International Co-operation on Theories and Concepts in Traffic Safety

27th ICTCT Workshop in Karlsruhe, Germany on 16 – 17 October 2014

Empirical data collection in the field - from hard core traffic conflicts till qualitative data collection

Book of abstracts

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What is ICTCT?

ICTCT is an association developed out of an international working group of safety experts with the aim to identify and analyse dangerous situations in road traffic on the basis of criteria other than past accidents, analogous to the methods of air and industrial safety.

Our Goal

International co-operation in the identification and analysis of potentially dangerous situations in road traffic, and their causes, on the basis of relevant safety data derived from observations and surveys.

The aim of ICTCT is to achieve a deeper understanding of problems in the area, to harmonise future research activities, and to provide for means for an optimal utilisation of research results from different countries.

To fulfil these aims ICTCT has been involved in a number of co-operative research efforts (workshops, calibration studies, formulation of international guidelines, clearing house for reports, etc.).

"WE DON'T NEED ACCIDENTS IN ORDER TO PREVENT ACCIDENTS!"
because we are aware of "danger indicators"

Danger indicators are, for example, traffic conflicts and near-accidents, as well as the behaviour and interaction patterns in which they are rooted. To improve knowledge about these events and behaviour patterns, which in the long run lead to accidents, is to be collocated within the ICTCT's sphere of activities.

Today's activities and future plans of ICTCT

- Information and co-ordination service for the international exchange of information
- Production and distribution of a regularly-published research journal ("Newsletter")
- Encouragement of international co-operation by the organisation of conferences and other events
- Development of research structure for the planning, realisation and implementation of projects
- Organisation and administration of an archive and a library ("Clearing house")
- Establishment of advisory centres for the identification, analysis, and solution of safety problems in line with the present state-of-the-art
- Advice on the development of facilities for the training of safety experts in the identification of risk indicators in traffic
- Publishing of material (e.g. handbooks, brochures, guidelines...)
- Public relations work
27th ICTCT workshop Abstracts

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Keynote Sessions
However they are called, traffic conflict techniques or methods for surrogate safety analysis have seen renewed interest in the past decade. This is related in particular to the development of automated methods often based on video analysis that promise to address the main shortcomings of manual methods: cost, reliability and objectivity. The first part of this talk will present a probabilistic framework that takes into account the various potential paths that may lead road users to collide and makes therefore the computation of severity indicators, firstly time to collision, more robust and generic. This framework has been demonstrated on several case studies amounting to hundreds of hours of video: urban intersections, roundabouts and highways, motor vehicles and vulnerable road users.

The second part of this talk will discuss open questions and action items to finally bring the promises of these surrogate methods to fruition, from the lack of availability and comparability of the methods, past and present, and data to the validation of the methods.
Accident statistics may have an important general monitoring function and form a basis for detecting specific traffic safety problems, but the information available from it is inadequate for analyzing and diagnosis, defining remedial measures, and evaluating effects. Systematic observations of road user behavior, combined with knowledge of human information processing capabilities and limitations, offer wider perspectives in better understanding the causes of safety problems and come up with solutions that work. The processes that result in traffic conflicts have much in common with the processes preceding actual collisions, only the final outcome is different. The analysis of road user behavior in critical encounters may not only offer a better understanding of the processes that ultimately result in accidents, but, perhaps even more efficient in the long run, also provides us with knowledge on road users’ abilities of turning a critical situation into a controllable one.

In the past, several Traffic Conflict Techniques (TCT) have been extensively discussed in the literature. Since the late seventies, an international cooperation on TCTs started that resulted in the international calibration study of traffic conflict techniques in Malmö in 1983. Eight teams from different countries simultaneously made their conflict observations at three intersections to enable a sound comparison. A comparison with video-taped conflicts and accidents at that time indicated that conflict severity scores by the individual teams were mainly correlated to Time-To-Collision (TTC) and type of encounter. Based upon the results of the Malmö study, the DOCTOR (Dutch Objective Conflict Technique for Operation and Research) technique has been developed.

Both the Swedish Traffic Conflicts Technique and the DOCTOR technique, that are largely based on TTC measures, are regaining popularity, due to both recent technical developments in observation and analysis methods and needs for specifying and identifying critical events for future in-car systems developments.

This presentation will briefly review the past of TCTs, developments and recent applications of DOCTOR, now mainly based upon judgments afterwards by human observers from video recordings instead of direct observations in the field. These include a long-term video observation study on both collisions and traffic conflicts, a study into the mutual behavior of bicyclists on bicycle paths, an evaluation of attention-increasing measures for crossing bicyclists at a black-spot intersection, and a before-and-after study on counter measures at three high-collision locations in Bangladesh. Moreover, the value and feasibility of adding site-based observations to naturalistic in-vehicle observations, as conducted in the EU-project PROLOGUE, will be discussed. The EU-proposal InDeV (In-Depth understanding of accident causation for Vulnerable road users) will focus on the applicability of, among other things, (automated) TCTs to better understand the processes of accident causation for vulnerable road users.
Session I

Conflicts
Title: There is no need to wait for accidents: applying observation of traffic conflicts and behaviour in Czech practice

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

Background
Traffic accident frequency has been used as a traditional risk measure; however it has been also known that accident occurrence is statistically rare and thus their data collection is time consuming. To this end various other means have been investigated, including observation of traffic conflicts and traffic behaviour. These surrogate measures may enable collection of larger samples and quicker safety assessment. In addition they make whole road safety management proactive, rather than relying on reactive approach based on traffic accidents occurrence only.

These needs have been recognized also in the Czech Republic. Traffic conflict technique, i.e. a method for the systematic observation of conflicting traffic behaviour, has 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 and reported in updated guidelines. The guidelines were reviewed, approved and certified by the Ministry of Transport.

Aim
In consequence Road and Motorway Directorate of the Czech Republic, which manages the main road network, expressed interest in using the guidelines. They requested Centrum dopravního výzkumu, v.v.i. to assess the risk at a newly-built intersection, where no accidents have yet occurred. The paper reports the findings of a case study, which employed risk and behaviour observation. The study was tailored to the needs of road agency, and proved feasibility of quicker and detailed safety evaluation, compared to long time waiting for accidents.

Method
Observation of traffic conflicts, according to the new guidelines, as well as traffic behaviour observation was employed, focusing on insufficient sight conditions for left turns. In order to allow for comparison, observation was concurrently conducted also at a comparable location.

Results
During 5 hours of observation in autumn 2013, several conflicts were detected at the given location, while none was observed at a comparable location. In relation to traffic volumes, left turn was identified as the most severe interaction. Based on these findings, speed measurement and sight conditions check, the originally suspected insufficient sight situation was confirmed. Several countermeasures to this were proposed, ranging from low-cost to more capital intensive ones.
In spring 2014 a low-cost safety treatment is planned at the location. Subsequently another observation will be conducted, in order to compare before/after conditions and check the measure performance.

