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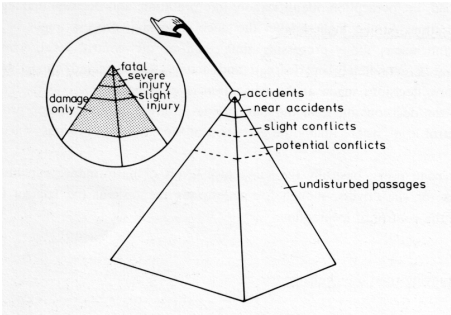
  - *Lund*
  - *TNO*

Introduction
Traffic Safety Assessment

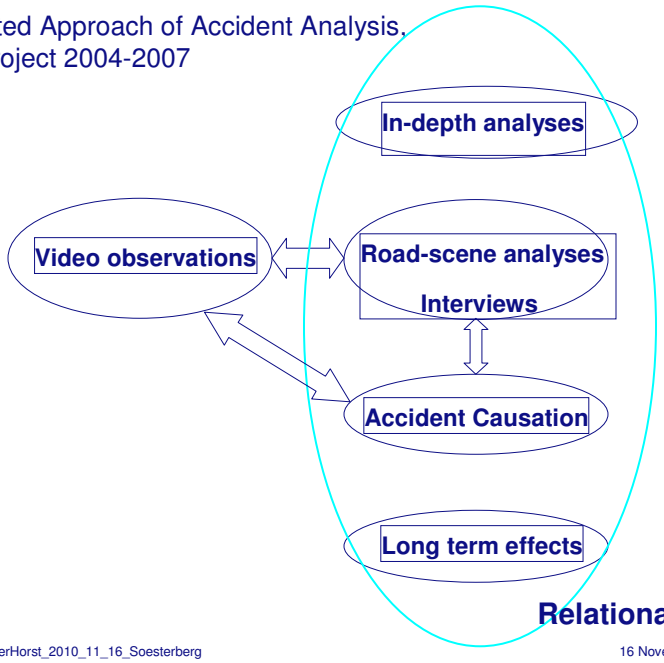
- Traffic Accidents
  - limited reflection of traffic (un)safety
- Police reports
  - limited sample of all accidents
  - limited for behavioral research purposes ?
  - Subjective interviews?
- Accident Analyses
  - many methods
  - validated?

- Traffic Safety Assessment
  - Do the thing right
  - Do the right thing

Introduction (2)
Traffic Safety Assessment



Integrated Approach of Accident Analysis,
TNO project 2004-2007



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

Traffic observations

T-junction - Pijnacker

Video recordings

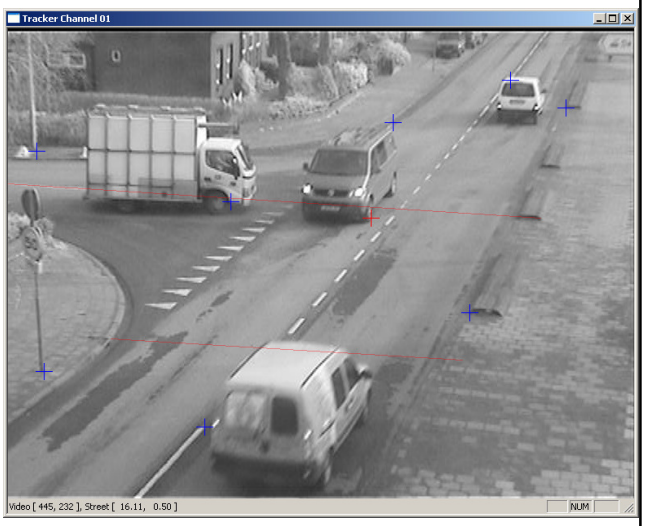
- At each location 1 or 2 CCD cameras
- PC + 3 hard discs (750 Gb) (> 2 weeks, 2 cameras)
- Separate jpeg pictures in a time-directory structure (date, hour, min, 60x 12.5 fields)
- Motion detection on the spot + specific areas excluded)

Video analysis

- Manual selection of collisions by specially developed fast Windows viewer (at high speed still good interpretable images)
- Windows application for quantitative analysis (semi-automatic), (basically the same as 30 years ago) of collisions and conflicts (speed, distance, TTC, PET, etc.)
- Still urgent need for automated procedure!!

