XI International Symposium
"ROAD ACCIDENTS PREVENTION 2012"
Novi Sad, 11th and 12th October 2012.

TRAFFIC CONFLICT TECHNIQUE AS A COMPLEMENTARY METHOD OF ROAD SAFETY MANAGEMENT

Jiří Ambros[a*]
[a]Centrum dopravního výzkumu, v.v.i., Líšeňská 33a, 63600 Brno, Czech Republic, jiri.ambros@cdv.cz

Abstract: Road safety management has been traditionally based on "direct" safety indicators which have been based on road accident frequency. However it has also been known to suffer from a number of biases, mainly the regression-to-mean (Hauer, 1997). Therefore various "indirect" safety indicators and their applicability have been studied. Traffic conflicts were termed "the most direct of indirect safety measures" (Laureshyn, 2010).

There have been various traffic conflict techniques (TCTs) developed. However international calibration studies showed general agreement between various TCTs and their results have similar conclusions (Grayson, 1984).

Current knowledge shows that TCTs have a potential of becoming a complementary method of road safety management. It will not only be effective in terms of time and budget but also more human through complementing reactive character of accident studies with preventive measures based on results of conflict analyses (Risser and Muhlrad, 2012).

In 2011 Transport Research Centre started a national project aiming to develop a unified TCT applicable in Czech conditions. It should compare the current methods and yield a common methodology. The final TCT will be approved by Ministry of Transport and put into practice. The paper summarizes current experience and outlines the further possibilities in the Czech Republic.

Keywords: road safety, road safety management, safety indicator, traffic conflict

1. ROAD SAFETY MANAGEMENT

Traffic has been necessary part of everyday life. However its negative outcomes include traffic accidents. According to European Road Safety Observatory, each year over 1 million people are killed and 50 million injured on roads around the world. In the European Union, road crashes comprise over 90% of all transport crash deaths and crash costs and are the leading cause of death and hospital admission for people younger than 50 years (ERSO, 2009). This toll includes huge socio-economical losses as well. The annual number of people dying on the European roads equals the number of inhabitants of a medium town (EC, 2010).

Road safety is thus a major societal issue. Fortunately it has been recognized that accidents and subsequent injuries are predictable, largely avoidable and amenable to rational analysis and remedy (ERSO, 2009; Shinar, 2007; Johnston, 2006; Wegman, 1996). World Health Organization stated that the level of road deaths and injuries is unacceptable, while it is to a large extent avoidable (Peden et al., 2004).

The road safety issue calls for specific interventions. The process of safety performance improvement is framed by system of road safety management. There are number of road safety management schemes (see e.g. ERSO, 2009 or PIARC, 2003) which will not be dealt with in

[*]Corresponding author. Tel. +420 549 429 362; fax +420 549 429 386;e-mail: jiri.ambros@cdv.cz (J. Ambros).

this text. On the operational level, road safety management process may form a following closed loop – see Fig. 1.

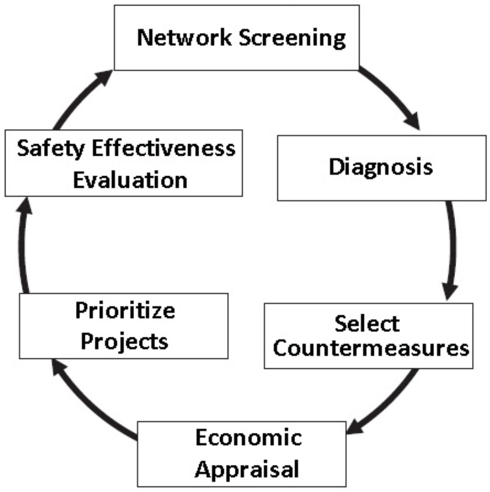

Fig. 1. Road safety management process according to AASHTO (2010)

To conclude, "*the limits to improved road safety performance are shaped by the road safety management system operating in a country*" (ERSO, 2009, p. 5).

