The Traffic Conflicts Methodology revisited

Richard van der Horst

Traffic Safety Assessment

- Traffic Accidents
  - limited reflection of traffic (un)safety
- Police reports
  - limited sample of all accidents
  - limited for behavioral research purposes?
  - Subjective interviews?
- Accident Analyses
  - many methods
  - validated?
- Traffic Safety Assessment
  - Do the thing right
  - Do the right thing
Traffic Safety Assessment

Traffic (un)safety

Accident Analysis

Behavioural Analysis

Traffic Safety Assessment

Traffic safety vs. traffic process

(Hydén, 1987)
Conflict method

Traffic safety research

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Serious conflicts</td>
<td>Accidents</td>
</tr>
<tr>
<td>Conflict analysis</td>
<td>Accident analysis</td>
</tr>
<tr>
<td><strong>Process</strong> description</td>
<td><strong>Product</strong> description</td>
</tr>
</tbody>
</table>

Model of the accident process
Asmussen & Kranenburg (1982)
Conflict technique development

- Perkins & Harris (1967). GM
- Hayward (1972). Time-to-Collision
- 1st Workshop Conflict Techniques Oslo, 1977
- 2nd Workshop+study, Rouen, 1979
- 3rd Workshop, Leidschendam, 1982
- 4th Workshop, Copenhagen, 1983
- International Calibration study, Malmö, 1983
- Trautenfels study, 1985
- DOCTOR, 1986

ICTCT

Past:
- International Committee on Traffic Conflict Techniques

Now:
- International Cooperation on Theories and Concepts in Traffic Safety

http://www.ictct.org
Definitions

• Encounter
• Critical situation
• Conflict
  – Conflict Severity (overall)
  – Probability of collision
  – Extent of consequences (injury severity)

Encounter

• A traffic situation in which two road users approach each other in time and space and may influence each other’s behaviour
Critical situation

- Detection of critical situations important element in conflict observation
- Encounter in which deviations from normal behaviour occur
- If the available manoeuvring space is smaller than the space needed for a normal reaction

Conflict

- Oslo definition:
  “A traffic conflict is an observable situation in which two or more road users approach each other in space and time to such an extent that there is a risk of collision if their movements remain unchanged”
- DOCTOR definition:
  “A conflict is a critical traffic situation in which two (or more) road users approach each other in such a manner that a collision is imminent and a realistic probability of personal injury or material damage is present if their course and speed remain unchanged”
Conflict Severity (overall)

- The severity of a conflict is determined by both the *probability of a collision* and the *extent of the consequences* if a collision would have occurred.

**Severity of Conflict**

- 1 and 2 slight conflicts
- 3, 4 and 5 severe conflicts

Conflicts: DOCTOR Score form

Leading parameters:
- Probability of a collision
- TTC: Time-to-collision
- PET: Post-Encroachment -Time (resulting tijdmargin of near-miss)
- Extent of consequences
Probability of a collision

- Defined by:
  - Time-To-Collision (TTC) and/or
  - Post-Encroachment Time (PET)

Malmö study
TTC versus Severity score
Swedish Ta versus TTCmin

Time-To-Collision TTC and Braking

Start braking at the latest moment you think you are able to stop in front of the object
Time-To-Collision (1)

Time-To-Collision (2)
Post-Encroachment Time PET

- The time between the moment $t_1$ that the first road user leaves the path of the second and the moment $t_2$ the second road user reaches the path of the first.

\[ \text{PET} = t_2 - t_1 \]

Extent of consequences (injury severity)
- Conflict type (who -> who)
- Speed
- Evasive action
  - No reaction
  - Controlled
  - Uncontrolled
- Type of action
  - Braking
  - Accelerating
  - Swerving
Long-term video observations

- Observation of 4 blackspots in 2-yr period
  - Pijnacker (T-junction) + Delft (3 signalized intersections)
- Rough data: 8 years of video material
- Selection: Collisions (# police-reported?) whole period
  - Incidents when observed
  - Conflicts (analyses ala ‘DOCTOR’ method) one day

- Methodology to determine driver behavior in the pre-crash phase
- Insight in the chain of elements of human behavior that either is resulting in, or avoiding an accident

Pijnacker T-junction rear-end + conflict C-C
Pijnacker Right-angle C-C

Analysis

- VIDARTS (VIDeo-based Analysis of Road Traffic Scenes)
- collisions and conflicts

Transformation from video to street
Semi-automatic procedure
-> V, DIST, TTC, TTCmin, PET, etc.