Conclusions
The presented case study highlights the applicability of surrogate safety measures in an application of proactive road safety approach. The case shows that risk behaviour observation and assessment may provide quicker and even more detailed evaluation of safety, compared to long time waiting for accidents followed by retrospective study of past conditions. Last but not least, the study demonstrates a good transfer of research results to practice.
Title: **ROAD TRAFFIC SAFETY ANALYSIS AT U-TURNS ON THAI HIGHWAYS USING TRAFFIC CONFLICT TECHNIQUE**

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Keywords: U-turn, Geometric Design, Traffic Conflict Technique, Conflict Indexes

**Background:**
Median at-grade U-turns (unsignalised, non priority control, non built-up environment) on divided Thai highways are provided for U-turning movements to facilitate road users to join opposite direction traffic stream. Several layout designs of U-turn are usage in Thailand. U-turn layout design varies with application and dimensions of elements, such as auxiliary lanes (acceleration, deceleration and loons). For this study purpose, eight type of design layout were identified. As compare to other highway access points and some intersections, acceleration (merging) lanes and deceleration (diverging) lanes at U-turns provided along inner lanes of highways. Placement of these auxiliary lanes make interesting and challenging to study road traffic safety at Thai U-turns. Practically inner through lanes of divided highway are used for overtaking and for vehicles moving with higher speed as comparing to outer lanes traffic stream. So merging and diverging at inner lanes make U-turns susceptible towards traffic accident hazards. Maneuvers of motorcyclist for U-turning movement make study more complex and challenging. Thai motorcyclist, mostly travel on paved shoulder along outer lane and rarely use inner auxiliary lanes for U-turning movements, so motorcyclists have to cross all through lanes of both directions. Similarly heavy commercial vehicles having difficulty to use inner acceleration lanes due to requirement of larger turning radius, so these vehicles either merge at through lanes or use loons (outer paved area). Therefore motorcyclist and heavy commercial vehicles make crossing conflicts with through lane traffic streams.

Thailand is among countries having high death rate due to road traffic injuries (13766 fatalities in 2010), but it is misfortune that traffic accident data are highly underreported and unreliable in this emerging country. In these circumstances, Traffic Conflict Technique is most suitable approach to compare road traffic safety for several U-turn layout designs.

**Aim:**
The aim of traffic conflict analysis is the evaluation of road traffic safety at U-turns with focus on their geometric design layout on divided Thai highways.

**Methodology:**
At U-turns, as most of conflict types are merging and diverging and higher posted speed (80 km per hour), so it is difficult to judge or measure conflict and conflict severity using indicators such as Time to Accident (TA), Time to Collision (TTC) and Post Encroachment Time (PET). Under such conditions complexity of evasive driving action is considered potentially viable indicator for conflicting situation. Three indicators (lane changing, brake light and hard brake) are considered for grading of conflicting situation. Conflict rates (number of conflicts per hour per 1000 vehicles unit per 100 turning vehicles unit) are figure out for comparing traffic safety at various U-turn types.

**Expected Results:**
Higher conflict rate signify lower traffic safety at particular U-turn type comparing to others.

**Conclusions:**
U-turns are considered among the most road traffic crashes prone section of highways by road traffic safety experts and practitioners. Identification of safest U-turn design layout for Thai highways not only improves road traffic safety also help to maintain consistency in road environment.
Title: Searching for the severity dimension of the traffic events

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Keywords: Traffic safety, Indirect safety indicator, Traffic conflict, Severity pyramid, Surrogate safety measure, Validity

One of the axioms behind the use of traffic conflicts as safety indicators is the existence of a continuous dimension that allows to order all the events in traffic according to their severity. The relation between the events severity and frequency is often referred to as the “safety pyramid”, and it is believed that knowing the shape of the pyramid it is possible to estimate the expected frequency of the very severe events (accidents) from less severe, but more frequently observed events. However, what exactly is meant by “severity” and how it can be measured is still very uncertain. Intuitively, we understand that in the row “injury/fatal accident” - “property damage only accident” - “near miss” - “normal passage” the severity is decreasing, but to find a good indicator that would reflect this change is not a trivial task.

One of the problems is that for the events that do not result in a collision the severity indicator(s) should cover both the “nearness” to collision and the consequences if it occurs. There is a wide diversity of the suggested indicators and conflict definitions based on these indicators, but the current problem is they are seldom properly validated and cross-compared. As the result, there is no clear answer on what approach to conflict studies should be used as producing the most reliable results.

In this study we investigate several ways to describe the severity hierarchy of the traffic events. We have examined all the encounters between left-turning and straight on-coming vehicles at a signalised intersection during 5 working days. Using semi-automated video-analysis software T-Analyst we extracted the trajectories of the involved vehicles that allowed us to calculate various indicators (Time-to-Collision, Time Advantage, Relative Speed, DeltaV, etc.) with high accuracy and temporal resolution. This is a unique dataset that contains all the encounters (potential possibilities for an accident) during a relatively long time period and with very wide range of severities – starting from time margins of 5 sec. and ending with near-misses with Post-Encroachment Time less than 0.1 sec.

We test different indicators and indicator combinations and illustrate how their choice change the shape of the severity pyramid. We also investigate how the event rating based on the indicators agrees with the subjective perceptions of the traffic safety experts. Even though the validity of the subjective judgements is quite questionable, this approach is still useful in getting first indication on whether the rating is making any sense or not. Finally, we suggest an approach that combines the “nearness” to collision and its possible outcomes into one indicator.