2. SAFETY CONTINUUM AND SAFETY INDICATORS

In the beginning, elementary terms it should have been clearly defined. Road safety is one of such elementary terms. It is usually defined through the number or frequency of accidents; however accidents make up only the tip of the "safety pyramid" (Hydén, 1987). Another vivid interpretation is a safety continuum – see Fig. 2.

Fig. 2. Safety continuum (adapted from Gstalter and Fastenmeier, 2007 and Frič et al., 2011)

Another elementary term is risk: objective and subjective risk may be distinguished (Klebelsberg, 1985, Wright et al., 1988). Objective risk is defined as a probability of having an accident, while subjective risk is estimated by the drivers themselves. Drivers adapt their behaviour to subjective risk; according to this theory, two states may therefore occur:

- objective safety > subjective safety ⇒ situation is unsafe
- objective safety < subjective safety ⇒ situation is safe

It has been long recognized that safety as a continuum should not be defined in accident numbers only. Asmussen and Kranenburg (1982, p. 24) put it as follows: ”*Traffic safety policy should not only be aimed at the promotion of objective traffic safety; subjective traffic unsafety has to be taken into consideration as well.*“

Accident numbers and frequency are the base of so called “direct” safety performance indicators (SPI). On the other hand, “indirect” SPI are defined as “*any measurement that is causally related to crashes or injuries, used in addition to a count of crashes or injuries in order to indicate safety performance or understand the process that leads to accidents*” (ETSC, 2001, p. 11).

The two key properties of every indicator are its reliability and validity. Laureshyn (2010) searched scientific literature for more than 100 safety indicators and found that, except for a very few ones, they were not validated. He further states that traffic conflicts are “the most direct” of indirect safety measures.

Analysis of differences between direct and indirect safety performance indicators may be found elsewhere (e.g. Hakkert et al., 2007). Following table (Tab. 1) compares the most important features, apart from regression-to-mean (Hauer, 1997) and underreporting (ETSC, 2006).

Table 1. Comparison of selected features of direct and indirect safety performance indicators (Ambros, 2012)

	Direct SPI	**Indirect SPI**
Data type	secondary data	primary data
Statistical frequency	low frequency	high frequency
Data reliability and validity	unknown reliability	partial reliability and validity
Safety analysis approach	reactive approach	proactive (preventive) approach

Following quote may be used as a conclusion: “*the absence of accidents is a necessary but not sufficient condition for road safety*” (Klebelsberg, 1985, p. 622). There is a need for a more holistic view on road safety; for instance such as the one stated in Oppe (1994, pp. 8 – 10): “*The level of safety of a transport system can be described by the amount of threat imposed on its users, resulting from the risk to get involved in a accident, with all its consequences.* (...) *The safety policy of the central government, as well as that of the local authorities, should be directed towards the reduction or removal of this threat imposed by traffic on the individuals.*”

3. TRAFFIC CONFLICT TECHNIQUES (TCTs)

As previously mentioned, traffic conflicts are considered “the most direct” of indirect safety measures (Laureshyn, 2010). Traffic conflict is 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, p. 135).

Tab. 1 listed some important advantages of indirect safety performance indicators over the direct ones. Accidents are too much rare events to conduct sufficient statistical analyses in a short time. On the contrary traffic conflicts are far more frequent than accidents and they are observable in real time on the site. What is more, they allow the safety assessment even before the occurrence of accidents (Ambros, 2011a, 2011b).

Using conflict analysis in safety evaluation and diagnosis has been recognized effective. It allows to show what kind of conflict type is the most common, what causes the breakdown in the interaction between the road users and the severity of this breakdown. In before-after studies, for example before and after an implementation of a measure, the results can be obtained within a relatively short period of time.

These facts lie behind the world-wide use of traffic conflict techniques (TCTs) for a number of decades. TCT is defined as “a method for the systematic observation of conflicting traffic behaviour” (Oppe, 1986, p. 1). There have been various TCTs developed: some of them use qualitative definitions, some are more quantitative and based on measured time- and space-related parameters (for a review see Güttinger, 1982; Muhlrad, 1986; Svensson, 1994 or Ambros, 2011a). Nevertheless, the most important fact is that calibration studies showed a general agreement between various TCTs and similarity of their results and conclusions (Grayson, 1984).