- DOCTOR (Dutch Objective Conflict Technique for Operation and Research)

Overall severity (scale 1-5)
- probability of collision (TTC or PET)
- extent of consequences if collision had occurred
Conclusions (1) Long term video observation study

- Traffic conflicts and analysing deviant behaviour together with road scene analyses give good insight in potential traffic safety problems at intersections. Good resemblance with results analysis of collisions from video.
- Remarkably, frequently, another road user (in)directly involved in pre-crash process
- Observing and scoring conflicts according to DOCTOR method from video feasible and advantageous compared to original method with observers on the street
- Time-related measures such as TTC and PET promising surrogate safety measures for predicting accident risks by microscopic traffic simulation models

Conclusions (2)

- We do not have to wait for accidents for improving road environment and traffic management
- Systematic observation of behaviour already gives you lots of clues for improving road safety at intersections
- Video observations rich source of information for natural traffic behaviour of road users (interactions mutually or in relation with road environment), in future additional to integral approach? -> Naturalistic driving studies (also on-site)
Renewed interest in Traffic Conflict Technique

DOCTOR

- Bicycle-bicycle conflicts: a systematic observation of behaviour from video
- Evaluation of attention-increasing measures at a black spot intersection (Hillegersberg)
- PROLOGUE, combination of in-vehicle and site-based observations
- Evaluation of small-scale infrastructural measures at rural black spots in Bangladesh
- EU-proposal InDeV: In-Depth understanding of accident causation for Vulnerable road users

Background (1) Bicycle-bicycle conflicts

- Increasing use of bicycle paths in the Netherlands
- Larger variety of type of users
- Large under-reporting of bicycle accidents without involvement of motorised traffic
- In-depth study hospitalised bicycle victims by type of accident:
  (ALVO, Stichting Consument en Veiligheid, N = 164)

<table>
<thead>
<tr>
<th>Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>With motor vehicle</td>
<td>20</td>
</tr>
<tr>
<td>With moped</td>
<td>4</td>
</tr>
<tr>
<td>Single-bicycle accident</td>
<td>62</td>
</tr>
<tr>
<td>With other bicyclist</td>
<td>12</td>
</tr>
<tr>
<td>With pedestrian</td>
<td>2</td>
</tr>
</tbody>
</table>
Background (2)

Typology of bicycle-bicycle accidents (Schepers, 2010)

<table>
<thead>
<tr>
<th>Type</th>
<th>Details</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Victim and counterpart in same direction</td>
<td>113 (76)</td>
</tr>
<tr>
<td>1a</td>
<td>a. Front wheel against rear wheel other bicyclist</td>
<td>30 (20)</td>
</tr>
<tr>
<td>1b</td>
<td>b. Handlebars hitting each other</td>
<td>27 (18)</td>
</tr>
<tr>
<td>1c</td>
<td>c. Collision in flank</td>
<td>26 (18)</td>
</tr>
<tr>
<td>1d</td>
<td>d. Colliding with bicycle in front</td>
<td>24 (16)</td>
</tr>
<tr>
<td>1e</td>
<td>e. Colliding during overtaking</td>
<td>6 (4)</td>
</tr>
<tr>
<td>2</td>
<td>Victim and counterpart intersect</td>
<td>18 (12)</td>
</tr>
<tr>
<td>3</td>
<td>Victim and counterpart in opposite direction</td>
<td>17 (11)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>148 (100)</td>
</tr>
</tbody>
</table>

Background (3)

- Often direct or indirect involvement of other road user
- IAAV study (2007), analysis pre-crash phase of real crashes
- SWOV (2012) Background document NOaF
- No collisions needed to solve traffic safety problems
- Systematic behavioural observations and analyses -> insight in underlying process of interaction between road users and with infrastructure
- Conflict method DOCTOR (Dutch Objective Conflict Technique for Operation and Research) suitable, more practical from video
- Application potential for traffic safety bicycle paths?
Amsterdam - conflict analysis

<table>
<thead>
<tr>
<th>Conflict type</th>
<th>1a</th>
<th>1b</th>
<th>1c</th>
<th>1d</th>
<th>1e</th>
<th>9</th>
<th>Total</th>
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<tbody>
<tr>
<td>Conflict parties</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-F</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>F-B</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>2</td>
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<td></td>
<td>2</td>
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<tr>
<td>F-V</td>
<td></td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>B-B</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B-V</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td>18</td>
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</tr>
<tr>
<td></td>
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<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