Pijnacker P1 T-junction

4 collisions
- 1 rear-end C-C
- 1 right-angle C-C
- 1 'right-angle' C-B (injury)
- 1 single-bicyclist B



- Left turn from minor road
- Crossing bicyclists
- Interaction

Delft D1

7 collisions
- 4 left-turn –opposing C-C minor road
- 2 rear end C-C
- 1 right-angle C- Moped

- Left turn from minor roads
- Left turn from below into wrong carriageway

Delft D2

1 collision
1 single-vehicle C

- Frequently U-turns -> conflicts (C-B-P-tram)
- Difficult path choice

(straight-on -> right turn)
Left turn -> wrong carriageway
-> Tram/bus lane

Delft D3

4 collisions
2 rear-end C-C
1 single-vehicle C
1 single-scootmobiel

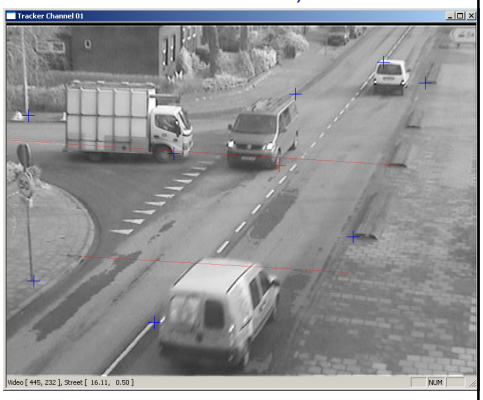
- Conflicts BU-B/P
- Many Bs own path-choice
- C straight-on -> left-turn
- Left-turn -> wrong carriageway

Delft D1 Left-turn opposing minor road

Pijnacker T-junction rear-end + conflict 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)

- 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
- Time-related measures such as TTC and PET promising surrogate safety measures for predicting accident risks by microscopic traffic simulation models (EU proposal SIMPAC)

Conclusions (2)

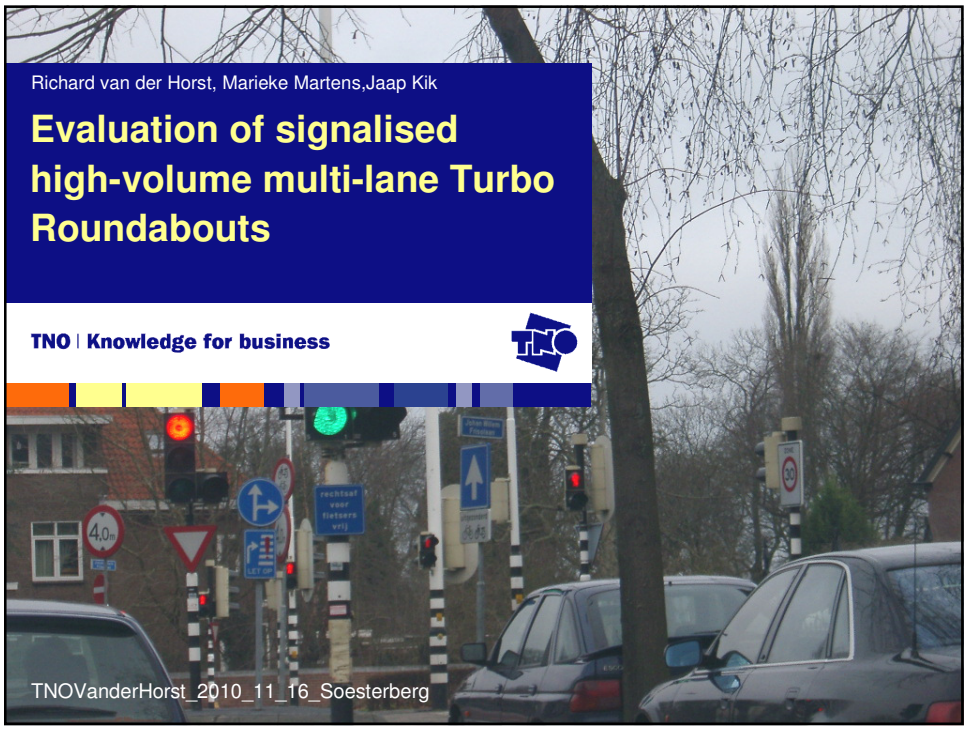
- We do not have to wait for accidents for improving road environment and traffic management
- Systematic observation of behaviour already gives you lots of clues for improving road safety at intersections
- Video observations rich source of information for natural traffic behaviour of road users (interactions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