The use of a traditional TCT requires trained human observers – trying to overcome this restraint has lead to development of automated methods. The most mature ones are based on automated video analysis (Laureshyn, 2010). Following scheme (Fig. 3) distinguishes between stationary and in-vehicle studies as well. In-vehicle observations may be done using human observer, such as with so called “Vienna driving test” (Chaloupka and Risser, 1994), or using automation (naturalistic driving studies).

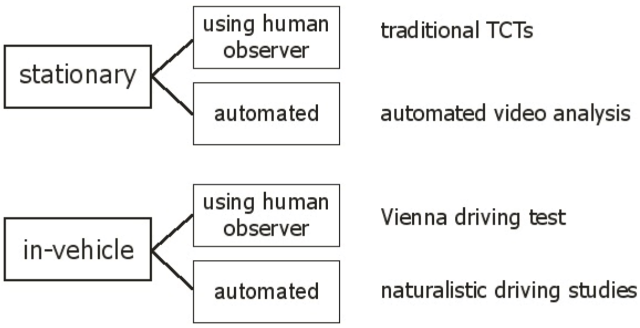

Fig. 3. Types and examples of traffic conflict studies

It is obvious that conflict studies have a number of advantages over the accident studies. Current knowledge shows that TCTs have a potential of becoming a complementary method of road safety management. It will not only be effective in terms of time and budget but also more human through complementing reactive character of accident studies with preventive measures based on results of TCT analyses (Risser and Muhlrad, 2012).

4. TCT IN THE CZECH REPUBLIC

TCT concept is not much known in Czech practice. So far it has been conducted mainly at universities. There have been two TCT schools in the Czech Republic: one at Czech Technical University in Prague (Slabý, 1997; Kocourek, 2011) and the second at Technical University of Ostrava (Folprecht, 2000; Křivda, 2006). The former one is based on manual observations, the latter one relies on video recording and analysis in the office. Although they are seen as different concepts, they are both subjective in nature: the decision on the occurrence and severity of conflict is always done by the observer.

As already mentioned, two crucial TCT issues have been reliability and validity. Reliability relates to variability of observers records and should be treated by effective previous training. Validity is the amount of correlation between conflicts and accidents frequencies. Reliability and validity also offer an answer to question: Which TCT is the most suitable? The most suitable should be the one with the highest reliability and validity. Nevertheless none of Czech methods have been tested for reliability and validity in a sufficient way.

Therefore Centrum dopravního výzkumu, v.v.i. (Transport Research Centre) undertakes a national applied research project KONFLIKT (Czech Traffic Conflict Technique Methodology), funded by Technology Agency Czech Republic. It is partnered by Czech Technical University in Prague and lasting since 2011 to 2013. The aim is todevelop a unified TCT appliable in Czech conditions. It will compare both current methods and yield a common methodology. The final TCT will be approved by Ministry of Transport and put into practice.

Initial literature survey (Ambros 2011a) provided following starting points:

- TCTs are meant to complement accident analyses, not to replace them. Both approaches have their pros and cons, it is thus ideal to combine them.
- Validity is a necessary condition of every scientific method. Due to its demands there are various opinions on necessity of validity.
- The future use of TCTs focuses on semiautomatic methods or automatic video detection.
- When developing a new TCT, one may choose from existing TCTs which were already calibrated.