With only one site and type of manoeuvre examined, this paper is more of a methodological than practical value. However, all the tools used for trajectory extraction and indicator calculations are implemented in a user-friendly software that is made public and free for research use. We encourage other researchers to make more studies using the same standardised procedures. This will create a bulk of results that are perfectly comparable and in a longer term will allow both the validation of individual indicators and cross-comparison of safety between different traffic conditions, sites designs, country differences, etc.
**Title:** Analysing traffic conflicts – comparing the Swedish Traffic Conflict Technique (TCT) and the Dutch Objective Conflict Technique for Operation and Research (DOCTOR)

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**Keywords:** Conflict analysis, Swedish Traffic Conflict Technique, Dutch Objective Conflict Technique, Cycling safety

Solely relying on accident statistics when assessing accident risk on a specific location or in a specific traffic situation in most cases does not provide sufficient information to define accident risk or to reveal the underlying mechanisms of unsafe situations. Important shortcomings of these accident statistics are: - not all accidents are reported (report rate is related to the accident’s severity and road-user type)- accidents are rare events, making it difficult to relate accident probability to actual traffic accidents - the preceding chain of actions of an accident in most cases is not reported, making it hard to develop insights into the causes of unsafe situations. In order to face these issues, several methods of conflict analyses have been developed. These approaches are based on the idea that conflicting interactions in traffic (‘unsafe situations’, in which a collision would have occurred if one or both road-users had not changed speed and/or direction) are related to accident risk. Two well-known methods are the Swedish Traffic Conflict Technique and the Dutch Objective Conflict Technique for operation and Research (DOCTOR). Both methods use somewhat different indicators and definitions to define a conflict and its level of seriousness. Whereas these methods were already developed in the 70’s and 80’s they are regaining popularity, partly due to the fact that technical developments provide us with possibilities to make the application of these methods less time-consuming and data-processing more accurate. In the current paper, strenghts and weaknesses of both methods will be elucidated. Differences in findings when applying both methods will be illustrated by a study into roaduser behaviour on two locations in Aalborg (Denmark) and Oslo (Norway). Both locations (4-armed crossings) have a fairly comparable infrastructure, having a cyclist-lane on the main road and a zebra-crossing on each arm. In order to see whether cycling safety as well as cycling culture between the two locations differ, typical as well as critical interactions between motorized traffic and cyclists will be considered (based on camera-observations). Finally, future challenges for improving validity and reliability of conflict-analysis will be discussed.
Title: Calibration of Drivers Perceived Level of Risk in an Uninterrupted Traffic Facility: An Experimental Study

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Keywords: Risk Homeostasis, Accepted Risk Level, Experimental Study

According to Wilde’s risk homeostasis theory (RHT), the system user tends to compare the perceived risk with the target (accepted) level of risk and decides to adjust behavior as a response in a way that minimizes discrepancy between the two risk levels. Despite criticism of the theory, and while the RHT is basically a theory in psychology, if well bridged into engineering knowledge, it may also have potentials in smart design in engineering domains. In engineering the final product should necessarily act out in the way that the user (system operator) is nudged to behave in the same way as expected by the designer, with minimal behavioral adjusting efforts (side effects) and erroneous actions.

Although perceived and accepted risk levels are key constructs in RHT, efforts to effectively measure the two terms in engineering applications are still considered inadequate. As an attempt to mitigate this gap, the present study aims to quantitatively detect occasions when the perceived level of risk equals the accepted risk level on an aggregate basis. To do so, a novel infrastructure to vehicle intelligent system was devised and implemented in an instrumented segment of uninterrupted traffic facility equipped with a variable message sign, with the aim to communicate with drivers, the near real time risk of rear-end collision. The real time micro-level traffic data obtained by inductive loop sensors were analyzed and the level of rear-end collision risk as a dichotomous variable was estimated, displayed and refreshed at 5-min intervals in the form of low/high risk levels. The appropriate levels were obtained based upon the predetermined proximal safety indicator and the crisp thresholds.

According to RHT, people get entertained by the risk level they are shown, in the form of amending behavior, once the risk level corresponds with perceived risk, and at the same time the two levels are equal to the accepted risk. In a reverse presumption, the occasions under which the significant amending effects in behavior are observed are those well-fitted to situations in which the transmitted risk level (by message), the real time perceived risk level and the real time accepted risk level have the same values. Such occasions can be translated into quantitative engineering measures, for further applications.

The system was in use for two days to send near real time risk of rear end collision to drivers, after it was operationalized under the continuous messages with no direct effects on car-following for two days. Safety Margin (SM) as a car following safety performance indicator was used to quantify behavioral changes under the message of "high risk". Mean values of SM under this message were compared with the mean values of SM under the null message. The strongest behavioral effect (in terms of increasing in SM values) under the message was observed in car-following cases where the time headway was less than three seconds. The effect was highly significant for slow moving lanes in night hours and significant in day hours, a slight effect was observed at the fast moving lane during night hours, but no effect at day hours. Furthermore the effect was not significant at the middle lane both during day and night hours.

In addition, driving speed as a safety performance indicator was used to quantify behavioral shifts under the message of low risk. Mean values of speed under this message were compared with the mean values of speed under the null message. The behavioral effects under the message (in terms of increasing in speed) were revealed in cases where the time headway was more than three seconds. The effect was highly significant for all lanes during
night hours and non-significant during day hours. Such situations correspond with situations when the drivers perceived the risk the same as what they are displayed.
Session II:

Theory and methods
Title: Attempts to improve road safety data in the Netherlands

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Keywords: Road safety data, policy development, data validity and reliability, strategic policy development, system approach

Background:
Due to cutbacks, and societal and organisational changes the quality of basic statistical data regarding travelling and road safety in the Netherlands has degraded. Long time monitoring studies (safety belts, child restraints, road safety conditions) have been stopped. Road safety authorities, particularly road authorities, have become (almost) blind regarding road accidents in their jurisdiction. Unexplainable trends in safety data are found. Research institutes want more and better data, but it is highly improbable that things will go back to the way they used to be.

Aim:
Improve insight in status quo and developments in road safety, in order to be able to develop strategies, policies and measures for the improvement of road safety, and thus support the wealth and wellbeing of the population.

Method or methodological issues:
In principle one will only find what one is looking for. Systems theory is used to help define questions. New ways of acquiring and validating insight in road safety and its determinants are developed. The aim is build goal-oriented, valid and reliable data sets for (integral) policy development and policy decisions. This is realized in two ways: by enriching existing data sets and by critically examining data sets on unexplained analysis outcomes.

Results obtained or expected:
Lean data collection is adopted because the financers (central government) are no longer in the position to take up the costs for other policy actors. Economic developments do not promise larger budgets for basic data sets. When it is more difficult to collect data anyway, data validity is not the first priority.

Combining data sets and triangulation can help to deliver adequate coverage of the road safety domain. This approach is used in many strategic projects, i.e. a study about travel safety risks of the elderly. Here an unexplained phenomenon was found: a 100% increase in 5 years in hospital admittances amongst elderly pedestrians and cyclist. This was researched. Indications were found that changes in casualty reporting (for a large part) explain the increase. The implication however was that older data had undetected underreporting as well.