Background Expert meeting Soesterberg

- Development of semi-automatic video analysis technique (1978-1984)
- Demonstration bicycle routes in The Hague and Tilburg (1979-1980)
  - Evaluation of several intersection solutions (placement of speed humps,
- Development of time-related measures TTC, TTI, TTS, etc.)
- ICTCT Conflict studies
  - Malmö Calibration Study (1983)
  - Trautenfels (1985)
- Strong need for joint effort for developing objective road user behaviour analysis tools
  - CARUSO (Cognitive vision for Assessment of Road Users Safety and Operational efficiency), EU-proposal 2003
  - Joint Workshop Lund 2006 (27 participants)

Expert meeting Soesterberg 15-16 November 2010

- Aim the expert meeting on automated video analysis of road traffic scenes (Soesterberg, 15-16 November 2010):
  - Exchange newest developments in automated video analysis techniques and applications and discuss future plans and activities
- 23 participants, 10 countries (Sweden, Netherlands, Finland, Denmark, Israel, Spain, Germany, Canada, USA, Belgium)
- Applications:
  - Motorway traffic (same direction, etc.) TNO
  - Intersections: Lund, UBC, TNO
  - Pedestrian crossings: Lund, UBC
- Future developments:
  - Data fusion with Stereo Radar, Laser scanner, Lidar
  - Observations from helicopter (Helsinki, TUD-NL)
  - Site-based and in-car observations combined (naturalistic driving studies)



Evaluation of signalised turbo roundabouts

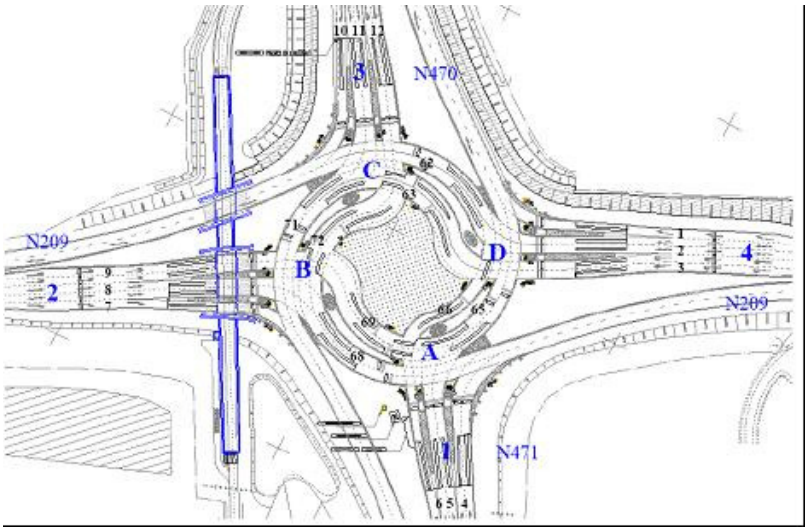
- Province of Zuid-Holland has two operational:
  Doenkadeplein and Tolhekplein

- Aim of study:

