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Ambros, Jiří; Turek, Richard; Valentová, Veronika
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THERE IS NO NEED TO WAIT FOR ACCIDENTS: APPLYING OBSERVATION OF TRAFFIC CONFLICTS AND BEHAVIOUR IN CZECH PRACTICE

Jiří Ambros, Richard Turek, Veronika Valentová

jiri.ambros@cdv.cz, richard.turek@cdv.cz, veronika.valentova@cdv.cz

Centrum dopravního výzkumu, v.v.i., Líšeňská 33a, 636 00 Brno, Czech Republic

Contrary to traditional reactive perspective based on traffic accident occurrence, evaluation using surrogate safety measures is preferred in a proactive safety approach. Traffic conflicts have been one of such indicators; to enable their use in Czech practice, Czech traffic conflict technique and guidelines were developed. The paper presents the study requested by road agency with objective of proving the feasibility of the guidelines. The case study assessed the risk at a newly-built rural intersection on motorway exit ramp before and after a change of road marking. Methodology, observation of traffic conflicts and behaviour, its findings and practical conclusions are reported.

Keywords: traffic safety, observation, traffic conflict, traffic behaviour, proactive assessment

1. INTRODUCTION

Traffic accident frequency has been used as a traditional risk measure; however it has been also known that accident occurrence is statistically rare and such data collection is time consuming. To this end various other means have been investigated, including observation of traffic interactions (traffic conflicts and traffic behaviour). Traffic conflict is internationally 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' (Amundsen and Hydén, 1977). The frequency of conflicts, considering their severity and types, may serve as an indirect safety performance indicator (surrogate safety measure). Compared to traditional indicators based on traffic accidents, conflicts are more frequent and thus enable collection of larger samples and quicker safety assessment. There have been various traffic conflict techniques (TCTs), i.e. methods for the systematic observation of conflicting traffic behaviour (Oppe, 1986), developed around the world, using different approaches to assessing the conflict types and severity levels. Some of them use qualitative definitions, some are more quantitative; for example Older and Shippey (1980) presented more than 10 different techniques.

The necessity of a proactive safety approach based on surrogate safety measures has been recognized also in the Czech Republic. TCTs have been known there in theory but not in practice. In order to enable full practical utilization of Czech traffic conflict technique, its foundations were revised (Ambros, 2013) and reported in updated guidelines (Ambros and Kocourek, 2013). The guidelines were reviewed, approved and certified by the Ministry of

Transport. In consequence Road and Motorway Directorate of the Czech Republic (ŘSD), which manages the main road network, expressed interest in using the guidelines. In order to prove practical feasibility of new TCT they requested Centrum dopravního výzkumu, v.v.i. (CDV) to assess the risk at a newly-built rural intersection on motorway exit ramp before and after a change of road marking. The reason behind the change was suspicion of insufficient sight conditions with left turns. Since no accidents have yet occurred at the intersection, proactive safety assessment was necessary. Its application is reported in the paper, in two stages of before-after study. The paper reports the methodology, observation, findings and conclusions of a case study.

2. METHODOLOGY

Observation of traffic conflicts and behaviour, according to the new guidelines, was employed. Czech traffic conflict technique uses assessment based on the intensity of evasive manoeuvre (braking, accelerating, swerving, etc.) assessed by observers on the site or from a video record. The technique is based on physical observation on-site or video observation in the office. Observers detect conflicts and assign conflict types (turning, rear, front, etc.) and severity grades to them. Table 1 shows the definitions of severity grades which are assigned to observed conflict situations based on severity of an evasive manoeuvre. Situations of specific behaviour (or rather misbehaviour) have severity grade 0, since they are situations of one user only and thus do not conform to a conflict definition. Severity grades 1, 2, 3 (highlighted in the Table 1) are assigned to conflicts according to the observed evasive manoeuvre severity, together with physical reactions and other characteristics. Obstruction and endangerment, used to distinguish between 2nd and 3rd severity grade, is defined according to the Czech law (Road Act No. 361/2000 Coll.). Severity grade 4 belongs to a traffic accident with property-damage-only and/or injury consequences.

Table 1 Characteristics of severity grades according to the Czech TCT (traffic conflicts are highlighted)

Severity grade and description	Severity	Physical reactions	Events	
			Related to vehicles	Related to pedestrians
0 – (mis)behaviour	none	none	breaking the rules without consequences, misbehaviour of road users	breaking the rules, e.g. crossing outside of crossing
1 – slight conflict	low	common	fluent, controlled, predictable manoeuvres	change of walking course, e.g. overtaking
2 – medium conflict	obstruction	sudden	pronounced, sudden, unpredictable manoeuvres	change of walking speed, sudden entering the crossing
3 – severe conflict	endangerment	sharp	critical, emergency manoeuvres	shocking manoeuvres
4 – accident	various levels (property damage only or injury consequences)			

3. OBSERVATION

The intersection was open for traffic in June 2013; the first observation was conducted in November 2013. In spring 2014 safety measure (change of road marking) was applied, followed by the second observation in November 2014. In the text the two observations will be referred to as *before* and *after*. Fig. 1 and 2 illustrate the change of road marking (after the change the original position is still visible).