Another approach to compensate for data quality changes is data enrichment. ‘Opportunities’ like ‘Big Data’, ‘data-mining’ are not the answer, because of uncertainties about their origin, validity, representativeness and reliability. Specialised consultants have big interests in ‘Big Data’ processing. A promising initiatives arose: the STAR system initiative. Data from insurance accident forms (delivered by a new dedicated reporting Apps), police reports, ambulance, ER, and hospital data, road environment and weather services data are linked. For accidents involving motorized vehicles this is a promising initiative. For accidents involving vulnerable road users, particularly single accidents, however, the STAR initiative is not likely to deliver a proper solution. A major problem will be localising the accident. This poses new challenges.
Title: The turning point in the number of traffic fatalities: two hypotheses about changes in underlying trends

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Keywords: traffic fatalities, long-term trends, turning point, traffic growth, fatality rate

The number of traffic fatalities reached a peak in many highly motorised countries around 1970. Previous studies have suggested that the turning point in the number of traffic fatalities does not necessarily reflect a change in the underlying trends influencing the number of traffic fatalities. If traffic grows gradually more slowly, and the fatality rate per kilometre of driving declines by a constant percentage each year, the number of traffic fatalities will stop growing and start declining when the percentage growth in traffic volume becomes smaller than the percentage decline in fatality rate. This will occur even if the long-term trends in traffic growth and fatality rate are the same both before and after the turning point. This paper proposes two hypotheses about the turning point in the number of traffic fatalities. One hypothesis is that the long-term trends in traffic growth and fatality rate were the same before and after the turning point. The other hypothesis is that the long-term trends in traffic growth and fatality rate were different before and after the turning point was reached, in particular that the annual percentage decline in fatality rate became greater after the turning point than before. Such a change would suggest that road safety policy became more effective. Analysis of data for six countries (Denmark, Great Britain, Netherlands, Norway, Sweden, United States) lends stronger support to the latter hypothesis than to the former.
Title: The relationships between social networks, activity patterns, and driving behavior

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Keywords: Social, Networks, Activity, Patterns, Driving, Behavior

To date there has been some research on the impact of social interaction on activity patterns and travel behavior, and to a lesser degree also on the impact of social interaction of driving behavior. Wafa et al (2010) found that activity pattern and travel behavior do have an effect on driving behavior and crash involvement. This paper expands this idea by adding the social interaction factor and how it impacts both travel patterns and driving behavior and risk exposure. It focuses on the multi-way complex relationships between socio-demographic characteristics, social interactions, activity participation and travel patterns, and driving behavior using structural equation approach.

The study is based on a unique data set currently being collected as part of a larger study on the factors affecting the high rates of the Israeli Arab population involvement in inter-city road crashes. The study includes an initial telephone survey of 600 respondents, of which hundred respondents will be asked to participate in a more detail face to face survey. The telephone survey will, among other purposes, identify violators' drivers and will ensure sufficient violators' driving participants among the 100 participants in the face to face survey. The participants in the face to face survey will be asked to carry a GPS for a period of couple of weeks. At the end of this period an interview will be conducted where questions seeking further details on the travel patterns identified by the GPS will be asked including the purpose of each trip and with whom was it made, in addition to various questions about driving behavior, driving violation and crash involvement, social interaction at different circles (close family within the household, relatives, friends, and work colleagues) and various attitudinal questions.

Social interactions questions will try to identify personal networks by asking about relationships with close family (parents, children, and siblings), relatives (cousins and other), friends and work colleagues. Questions will identify frequency of visits and other communication (phone, email) and type of relationships (attitude/support) as well as social norms within these circles. The survey will focus on one village in the Galilee Region in Northern Israel so it is expected that various respondents will be both egos, those the survey is concentrate on and alters, those who have relationships with them (Carrasco and Miller, 2009), so we could analyze the impacts of various types of alters and their social network on egos.

It is expected that better understanding of the social structure and daily life will improve our understanding of driving behavior, which can guide policy makers to direct efforts in improving driving behavior to specific populations with specific characteristics, and identify the importance of social norms and interactions.
Title: Increasing the health benefits of active transport by network level separation of motorised and active transport modes

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Keywords: road safety, vulnerable road users, health effects, route choice, road networks

Background
Research shows that exposing cyclists and pedestrians to high speed motorised traffic reduces the health benefits of these active transport modes as a result of an increased crash risk and inhaled air pollution. Moreover, the associated perceived unsafety may decrease the amount of walking and cycling thereby preventing people from taking advantage of the health benefits.

Aim
As bicycle tracks and sidewalks allow for conflicts at intersections and a short distance to the source of air pollutants, this paper explores the opportunities for separation of cyclists and pedestrians from motorised traffic at the network level. Within the context of developed countries, the paper focused at road hierarchies, networks for motorised and active transport, concepts such as filtered permeability and bicycle boulevards, route choice, etc.

Method or methodological issues
The study uses theories and scientific and grey literature from developed countries to explore the opportunities for network level separation of motorists and active transport users. Methodological issues to be discussed in the paper are that a host of measures at locations can contribute to network level separation, that the degree to which cyclists and pedestrians are exposed to high speed motorised traffic within a network is hard to measure, and that the applicability is context dependent. But there are also issues for practitioners such as how to implement a road hierarchy and deal with resistance.

Results obtained or expected
The result is a first estimation of the opportunities for network level separation of active and motorized transport within developed countries and suggestions for future research on the effectiveness of measures to achieve network level separation and its health impact. Most research is focussed at the location level and monodisciplinary. Research on opportunities and effects has to be conducted at or aggregated to the network level. For instance, multi-disciplinary research is needed for the health impact is dependent upon modal shift, road safety, and air pollution.
Title: Data collection and evaluation methods in the fields of ITS technologies for VRUs

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Keywords: ITS, VRU, evaluation, field trials, technology development, stakeholder involvement, user centred design, user experience

Recent developments in the ITS sector have put a stronger focus on vulnerable road users (VRUs), leading to an increased demand for research activities in this field. Consequently actual effects of these emerging technologies need to be assessed in view of safety, mobility and comfort aspects of pedestrians, cyclists and powered two-wheelers. To address the rising need for data on both potential user groups of these systems as well as on data on potential impacts a broad inventory of research methods, ranging from exploratory to (quasi) experimental designs have to be applied. Sustainable solutions, especially in the ITS sector, need to be developed and evaluated not only based on basic usability and design principles, but also take underlying levels of road user behaviour and mobility needs into account. Based on experiences in national Austrian projects such as TrafficCheck.at (Urban sensing platform to improve traffic lights), TellMeTheWay (Multi-modal routing in urban transport systems), Ways2Navigate (Pedestrian navigation technologies based on speech, digital map and augmented reality), applied methodology is discussed. Focussing on both data collection as well data analysis a variety of different methods is presented.