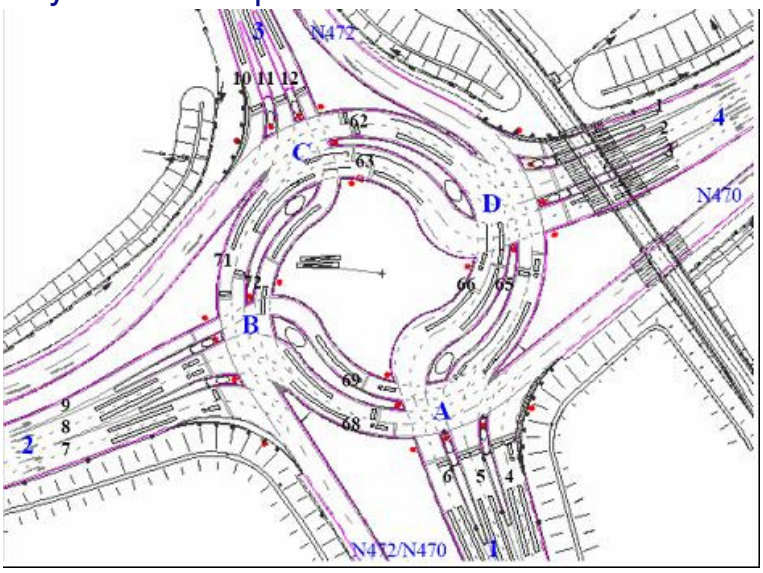
Better insight in functioning with respect to
traffic flow and road users' behaviour and experience

  - (Traffic flow)
  - Road Scene Analyses
  - **Behavioural observations by video**
  - Road user surveys

Lay-out Doenkadeplein



Lay-out Tolhekplein



Traffic flow

- Comparison Doenkadeplein with conventional signalised intersection
- Two-phase control -> reduction in:
  - Cycle time (-47%)
  - Waiting time (-41%)
  - Waiting queue length (-39%)
- Better traffic throughput, higher capacity

Video behavioural observations

- Doenkadeplein



Video behavioural observations

- Tolhekplein



Video behavioural observations

- 15-19 oktober 2007
- Three video-camera's each, 1 looking backwards filtering lanes, 1 central area, 1 zoomed in furthest away area
- Selection:
  - Rush hours: 07:30-9:30,16:30-18:30
  - Non-rush hours: 09:30-16:30
  - Total 11 hours each
- Error manoeuvres and deviant behaviour

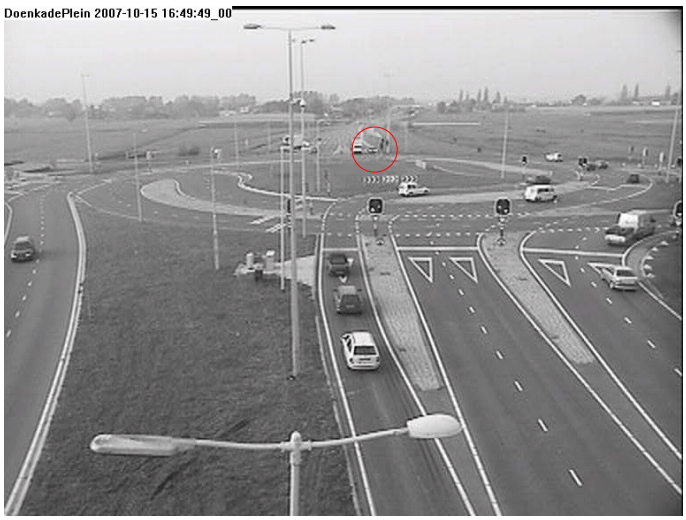
	Number	% total	Non/Rush	Fraction left turn
Doenkadeplein	173	0.55	1.9	80.4%
Tolhekplein	153	1.07	3.5	52.3%

Video behavioural observations

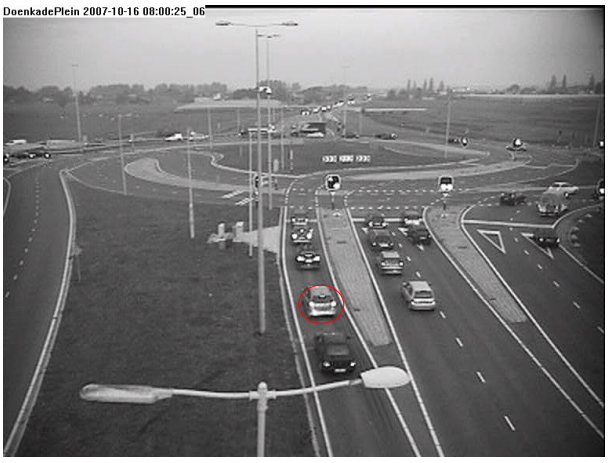
- Error manoeuvres by type

	Left turn inside-out	U-turn	Complex	SO-LT/LT-SO/SO-RT	Filtering	Other
Doenkadeplein	80	37	32	8	5	11
	46.2%	21.4%	18.5%	4.6%	2.9%	6.4%
Tolhekplein	36	27	18	42	16	16
	23.2%	17.4%	11.6%	27.2%	10.3%	10.3%