These points, mainly the last one, showed possible steps of Czech TCT development. If it is to be practically used, it has to

a) follow existing valid TCT method or
b) use Czech method which has to be validated

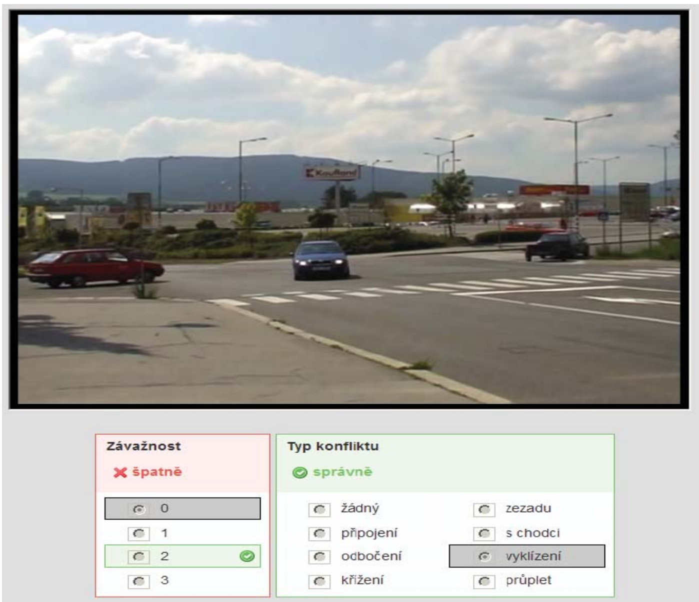

Fig. 4. Example from working version of e-learning application: assessment of conflict severity and type

It is therefore necessary to study reliability and validity of both existing Czech TCT approaches. In order to compare (calibrate) them, several observations are being undertaken (Ambros, 2011b; Kozel, 2012; Kocourek et al., 2012).

Lessons learned up to now in the KONFLIKT project give following messages (Ambros, 2011b):

1) It is crucial to provide training scheme which will ensure reliability of selected trained observers. It will contain in-door lectures, testing observations in the group with comparison and discussion of results and e-learning application for repeated testing with short video clips (see Fig. 4).
2) In the further course of the project, the aim is to test the training scheme and conduct further observations on various selected sites. It is necessary to accumulate enough experience to be able to produce common TCT guidelines which will be used in practice.

5. CONCLUSIONS

Road safety management has been traditionally based on accident occurence. However accident frequency suffers from a number of methodological and statistical biases which may deteriorate its usefulness and thus limit the efectiveness of road safety management system. Therefore other indicators are sought – one of the most attracting ones are the traffic conflicts.

There have been various traffic conflict techniques (TCTs) in use since the end of 1960s; calibration studies in early 1980s proved that they lead to similar results. What is more, modern automated approaches appeared as well. They include for example automated video analysis or naturalistic driving studies. Nevertheless, "*for a specific location on a community based level, a traditional traffic conflict studies – whether with observers or advanced video techniques – is the method of choice*" (Schermers et al., 2011, p. 131). It has to be further noted that automated video analysis is still not mature enough to be put into operational use (Laureshyn, 2010). To sum up, traditional TCT using human observers is still the operational standard to be recommended. As ITE's *Manual of Transportation Engineering Studies* remarks, "*a well-designed data form remains the best choice for most traffic confict studies*" (Schroeder et al., 2010, p. 395).

When thinking about using a TCT, one should therefore consider using the existing one which has been already calibrated. Specifically in the Czech Republic, there have been two TCTs used in academia. In order to provide universal methodology, it is necessary to study reliability and validity of both approaches. Reliability will be achieved by observers' consistency. "*Without the confidence that what is called a confict now will be called a confict later, traffic conflict studies degenerate into simply observing traffic"* (Schroeder et al., 2010, p. 395). Validity may be challenging to prove, nevertheless it may be seen as a way to "market the procedure" (Brown and Cooper, 1990).

Final and calibrated methodology, accompanied with operational guidelines, may be put into the practice. It is not meant to replace accident studies but to complement them. Both approaches have their pros and cons – and that is why their combination has a potential of improving the effectiveness of the whole road safety management process.

Acknowledgement: *The paper was elaborated with support of the Technology Agency Czech Republic project TA01030096 "Czech Traffic Conflict Technique Methodology".*

6. REFERENCES

[1] Ambros, J. (2011a). *Metodika sledování a vyhodnocování dopravních konfliktů v českém prostředí: výstup etapy E1 – Rešerše a výběr vhodných metod*. Project literature review. Centrum dopravního výzkumu, v.v.i. and Czech Technical University in Prague.