Methods discussed cover the basic research phase of technology development projects, including user need assessment and identification of special interest groups (i.e. in course of exploratory and heuristic methods, including expert interviews and focus group discussions). In addition sociological and psychological methods applied in course of iterative development processes of solutions specifically addressing VRU mobility needs, based on user-centred design approaches are discussed. Proven instruments and issues in research design and participant sampling experienced in course of the above mentioned projects are introduced. Specific tools for Usability assessments, field trials and stakeholder involvement are presented in view of their advantages and potential disadvantages in research projects, where user experience and involvement is treated as resource for the development of technological innovation.
Title: Impacts of ITS in different transport modes

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Keywords: Impact, evaluation, ITS, intelligent transport, road, rail, maritime

Background
Today, with decreasing public budgets, transport system managers and operators need to employ the most cost-efficient tools to deal with transport problems and the maintain the requested level of service to journeys and transports, to travelers and hauliers. In order to utilize also ITS services and tools for such purposes, we need to know what are the impacts of the different ITS services and systems.

Aim
The main aim was to investigate current knowledge on the effectiveness of traffic management, especially on safety but also on the fluency of traffic, the environment such as CO₂ emissions, and energy consumption.

Method
This study covered road, railway and maritime traffic, and was carried out by VTT Technical Research Centre of Finland. Only traffic management practices considered relevant to Finnish circumstances were considered. The main research method used was literature review. Additionally, two group discussions (one on railway traffic and one on maritime traffic) were conducted.

Results
The effects of some road traffic management practices are fairly well known, whereas few studies have been conducted on the effects of other traffic management practices. Most evaluations merely cover the safety effects of different systems and services. Not a lot of information is available on the effects of traffic management on safety, fluency and environment in railway traffic. The only exception is the management of encounters between railway and road traffic. The research in this field chiefly includes studies on the safety effects of measures implemented for level crossings. Few if any quantitative results can be found on the effects of traffic management practices on maritime traffic. The results of available studies vary significantly and are mostly based on risk analysis conducted prior to the implementation of specific traffic management practices. International studies cannot be directly applied to Finland because of differences in the operational environment and prevalent circumstances.

Conclusions
As a conclusion, the experts in the Finnish Transport Agency identified the gaps in the knowledge needed especially in the light of the likely deployments in ITS services and systems up to 2020. This action produced a short list of evaluation studies, which need to be initiated as soon as possible as well as those, which need to be carried out during the next years.
Session III

Video, simulator and observation studies
Title: **Midfield-width, lane width and effects on speed and mental workload: A simulator study**

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Keywords: Driving speed choices, private rules, mental workload, skin conductance, simulator experiment, road width parameters

The paper will present results from a simulator study where 36 subjects were exposed to 12 randomly ordered conditions - each condition comprising the same 10 km stretch of road with constant speed limit (90 km/h). Midfield- and driving lane width were systematically varied in a 3x3 factorial within-subjects design. All subjects had their own "private rules" regarding choice of driving speeds on rural 2-lane roads with a speed limit of 90 kmh. An example of private rule: “In 90 km/h speed limit zones I drive approx 100 km/h”. All subjects were asked of these rules after the simulator sessions. When the actual driving speeds in the simulator were checked against their private rules, the speeds that were chosen were in remarkable agreement with their rules of driving speed choices. Drivers choosing the lower levels of driving speeds showed practically no variation in average speeds across the experimental conditions, while the group stating that they usually would drive 110-120 kmh in a 90-zone, varied across experimental conditions by having their highest mean speeds when midfield was narrow and driving lane was wide and lowest mean speed when midfield was wide and driving lane narrow. The maximum speeds of this subgroup was also significantly higher than speeds of the rest of the drivers. The driving speeds seem to be determined partly by "private rules", partly by emotions as measured by skin conductance (SCR).
Title: Safety assessment of pedestrian crossings with video analysis

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Keywords: pedestrian crossing, image analysis, conflict technique

Poland has the worst pedestrian fatality rate in the European Union. In the years 2007-2011, 7 944 pedestrians were killed and 61 635 injured on Polish roads. About 30% of these pedestrian victims were hit by vehicles on marked pedestrian crossings. The aim of the project Mobis is to develop and test a method for assessing the safety of pedestrians on road crossings using for the first time in Poland automatic video image analysis. Pedestrian and vehicle traffic is recorded with at least two digital cameras in each traffic direction. To verify the accuracy of the automatic speed detection speed profiles calculated from the video recordings were compared with those recorded by a test vehicle equipped with a very accurate laser speed recorder. The comparison revealed some differences (10-25%) between the two measurements. They can be reduced to the level of about 3% by calibrating the speed profiles resulting from the video recordings. Statistical analysis of conflict and dangerous situations will be conducted in order to develop surrogate safety measures appropriate for pedestrian crossings. It is hoped that the new method will accelerate pedestrian crossing safety assessments and improve the planning of modernisation works, based on the priority. The new method can also be used for assessing the effectiveness of road safety measures.

The paper will present the preliminary findings from the project, and discuss the results of field tests conducted on zebra crossings with different safety measures. Pedestrian and vehicle traffic was recorded at a selected crossing in Warsaw (SignFlash and speed humps) and in Wroclaw (Levelite) for 2 months, before and after the installation of safety measures. Speeds of approaching vehicles were measured and vehicle-pedestrian conflict situations identified using video analysis. Preliminary results from Warsaw indicate that both SignFlash active signage and speed humps have a positive impact on driver behaviour, reduce the mean vehicle speed and the number of conflicts between pedestrians and drivers.
Title: Exploring interaction processes between cyclists and car drivers - a Grounded Theory and mixed method approach

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Keywords: Bicyclists, car drivers, interaction processes, Grounded Theory, mixed method approach

Bicyclists face a higher accident risk than other road users. The number of killed cyclists in the 24 EU countries in 2010 was 2100. Between 2001 and 2010 the number of fatally injured cyclists was reduced by just 39% compared to the 43% overall reduction of road death in the same countries. The main opponent in the accidents are cars (ETSC 2012). The question therefore is how traffic safety for bicyclists can be enhanced? Which factors have to be adapted to improve their traffic safety? The study assumes that conflicts can be considered as the effect of failed interaction processes of the involved persons. Therefore the focus of the research is put on interaction processes and the influencing aspects, e.g. present infrastructure, driving experience etc. that lie behind these processes.

The study follows the Grounded Theory (Glaser, Strauss 2010). Using Grounded Theory enables to uncover relevant influencing aspects and conditions of social phenomena and to explain and describe the phenomena. The data for exploring the interaction processes between cyclists and car drivers at intersections will come from various sources, the mixed method approach (Creswell, 1999) will be applied. The basic principle of Grounded Theory is that the data collection and the analysis are interrelated processes.