Doenkadeplein: Left turn inside out



Doenkadeplein: Complex 2 rounds



Conclusions behavioural observations

- Route choice
  - Tolhekplein more problematic than Doenkadeplein
    - (before roundabout 10 vs. 3% error manoeuvres,
      At roundabout 22 vs. 5%)
- Path choice
  - Left turn manoeuvre most problematic
    - Tolhekplein -> ghost riding, directly turning left at 1st light
    - Both roundabouts -> turning left at 2nd light
    - U-turns
- Conflicts
  - Number limited

Conclusions signalised turbo roundabouts

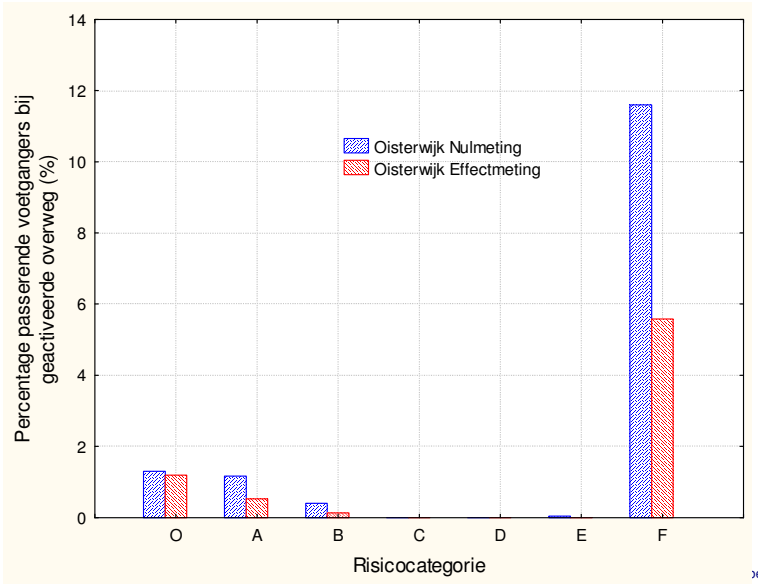
- Traffic flow much better compared with conventional signalised intersection
- Road Scene Analyses
  - Route signing before roundabout okay, on and after roundabout missing -> hesitant/uncertain behaviour?
- Behavioural observations
  - Route choice: issue at Tolhekplein (temporary?)
  - Path choice: Left turn manoeuvre problematic (ghost riding 1st light Tolhekplein, left turn at 2nd licht, U-turns)
  - Conflicts and running red: limited
- Road user survey
  - After habituation reasonably positive (truck drivers more, incidental users less positive)
  - Mistakes/errors (when new), also by others

Recommendations

- Approaching and negotiating signalised turbo roundabout appears to be a complicated manoeuvre, especially for the less familiar road user and result in errors/mistakes
- Several detailed improvements possible, but these will not exclude all errors
- Only consider application if traffic capacity for heavy crossing flows requires so

Video observations before and after design

Deurne, after


Percentage passerende voetgangers bij geactiveerde overweg (%)
14
12
10
8
6
4
2
0
Oisterwijk Nulmeting
Oisterwijk Effectmeting
O
A
B
C
D
E
F
Risicocategorie

Oisterwijk

Oisterwijk 23:10

- PROLOGUE in-car plus site-based, see separate presentation, Jasper Pauwelussen

Conclusions

- A lot of progress has been made, several excellent examples of new applications (datafusion, sit-based + in-car, multisensor, etc.)
- But still a lot of pre-knowledge has to be put into site-based observation and analysis
- Strong need for further cooperation for both developers (computer scientists) and users (road designers, traffic engineers, and behavioural scientists)

- We will explore further possibilities for this:
  - ICTCT
  - EU-proposal
  - COST action