- Serious conflicts: in total 40
  - Type 2 (intersecting): 23 (mainly bicyclist – crossing pedestrian)
  - 2 botsingen
  - Type 3 (oncoming traffic): 1 (moped/bicyclist overtaking manoeuvre of 1 (or 2) bicyclist(s))
  - Type 1 (same direction): 4

Black-spot intersection Hillegersberg

Before:

After:
- Continuing red asphalt
- Smart studs
- Conspicuous signing
Black-spot Hillegersberg

- Video recordings, before and after
- Automatic selection of bicycle passages by Video Based Monitoring
- DOCTOR from video
- Total # of conflicts from 27 to 14 % of all bicycle passages, serious conflicts from 1.12 to 0.68%
- Blocking of bicycle path by cars most frequently occurring slight conflict
- Car drivers more aware of bicycle path, approach speed lower and earlier braking

The Dutch field trial

- Combination of site based observation (TNO) and in-vehicle observation (SWOV)
- Focus on behavior at Intersections
  - Speed
  - Interaction with vulnerable road users
Two complementary observation methods

In-vehicle observations over several intersections

Site-based observations

Cases with complementary data from both observations

Research questions

Site based and in-car:
- What is the added value of the combination of these two methods?
- Is there a difference in behavior (looking behavior, speed, TTC and PET) of cars on signalized intersections that allow potential conflicts with cyclists when:
  - The vehicle turns right after red traffic light (stopped) and green traffic light (driving)
  - There are cyclists present and there are no cyclists present
Results

- Crossing speed higher when no bicyclist present
- In driving situation turning cars more involved in severe conflicts than turning from stopped situation

Stopped vs. driving:
- # of glances >
- Crossing speed lower
- No situations with bicyclists present

Combining in-car and site-based:
- Data from one study enriched with complementary data of other study
- More in-depth understanding and to generalise and validate naturalistic driving results to the behaviour of non-participants
- Future applications: driving behaviour and specific infrastructure and the interaction between drivers and vulnerable road users

Evaluation of small-scale infrastructural measures at rural black-spots Bangladesh

<table>
<thead>
<tr>
<th>Location</th>
<th># of days with accident registration</th>
<th># of accidents/year</th>
<th># of injuries/year</th>
<th># of fatalities/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil Kuthi</td>
<td>460</td>
<td>29</td>
<td>79</td>
<td>7</td>
</tr>
<tr>
<td>Nama Para</td>
<td>250</td>
<td>61</td>
<td>135</td>
<td>3</td>
</tr>
<tr>
<td>Kundar Para</td>
<td>250</td>
<td>38</td>
<td>62</td>
<td>4</td>
</tr>
</tbody>
</table>
Area of special interest for video observations

Bangladesh collision CNG-Motorbike
TTC and Collision Avoidance Systems
- Conflict studies and experimental research on driving behaviour in fog give input for the setting of in-car systems:
  - \( \text{TTC}_{\text{gas}} = -1.15 + 0.83 \times \text{TTC}_{\text{stim}} \)
  - \( \text{TTC}_{\text{min}} = -2.58 + 0.8 \times \text{TTC}_{\text{stim}} \)
  - \( \text{TTC}_{\text{min}} = -1.43 + 0.96 \times \text{TTC}_{\text{gas}} \)
- Result: good trigger for CAS: \( \text{TTC}_{\text{stim}} = 4.5 \) – 5 s
- Link between TTA (Lund) and TTCmin (NL)?

InDeV: In-Depth understanding of accident causation for Vulnerable road users
- Lunds University
- University of Aalborg
- UHasselt
- École Polytechnique de Montréal
- BAST
- TNO
- Ingeniería de Tráfico SL
- WUT
- Purdue University
To conclude

› We do not have to wait for accidents for improving road environment and traffic management
› Systematic observation of behaviour (including traffic conflicts) already gives you lots of clues for improving road safety at intersections
› Also good basis for the development of in-car systems
› Site-based observations complementary to naturalistic driving studies
› Strong need for automated video analysis of road user behaviour -> good progress, InDeV project next step?
› Link between TTCmin (NL) and TTA (Lund)?
› \[ \text{TTCmin} = -1.43 + 0.96 \times \text{TTCgas} \]

Thank you!
Car -> bicyclist collision