The starting point of the study are in depth interviews. Cyclists and car drivers explain their point of view how they experience interactions between cyclists and car drivers in traffic. The data of these in depth interviews provide a comprehensive list of influencing factors for interaction processes in traffic (= concepts) which are experienced as important. The further procedure is based on the already gathered data and the results of the data analysis. Focus group interviews with cyclists will be applied in order to provide additional data about aspects that would remain unspoken in an individual interview. Within focus group interviews it is possible to follow aspects other participants introduce. Field observations, assisted by video cameras at four intersections in Vienna, will provide the quantitative data about interaction processes in traffic. Altogether, 200 bicyclists and their interaction processes with car drivers will be observed. The recordings will be analysed with the video-analysis software INTERACT, by using traffic-conflict technique and manual coding of behaviour sequences. The criticality of encounters between cyclists and car drivers and the contribution of the related interaction processes to criticality will be explored. The obtained qualitative data will be liaised with the quantitative data. This will be done by making comparisons of the identified concepts and developing and relating categories out of the gathered data.

The aim of this study is to analyse the interaction processes in detail and to survey basic interaction forms in traffic, in order be able to identify safety-enhancing interaction behaviour and to explore the contribution of other influencing factors, as infrastructure to these interaction processes.
Title: An examination of the influence of crosswalk marking removal on pedestrian safety

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Keywords: Pedestrian, crosswalk marking removal, behaviour, safety

In the international practice there is a belief that removing road marking at non-signalized crosswalks may improve pedestrian safety. In some local authorities in Israel, road markings were removed from non-signalized crosswalks situated on multilane dual-carriageway urban roads. The purpose of this study was to examine whether this treatment contributes to pedestrian safety, based on the analysis of road user behaviours and pedestrian crossing conditions at sites without crosswalk markings (treatment sites) versus those with the markings (comparison sites), where the behaviours are collected through field observations. Six sites were selected for the study: one treatment site in Beer-Sheva and another one in Tel-Aviv, where, for each treatment site, two comparison sites were fitted, with similar road characteristics and type of urban environment. For each study site, road accident data were collected for the years 2006-2011, and field observations were carried out, including free-flow speed measurements and video-recording of pedestrian and vehicle behaviours at the crossing site. The road user behaviours examined were: giving-right-of-way to pedestrians by vehicles; keeping to safe crossing rules (stopping and checking the traffic prior to crossing) by pedestrians; conflict occurrences between pedestrians and vehicles at the crossing site; waiting time by pedestrians prior to crossing and the time of crossing the road.

The accident numbers observed at the study sites were small, thus, making it impossible to reach a conclusion as to the influence of crosswalk marking removal on road accidents. The speed data analysis demonstrated that the sites with removed pedestrian crosswalks were associated with higher speeds compared to other sites, yet the tendency to higher speeds was not identical in both directions of travel. The speed indicator values at the treatment sites were sufficiently high to create a threat of severe injury for the crossing pedestrians. Considering road user behaviours at the treatment versus comparison sites, it was demonstrated that the treatment sites are associated with higher rates of pedestrian stops before the crossing and low rates of pedestrian-vehicle conflicts during the crossing, but also with long waiting times by pedestrians prior to crossing, low rates of giving-right-of-way to pedestrians (in Tel-Aviv) and vehicles ignoring pedestrian needs to cross (in Beer-Sheva). A lower influence of the treatment was observed at the Tel-Aviv site, where high-mounted traffic signs of pedestrian crosswalk remained at place, so that for drivers the arrangement probably continued to serve as a regular pedestrian crosswalk.

It was concluded that pedestrian crosswalk removal brought about a worsening in the possibility of crossing the road for pedestrians. The conditions observed at the treatment sites: vehicles ignoring pedestrians which need to cross; long waiting times for pedestrians; considerable times required for pedestrians to cross the road and high vehicle speeds on road sections, cannot be recognized as an improvement in pedestrian crossing safety, despite a higher level of obedience of pedestrians to safe crossing rules. The study findings do not support the claim that removing a pedestrian crosswalk marking leads to safety benefits for pedestrians.
Title: On site observation of driver`s and pedestrian`s interaction at zebra crossings

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Pedestrians, Zebra crossing, Driver-pedestrian interaction/ communication,

Keywords: Road-crossing strategies, Pedestrian safety, Pedestrians` accidents/ collisions, Pedestrians` behavior

Background
Our work is based on the social psychological theory of power distribution. We assume, that this distribution between driver and pedestrian is unbalanced, in favour of driver (the one who can force his way with his car as a shell). This affects drivers and pedestrians behaviour and interaction while encountering at zebra crossings.

Aim
The aim of this work is to describe pedestrians’ and drivers’ behaviour at zebra crossing and their mutual interaction. Further more, to understand strategies, which pedestrians and drivers use to maximize their benefits (whether it means to safe time, feel safely or something else). Implications of this work are in identification of risky factors on drivers and pedestrians behaviour and especially identification of combination of these behaviours (or strategies) which may lead to conflicts, near misses or accidents.

Research design
Mixed methods design was used, following these steps:

1. Exploration of pedestrian and driver needs and conflict situations (identification of the problem) – focus groups with pedestrians and drivers (separately).
2. Pilot study (spots, questionnaire, observation sheet, camera recordings).
3. Data collection: on site observations (4 spots - zebra crossing, in urban area, 3 observers, at each spot 50 hours), camera recordings (24 hour), speed measurement, interviews (on site rapid interviews with pedestrians).
4. Exploration and generalisation – expert workshops

On site observations were carried out during December 2013 – March 2014, observation times: 7.00 – 9.00, 12.00 – 13.00, 16.00 – 17.00. No snow, ice or wet conditions. Cameras recording – from selected spots, 24 hours, car and pedestrian densities were counted. Speed measurement at selected spots during observing times.

All together 1584 observations (observed situations at 4 spots) were analysed.

Outcomes
The expected outcome is a description of situational factors which may lead to a traffic accident in the future, focusing on pedestrians' and drivers' behaviour, communication and their strategies in situations where their ways cross. Exploration of pedestrians' attitudes and behaviour is summarized based on interviews.
Session IV

Field studies
Title: Controlled studies and naturalistic driving - the best of both worlds?