Fig. 1 Intersection photograph before and after the change of road marking (source: Mapy.cz and CDV) with symbol of left turn trajectory

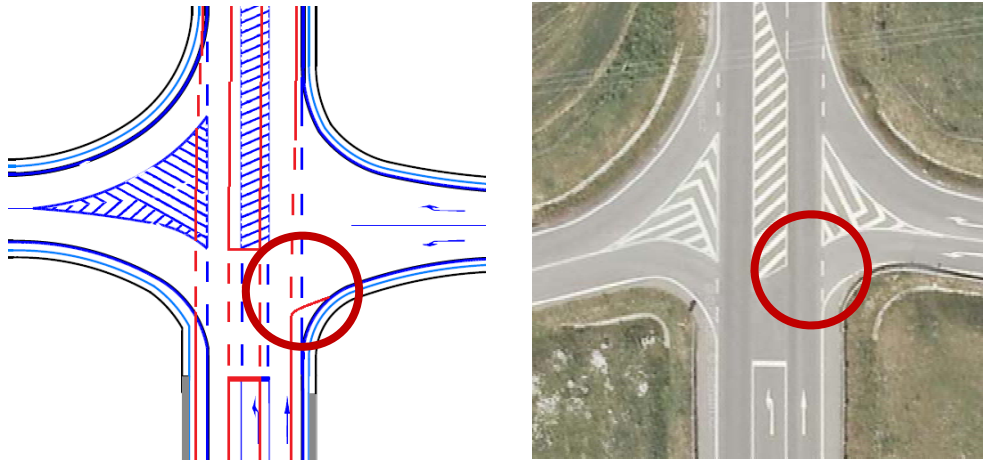


Fig. 2 Left turn sight before and after the change of road marking (source: CDV and ŘSD)



The observations focused not only on mentioned left turns (with *insufficient* sight conditions) but on other interactions (both conflicts and behaviour) as well. In order to allow for comparison and control for potential confounding factors, observation was concurrently conducted also at a comparable location. This location was selected according to the similarity of its geometry, with the exception of *sufficient* sight conditions. It is also an intersection on exit ramp, found on the same motorway, 30 km from the first intersection. Fig. 3 illustrates the design similarity of treated and comparison location.

Fig. 3 Layout of treated and comparison intersections (source: CDV and Mapy.cz) with indication of left turn area



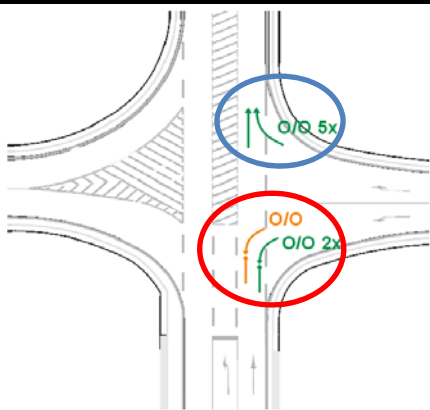
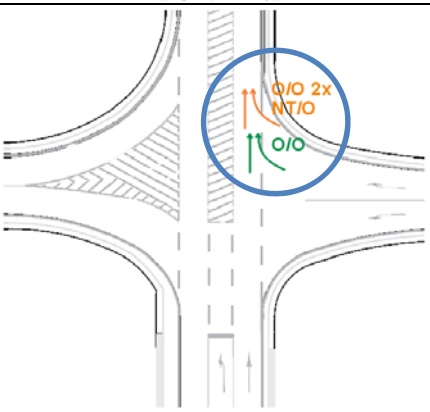
In order to have comparable results both *before* and *after* observations were conducted in November, on Friday, between 10 AM and 3 PM (5 hours) with the same observers. Observation and registration was done on the site, and video record was made for the needs of backup and potential checks. Directional traffic volume counts were also conducted, in order to be able to calculate relative conflict rates linked to specific traffic streams.

Speed is another indicator of conflicting behaviour. In order to find its value, stationary radar was located close to the intersection (on a traffic sign post, which is visible in Fig. 2). Obtained values were used for check of sight conditions according to the Czech design standard ČSN 73 6102.

4. RESULTS

During both observations, several conflicts were detected at the given location, while none was observed at a comparable location. Diagrams of observed conflicts *before* and *after* are summarized in Table 2. Green and orange trajectory symbols indicate severity grades 1 and 2 (according to Table 1). Letters O and NT indicate road user categories (personal vehicle, heavy goods vehicle), numbers show conflict frequencies.