[2] Ambros, J. (2011b). Traffic conflict technique in the Czech Republic. In *Proceedings of the 24th ICTCT workshop,* Warsaw.
[3] Ambros, J. (2012) *Nehodovost na úseku pozemní komunikace z hlediska charakteru daného úseku.* Dissertation literature review. Czech Technical University in Prague, Faculty of Transportation Sciences.
American Association of State Highway and Transportation Officials (AASHTO) (2010) *Highway Safety Manual. First Edition*. ISBN 978-1-56051-477-0.
[4] Amundsen, F.H., Hydén, C. (Eds.). (1977). *Proceedings: First workshop on traffic conflicts.* TØI Oslo and LTH Lund, ISBN 82-7133-195-7.
[5] Asmussen, E., Kranenburg, A. (1982). *An analysis of the traffic safety phenomenon*. Institute for Road Safety Research SWOV, Leidschendam, publication 1982-1E.
[6] Brown, G.R., Cooper, P.J. (1990). Role of conflicts in traffic analysis. In *Proceedings of the 3rd ICTCT Workshop,* Cracow.
[7] Chaloupka, C., Risser, R. (1994). In-Car Observations. In Oppe, S. (Ed.) *Guidelines for Retrospective Safety Analysis,* chapter XII. Institute for Road Safety Research SWOV, Leidschendam, report R-93-75.
[8] European Comission (EC). (2010). *Towards a European road safety area: policy orientations on road safety 2011-2020. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.* COM(2010) 389 final, Brussels.
[9] European Road Safety Observatory (ERSO), (2009). *Road Safety Management*.
[10] European Transport Safety Council (ETSC), (2001). *Transport Safety Performance Indicators*. ISBN 90-76024-11-1.
[11]European Transport Safety Council (ETSC), (2006). *Road accident data in the enlarged European Union: learning from each other*. ISBN 90-76024-22-7.
[12] Folprecht, J., (2000). Dosavadní vývoj a perspektivy metody sledování a hodnocení konfliktních situací v silničním provozu. *Silniční obzor*, vol. 61, pp. 39 – 44.
[13] Frič, J., Skládaný, P., Andres, J., Daňková, A., Ambros, J., (2011). Ukazatele bezpečnosti. In *Bezpečnost silničního provozu – aktuální poznatky, I. díl,* chapter V. Centrum dopravního výzkumu, v.v.i. ISBN 978-80-86502-35-9.
[14] Grayson, G.B. (Ed.), (1984). *The Malmö study: a calibration of traffic conflict techniques*. Institute for Road Safety Research SWOV, Leidschendam, report R-84-12.
[15] Gstalter, H., Fastenmeier, W., (2007). Thirty years of traffic safety research: A personal retrospective of concepts and methods. In *Proceedings of the 20th ICTCT workshop,* Valencia.
[16] Güttinger, V.A., (1982). From accidents to conflicts: alternative safety measurement. In *Seminar on Short-term and Area-wide Evaluation of Safety Measures*, pp. 161 – 167. Institute for Road Safety Research SWOV, Leidschendam, report R-82-7.
[17] Hakkert, S., Gitelman, V., Vis, M.A. (Eds.), (2007). *Road Safety Performance Indicators: Theory.* Deliverable D3.6 of the EU FP6 project SafetyNet.
[18] Hauer, E., (1997). *Observational Before-After Studies in Road Safety: Estimating the Effect of Highway and Traffic Engineering Measures on Road Safety*. Elsevier, Oxford. ISBN 0 08 043053 8.
[19] Hydén, C., (1987). *The development of a method for traffic safety evaluation: The Swedish Traffic Conflict Technique*. Dissertation, Lund University, Bulletin 70.
[20] Johnston, I., (2006). Highway Safety. In Fwa, T.F. (Ed.) *The Handbook of Highway Engineering,* chapter 4. CRC Press. ISBN 0-8493-1986-2.
[21] Klebelsberg, D., (1985). Safety evaluation versus system evaluation. In Biecheler, M.B., Lacombe, C., Muhlrad, N. (Eds.) *Evaluation 85: International Meeting on the Evaluation of Local Traffic Safety Measures, Tome 3,* pp. 617 – 627.
[22] Kocourek, J., (2011). *Metodika sledování dopravních konfliktů*. Czech Technical University in Prague. ISBN 978-80-01-04681-4.
[23] Kozel, P., (2012). *Možný přístup k vyhodnocení počtu dopravních nehod při sledování konfliktních situací.* Study text, Technical University of Ostrava
[24] Kocourek, J., Kočárková, D., Padělek, T., (2012). Sledování a vyhodnocování dopravních konfliktů v rámci projektu KONFLIKT. In *Bezpečnosť dopravy na pozemných komunikáciách*, Senec.
[25] Křivda, V., (2006). Videoanalýza konfliktních situací a její využití v praxi. *Silniční obzor*, vol. 67, pp. 342 – 347.