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Keywords: Method, behaviour, analysis, secondary task, controlled study, naturalistic driving

The recent debate about whether results from controlled laboratory and field experiments and naturalistic driving studies are contradictory, or whether they show two sides of the same medal has inspired us to investigate whether we can extract the best of both worlds and shed some light on the question. In one driving simulator study and one field study with bicyclists we kept the experimental setup of a baseline and treatment phase to which participants were assigned, but we encouraged the participants to choose how and where to execute the secondary tasks in the treatment phase to obtain as naturalistic behaviour as possible. Cyclists could, for example, stop cycling to read an sms or delay an outgoing phone call to avoid dialling in a complex traffic situation. Car drivers who had to report hazards along a route could decide what to report and when. The results show clearly that road users employ useful compensatory strategies when dealing with secondary tasks in traffic. They choose a suitable location, reduce their speed to prepare for a phone call, adapt their glance behaviour to accommodate a visual secondary task without neglecting traffic relevant targets, and so on. However, as the compensatory strategies depend both on the individual and the current traffic circumstances, participants typically choose differing locations and strategies to complete the task at hand. This complicates the analysis, as there is not one given baseline for all participants. We chose the approach to extract individual baselines for each treatment case, accepting that the resulting baseline sections may not be completely equivalent. We will discuss the advantages and disadvantages with this approach and its implications for observational studies, the interpretation of results and how it may be possible to differentiate whether a found effect depends on a conscious strategy or indicates an unplanned deviation.
Title: Investigating the psychological effects of worksites on road users and drivers' behavior in field studies

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Keywords: Exemplary Paper, Human Systems Integration, Systems Engineering, Drivers' Behavior, Traffic Psychology

A large part of German motorways is increasingly overaged and in need of maintenance. In addition, the dimensioning of traffic routes has to be adapted to consistently growing traffic volumes. Thus, many worksites for road preservation and development are already installed and even more are planned, following the existing technical regulations. However, the human factor is only considered poorly. Nevertheless the drivers' behavior needs to be considered into the construction process, because the interaction between the human factor, drivers' behavior and the road is not trivial. (e.g. ECHTERHOFF, 1991)

Therefore, also psychological aspects should be taken into account for the design of worksites in the future. Some studies have shown that route constructions are associated with a changing driver behavior. Yet, appraisal about the subjective influence of route constructions is missing. The aim of the present study was to investigate how drivers' state is modified, behavior-related and emotional, when confronted with different challenges due to construction works.

In the study, three German worksites were selected, differing in length, width of lane, staggered arrangement and design. Eye-tracking data and heart rate of the driver were monitored to assess gaze behavior and autonomic nervous system activation in order to detect episodes and antecedents of drivers' perception and activation. In addition, the drivers' behavior was investigated by recording speed and distance to other vehicles, breaking behavior and standard deviation of lane position. Current traffic conditions were additionally documented. The combined captured data allow a detailed evaluation of the different driving episodes, the drivers' behavior and the psychological effects of worksites on road users. In total 150 segments of eye-tracking data in various particular driving events were classified and further investigated. To capture the road users' subjective attitude, a questionnaire was additionally created and evaluated not only among the probands but also among road users via internet and personally on lay-bys near the worksites.

Based on the findings, recommendations for the installation and arrangement of worksites will be compiled which lead to considerations to the driving behavior. Overall, the strains for road users in areas of worksites are thereby to be reduced and a reduction of accidents is to be achieved.
Title: **Driver behavior, critical situations and vehicle condition**

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Keywords: driver behavior, critical situations, vehicle condition, safety risks, periodical technical inspection

The European Union has set ambitious goals until the year 2020 regarding traffic safety. Targeted and practical measures are indispensable for their implementation. Particularly the dissemination of already available safety functions in vehicles greatly influences the improvement of traffic safety. Periodical technical inspection (PTI) of vehicles makes a major contribution towards preserving the safety level of every vehicle in use throughout its lifespan. For this purpose examination procedures are being generated and adapted to further developed vehicle technologies.

Data collected under real-life traffic conditions serve as a basis since systematical further development of the PTI and the applied inspection technologies requires knowledge as accurate and comprehensive as possible about vehicle safety risks, e.g. degradation, disturbances and failures of safety-related parts and systems.

In this context, accurate and comprehensive knowledge includes answering the following questions:

“When and under which circumstances do these safety risks emerge?”,

“Do they increase in severity and frequency?”,

“What is their influence during different operating states?”

For this purpose vehicles have been equipped with specially developed tachographs. Driving dynamics measures as well as in-vehicle communication are continuously analyzed and detected abnormalities concerning the vehicles condition and components are recorded on a ring memory. An intelligent algorithm detects critical events marked by deviations from the normal driving behavior in the given situation, e.g. an emergency breaking event, excessive steering or ESP activation and stores them permanently. Thus, 30-second-sequences are created which contain necessary information about the critical situation and the circumstances which lead to this event. Additionally, GPS-triggered recordings at already known accident black spots offer the opportunity to analyze conditions under which critical situations occur, including vehicle-related data as well as driver behavior.

Taken together, this data is used to analyze changes in the vehicles technical condition during everyday use on the one hand. Knowledge for the evaluation and future design of the technical vehicle inspection can be derived from observations regarding condition, function and effect of components and safety functions. On the other hand, handling properties are also part of the analysis. The primary focus is on critical situations, meaning extreme vehicle motions like under- or oversteering, emergency braking or interventions by the safety system, situations requiring rapid and safe intervention.

This way an extensive data trove is created which offers numerous opportunities for analysis regarding enhancement of vehicle and driver safety.

We would like to present the current stage of data pre-processing and analysis. Special attention is paid to the description of driver-driving-behavior, critical situations and vehicle condition. Additionally, we want to encourage discussion of further potentials the gathered data offers and look forward to creating new ideas and even possibly identifying potential synergies with other external research projects.
Title: **AIM Research Intersection - Infrastructure for Research on Interacting Urban Traffic**

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Keywords: infrastructural detection system, trajectory data, situation assessment, safety related situations, cooperative driver assistance systems

The AIM test site (Application Platform for Intelligent Mobility) is a large-scale research infrastructure in the city of Braunschweig, Germany. It is built-up and operated by the Institute of Transportation Systems from German Aerospace Center (DLR). In AIM, an entire city serves as a platform for application-focused research and development in the field of intelligent mobility services. AIM consists of parts for observing and influencing traffic, which are placed on dedicated test tracks, real urban areas, and selected parts of the surrounding regions, supported by simulation toolboxes and simulators, and a powerful back end structure (http://www.dlr.de/ts/aim).

One of the facilities of AIM is the Research Intersection. It is a service platform for real-time detection, prediction, and classification of motorized and non-motorized traffic participants at one of the most complex urban intersections in Braunschweig. The technical set-up comprises different sensor technologies. For example the sub-system for detecting motorized traffic consists of mono-cameras, 24Ghz radar systems and infrared spotlights to enlighten the scene in case of bad illuminations (e.g. at night). Four redundant installations are attached to different poles in the intersection, in order to cover the whole inner area and prevent data loss due to covered scene details. The sub-system for detecting non-motorized participants, like pedestrians and cyclists, uses stereo-camera technology as well and monitors the cross-walks.