Table 2 Conflict diagrams and comments on before and after observations

Before		<p>Right turn:</p> <ul style="list-style-type: none"> ▪ 5 conflicts ▪ at average hourly volume 35 vehicles ▪ i.e. 0.14 conflicts per one turning vehicle <p>Left turn:</p> <ul style="list-style-type: none"> ▪ 3 conflicts ▪ at average hourly volume 12 vehicles ▪ i.e. 0.25 conflicts per one turning vehicle
After		<p>Right turn:</p> <ul style="list-style-type: none"> ▪ 4 conflicts ▪ at average hourly volume 36 vehicles ▪ i.e. 0.11 conflicts per one turning vehicle <p>Left turn:</p> <ul style="list-style-type: none"> ▪ no conflicts

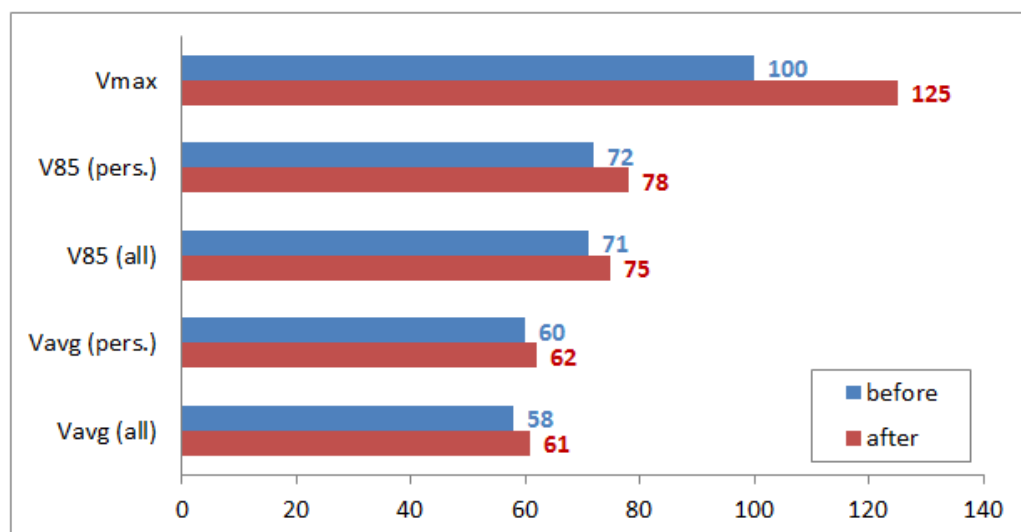
Left turn conflicts (*before* the change) were associated with insufficient sight, which caused turning drivers overlook the vehicles on major road. Drivers on major road were forced to change their trajectory in order not to collide with the vehicle turning from minor road. *After* the change, no conflicts were observed.

Right turn conflicts (both *before* and *after* the change) occurred when turning drivers underestimated speed of vehicles on major road; drivers on major road then needed to apply braking. According to observed intensity of braking these conflicts were found to be even more severe *after* the change.

In original configuration the sight conditions were found to be insufficient. After the change of road marking (shift towards the intersection), the space provided sufficient (unlimited) sight distance (as illustrated in Fig. 2).

Fig. 4 shows comparison of speed indicators before and after the change of road marking (maximal speed, 85th speed percentile, average speed, for *personal* vehicles or for *all* vehicles). The speeds *after* are obviously higher; the difference was found to be statistically significant at the 0.05 level. While average speed increased by 2 – 3 km/h, speed V_{85} of personal vehicles (which comprised 85 % of total vehicles) grown up even by 6 km/h.

Fig. 4 Speed indicators before and after the change of road marking (maximal speed, V_{85} , $V_{average}$ for personal vehicles or all vehicles)



5. CONCLUSIONS

Conflict rates (Table 2) show that safety has improved following the change of road marking:

- left turns: decrease from 0.25 conflicts per one turning vehicle to no conflicts
- right turns: decrease from 0.14 to 0.11 conflicts per one turning vehicle

Nevertheless severity of right turn conflicts has increased (grade 1 before, grade 2 after), probably due to speed increase. Speeds before and after were not higher than speed limit 90 km/h, but their increase may have resulted in lack of time for drivers from minor road to merge into major road. Such situations then creates obstructions or even endangerments to drivers on major road.

To sum up, the applied road marking change proved to be beneficial for safety, as indicated by observed conflict frequencies. The sight conditions were improved, and left turn conflicts then eliminated. Relative frequency of both left and right turn conflicts decreased; this state is also confirmed at comparison location (which differed only in sight conditions), where no conflicts occurred in both observations.

Speed increase may be associated with widening of shoulder (by approx. 1.7 m), which is consistent with general literature (e.g. Fildes and Lee, 1993; Edquist et al., 2009; Ivan et al., 2009; Stamatiadis et al., 2009). A potential low-cost solution may be covering the shoulder area with hatched road marking (diagonal lines).

The case study showed that risk behaviour observation and assessment may provide quick and detailed evaluation of safety. In both periods no accident occurred; the presented case study thus highlights the benefits and effectiveness of using surrogate safety measures, compared to retrospective studies relying on rare accidents to occur. It is hoped that Czech traffic conflict technique guidelines will be used in further studies for road agency in order to foster proactive traffic safety approach.

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