[26] Laureshyn, A., (2010). *Application of automated video analysis to road user behaviour*. Dissertation, Lund University, Bulletin 253. ISBN 978-91-628-8003-3.
[27] Muhlrad, N., (1986). Application of traffic conflicts and other intermediate measures: an overview. In *Proceedings of the workshop Traffic Conflicts and Other Intermediate Measures in Safety Evaluation*. Institute for Transport Sciences, Budapest.
[28] Oppe, S., (1986). Evaluation of traffic conflict techniques. In *Proceedings of the workshop Traffic Conflicts and Other Intermediate Measures in Safety Evaluation*. Institute for Transport Sciences, Budapest.
[29] Oppe, S., (1994). Concepts and Definitions. In Oppe, S. (Ed.) *Guidelines for Retrospective Safety Analysis,* chapter I. Institute for Road Safety Research SWOV, Leidschendam, report R-93-75.
[30] Peden, M.; Scurfield, R.; Sleet, D.; Mohan, D.; Hyder, A.A.; Jarawan, E.; Mathers, C. (Eds.), (2004). *World report on road traffic injury prevention*. World Health Organization. ISBN 92 4 156260 9.
[31] PIARC Technical Committee on Road Safety, (2003). *Road Safety Manual: recommendations from the World Road Association*. Route2Market. ISBN 2-84060-158-3.
[32] Risser, R., Muhlrad, N., (2012). *Traffic Conflicts or Why is the focus on post-crash investigation greater than on accident prevention?* ICTCT fact sheet, Vienna .
[33] Schermers, G.; Cardoso, J.; Elvik, R.; Weller, G.; Dietze, M.; Reurings, M.; Azeredo, S.; Charman, S., (2011). *Recommendations for the development and application of evaluation tools for road infrastructure safety management in the EU*. Deliverable 7 of the EU project RISMET.
[33] Schroeder, B.J.; Cunningham, C.M.; Findley, D.J.; Hummer, J.E.; Foyle, R.S., (2010). *Manual of Transportation Engineering Studies, 2nd Edition*. The Institute of Transportation Engineers. ISBN 978-1-933452-53-1.
[34] Shinar, D., (2007). *Traffic Safety and Human Behavior*. Emerald. ISBN 978-0-08-045029-2.
Slabý, P. (1997) Aktivace výzkumu dopravní nehodovosti v letech 1996 – 1999. *Silniční obzor*, vol. 58, pp. 53 – 56.
[34] Svensson, Å., (1994). Conflict Analysis. In Oppe, S. (Ed.) *Guidelines for Retrospective Safety Analysis,* chapter X. Institute for Road Safety Research SWOV, Leidschendam, report R-93-75.
[35] Wegman, F., (1996). *Road accidents: a worldwide problem that can be tackled successfully!* PIARC Committee on Road Safety (C13), document 13.01.B. ISBN 2-84060-041-2.
[36] Wright, C., Boyle, A., Redgrove, J., (1988). Subjective and objective risk in road accident causation: the objective risk problem. In *Traffic Safety Theory & Research Methods, Session 3: Theoretical analysis and models,* Amsterdam.