average TA-values for our observers showed a 0.05 seconds difference from the objective assessment. In 50 % of the conflicts, the observers' estimations were within the objectively evaluated value ± 0.2 seconds. The speed estimations were on average, only 3.0 km/h lower than the objectively evaluated speeds.

These results were very encouraging. My conclusion was that human observers can detect and score (estimate TA and speed) without any problems for the use of the technique from this view-point.

Regarding validity of the technique, that issue can be split in two parts, product validity and process validity. I will discuss these issues below, where they fit in the historical review.

International co-operation

In 1977 the *first international workshop on conflicts* was held in Oslo, Norway. One of the main results of the workshop was a commonly agreed definition of a conflict:

A conflict is 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.

The definition describes a *potential accident situation*. Thus the definition excludes for instance traffic violations per se.

In 1979 an international organisation - ICTCT , International Committee on Traffic Conflicts Techniques - was founded. I was elected the chairman, and I have been it since then. In 1986 ICTCT became an official organisation with its secretariat in Vienna, Austria. The organisation gradually changed from being involved in traffic conflicts issues only to being more generally interested in traffic safety assessment. The acronym ICTCT was therefore changed in the eighties, to International Cooperation on Theories and Concepts in Traffic Safety.

One of the main achievements of ICTCT so far is a major calibration study of different conflict techniques, carried out in Malmö, Sweden in 1983. The reason behind the calibration study was the fact that quite a few different techniques had been developed, however all with different theoretical foundations. It was therefore felt that there was a strong need to find out what the theoretical differences actually were representing, and what elements that could be commonly agreed on, regarding what was important for the definition of serious conflicts. The study was designed as a field study at three different intersections, where teams from eight countries made simultaneous recordings of conflicts. The results of the study indicated that even though the approaches regarding severity classification differed the end result was quite comparable. It was for instance possible to put all the severity scores in a one-dimensional scale so that results regarding severity that were obtained with one technique could be compared with the severity scoring of another team from another country.

The results also indicated what elements were the most important ones in describing the severity of a conflict. Those were: (1) Proximity in time and space, (2) Speeds of the vehicles involved, (3) Type of road user, and (4) Manoeuvre type (partly).

Product validation

The main question throughout the years has been the validity issue. Originally validity issues were focusing only on "product validity", i.e. to what extent conflict numbers correlated with accident numbers. The correlation achieved was most often quite low. It could partly be explained by the fact that accident numbers were not precise (low reporting, etc.) and that accidents - as conflicts - were due to a great deal of randomness.

A large scale study in the U.S. in 1985 represented a breakthrough both theoretically and practically. The validation was no longer based on correlation but on a validation of conflicts *against average expected number of accidents*. This implied the importance of the fact that accidents happenend of course also only represents a basis for predicting the average

expected number of accidents. Migletz et. al. (1985) showed that serious conflicts very well may be *as good predictors as accidents* of the average expected number of accidents. Similar results have been obtained with the Swedish technique (Svensson 1992).

I will also give an example on what could be defined as a practical validation. I have compared conflict frequencies that we have assessed in studies in four different cities from different parts of the world. They are made on arterial streets in these cities and are used to produce representative conflict frequencies in these cities. They are then compared with fatal accidents in the respective city.

City{PRIVAT }	Population	Killed total	Serious conflicts per hour	Killed per pop. and year
Göteborg, Sweden	450,000	15	1.0 */	1.0 */
Bradford, England	470,000	34	1.7	2.2
Cochabamba, Bolivia	500,000	115	5.5	7.0
Kingston, Jamaica	700,000	93	4.2	3.9

*/ Given the value 1.0

Table 1: A comparison of frequency of serious conflicts and killed in four cities

The results of the comparisons give a clear indication that conflict studies seem to produce useful and valid results even under very different traffic conditions.

Process validation

A very important complement to comparing numbers, is to compare the processes of conflicts and accidents. I have carried out a process validation of the Swedish technique. I compared the last phases of accidents (based on police investigations of accidents) and serious conflicts, i.e. from the moment

when evasive action started. There is not space for me here to present any details of this validation. I refer to my thesis (Hydén 1987) for those who might have a greater interest. The main conclusions of my comparisons were:

- Comparisons of TA-Conflicting Speed distributions of conflicts and accidents showed that accidents and conflicts are very equally distributed with only a slight displacement of accidents towards lower TA-values and (partly) higher speeds.
- Evasive actions in conflicts and accidents were compared. "Braking only" was by far the most common action, both in conflicts and in accidents. (79 % and 68 % respectively, on the whole data-set). "Braking + swerving" was the second most common action (14 % and 20 % respectively), "swerving only" third (5 % and 10 % respectively). "Accelerating" was the least common action with 2 % among both conflicts and accidents.

The similarities between conflicts and accidents are big enough to draw the general conclusion that conflicts work satisfactorily as substitutes for accidents even from this point of view. My interpretation of the results of the process validation is that accidents and conflicts can be distributed along the same scale based on TA and Conflicting Speed. The difference is *only* that accidents represent one of the ends of the scale where the most severe events are located.

Why do we need conflicts as a complement to accidents

I will make a synthesis of my long experience with the conflict technique and summarise the most important points regarding the need for conflict studies

- *A large part of the variation in accident numbers are due to randomness.* This has become very obvious when I have studied different evaluations of safety effects of various countermeasures. There are very few examples on evaluations built on accident studies only that have been able to produce consistent and firm conclusions.

- *The link between what is observed and our real interest is weak.* As I have mentioned earlier the average expected number of accidents is our real interest. We want to predict what will happen, not what has already happened. In practice it seems as if conflicts often make the prediction at least as good as accidents

- *Traffic safety is a health problem.* Focusing too much on accidents only does not give the full dimension to a safety assessment. The most easy example to give is the situation of elderly people. If they do not dare to go out because they are afraid of crossing a street, this will never be detected by an accident analysis. Conflict studies are linking behaviours with risks, and are therefore much more capable of detecting "more sophisticated" safety problems.

- *Qualitative information about processes leading to accidents is very poor.* Accidents are historical events. The history behind the accident is very much hidden, simply because accidents can not be observed. Conflicts, however, can be observed and are therefore more capable of analysing what processes are producing risks.

- *There are ethical aspects that makes it impossible to make experiments and use accidents as the safety criterion.* To make experiments in traffic is ethically demanding. It would not be possible to carry out experiments, and then wait until there are accidents enough to be able to draw conclusions on the safety outcome. Conflict studies makes it possible to make a first evaluation of the predicted effects just a few months after the implementation of a new measure. Besides the conflict study do not only indicate *if* a measure works or not, but also *why* it does.

- *Accident analysis is a desk tool, <u>not</u> an observation tool.* This is a general point with important long-term implications. Working with conflicts results in a great interest for what is actually going on on the streets. The interest of explaining behaviours etc. is growing a lot thanks to the use of conflict studies. This in turn results in a much broader approach to possible

countermeasures than what accident studies do. They primarily conserve peoples general view on safety problems. This point is of course impossible to validate, but my long experience have given me many indications supporting it.

General statements about the use of conflicts and accidents

I will end my presentation by making some general statements, again based on my long-term experience with safety assessment in general.

- *There is not only <u>one</u> tool, there are many.* This is important, and also quite obvious to anybody that is involved. Most often there is a need for both accident analysis, conflict studies and different supporting types of behavioural studies. Quite often there is also a need for interviews with road users in order to improve the understanding.

- *Any tool used must be used intelligently.* It may be to overdo it to mention this point, but I still do it because I have learned that all the different tools in practice have been used in "more and less" intelligent ways, and thereby influenced the reputation of the different tools.

- *The main question should be: What have conflict analysis and accident analysis contributed to regarding traffic safety implementation?* I would very much welcome some kind of more comprehensive assessment of how the different tools works, and what their overall benefits and disbenefits are. Today it seems as if focus always is on one aspect at a time thereby reducing the scope too much.

- *How well is the average expected number of accidents predicted <u>by accidents and by conflict?</u>* I am afraid that I have to repeat this. It is obviously so that many people in the area still do not appreciate the fact that occurred accidents also have to be used for the prediction of average expected numbers. Just as conflicts.

To end; I have tried to focus on the main achievements and issues relevant for a presentation of traffic conflict techniques. My impression is that there is

still a lot to do for the improvement of communication between researchers. There is still a lot of misunderstanding about "others scope". There is, however, light at the end of the tunnel. Right now there is a lot of research going on in the area of image processing and conflict studies. In the long run this development will lead to a lot of completely new options. One of the most important ones will be to be able to record all elementary events - insufficient numbers - at e.g. specific locations or specific types of locations. Thus including accidents. When we have come so far, we have finally the opportunity to link all the tools, and actually develop models that link behaviours with conflicts and conflicts with accidents. This will be the starting point for new ways of communicating and cooperating among a much broader range of researchers interested in safety concepts and theories. I am looking forward to that!

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