The main output of the system is trajectory data of the traffic participants with corresponding scene videos. The trajectories contain the objects’ positions in the scene and other relevant state information (e.g. velocity, acceleration or specifications about the objects’ length and width). In combination with the given traffic light data, this output allows to receive an overall understanding about the respective traffic situation.

The AIM Research Intersection can be used as basis for an analysis of interaction patterns between differing traffic participants. With this, it can serve as basis for many fields of mobility research. For example current work at DLR brings safety critical situations into focus. The given data allows on-line situation assessment based on time series of safety surrogate measures, e.g. PET (Post-Encroachment-Time) or TTC (Time-To-Collision). These can be used for automatically detecting near-misses or potential safety critical situations. This information can be used to deduce demands for developing advanced driver assistance systems that support drivers appropriately in the given situations. Other works incorporate the Research Intersection as part of infrastructural supported cooperative driver assistance systems. This is done by combining the detection systems with DSRC functionality to bring the situation related information into the vehicles in the vicinity of the intersection. Such communication systems are available in AIM as part of an additional service called AIM Reference Track.

The full manuscript will give a detailed insight view on the named infrastructure and illustrate existing outcomes from current works.
Session V

Speed
Title: Speed calming measures and how they affect speed violations and driving pattern

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Keywords: speed calming, effect study, driving behaviour

Background:
Inappropriate speeding is one of the most important reasons for fatalities and injured in the traffic. Despite many years of education, police control, information, and speed limit signs spread on the road network, more than 50% of the Danish car drivers are speeding regularly on urban roads, while it is nearly 75% on rural roads. Moreover, nor speed-regulation or speed-preventing Intelligent Transport Systems, nor serious enhanced enforcement are expected to be implemented in the next decade. Hence, speed bumps, elevated surfaces, and narrowing are spread out on significant parts of the Danish road network to reduce the speeding problems.

Aim:
The speed-calming measures are made as different types and with different interval. The selected solutions are often not selected due to their safety effects, but rather on other basics, which are not clear in all cases. On decision taker level are all solution seen as suitable solutions to improve road safety. However, former studies have shown that the effect from different types of solutions differs significantly and that not all are reducing the speed, as it is required. The aim is to study the effect on speed and speed variation of the most used speed-calming solutions.

Method or methodological issues:
The method is based on GPS data from driving cars, called Floating Car Data (FCD). From a large number of cars FCD from the passage of the speed-calming measures are analysed. In total speed-calming measures in 14 minor towns covered by nearly 31,000 trips on the basis of 63-220 unique vehicles are analysed. Roads with speed calming measures in big towns and cities are not included as the data might be less reliable for two reasons. Congestion problems in a big town might overshadow any effect on speeding. Also, the number of functions, which might result in deviations in the driving behaviour in a big town, is high and too many of such deviations might also shadow the effect from the speed calming measures.

Results obtained or expected:
The FCD are still in analysis, but the preliminary outcome is the effect on driving from each of the most used types of speed-calming measures. The effect will be measured by speed at the passage, speed variation at the passage, and how lasting the effect is (in distance from the measure).

Conclusions:
The expected results are that speed bump and narrowing overall have sufficient effect on speeding, while the effect from elevated surfaces is expected to be smaller. Also, it is expected that speed bumps and elevated surfaces result in rather low speed variation while it is expected to be high regarding narrowing. The latter due to the fact that a narrowing has its clearest effect when oncoming vehicles pass each other near the narrowing, and limited effect might be the case, if no oncoming vehicle appear during passage. For each of the measures it is expected that the effect only is lasting for a short distance.
Title: Effects of automated motorway speed enforcement: average versus instantaneous speed control

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Keywords: Enforcement, speed, motorway, camera

Background
Speed enforcement cameras are widely applied nowadays, also on motorways. More recently average speed enforcement is introduced, involving cameras installed over a stretch of road. In this system, data on speed and time are recorded for each vehicle as it enters and leaves two points in the system, a road section. The data are then used to calculate the average speed of the vehicle.

Aim
The presentation discusses effects of both instantaneous speed cameras and average speed enforcement. Effects on speed behaviour as well as effects on crashes are discussed based on recent empirical evidence.

Method
The effects on speed behaviour were examined at two locations with speed cameras and at two road sections with average speed enforcement, all located on motorways in Flanders, Belgium. The effect is analysed through a before- and after and a cross-section comparison of travel speeds.
In the second part of the study, the traffic safety effects at 26 locations with fixed speed cameras on motorways in Flanders-Belgium were evaluated by means of a before- and after comparison of the number of crashes.

Results
The results show a V-profile in the speed distribution for both locations with instantaneous speed cameras, with speed decreases at the speed camera location. Both the proportion of drivers exceeding the speed limit and the proportion of drivers exceeding the speed limit more than 10% decreased considerably. However, before and beyond the cameras the speeds hardly, if at all, reduced. Moreover the analyses of the speed profiles before and beyond the cameras show that drivers do slow down quite abruptly before the camera and speed up again after passing the camera. It is concluded that a V-profile is found in the spatial speed distribution for both locations. The installation of average speed enforcement systems led to decreases of the average speed, of the odds of drivers exceeding the speed limit and decreases of the odds of drivers exceeding the speed limit with more than 10%.
Within an average speed enforced section, speeds turn out to be relatively homogenous.
Upstream from and at the camera location (-1200 m up to +200 m) increases were found in the number of crashes. Downstream from the camera decreases were found in the number of injury crashes. A separate analysis according to the crash type generally showed unfavourable effects in the number of side and rear-end crashes, however favourable results were found for the number of crashes against an obstacle outside the roadway. A comparison of the study results shows that the unfavourable results at the camera locations can probably be attributed to the sudden braking behaviour before the speed camera.

Conclusions
The results show that automated speed enforcement on motorways has an important, but sometimes possibly adverse impact on road user behaviour. Fixed speed cameras at motorways tend to lead to a V-profile of speeds ("kangaroo jumps") and ambiguous effects on crashes. Section control tends to produce more homogenous speed reductions, with some indications for spillover effects.
Poster Sessions
Title: Combining quantitative and qualitative research when analysing driver behaviour

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Keywords: quantitative analysis, qualitative analysis, driver behaviour, glance behaviour, field study

Quantitative research has historically been the cornerstone of social- and human science research. Representatives of quantitative methods call for researchers to "eliminate their biases, remain emotionally detached and uninvolved with the objects of study and test or empirically justify their stated hypotheses" (Johnson & Onwuegbuzie, 2004, p.14).

In contrast, representatives of qualitative methods support a constructivist or interpretivist paradigm and "contend that multiple-constructed realities abound, that time-and context-free generalizations are neither desirable nor possible, that research is value-bound, that it is impossible to differentiate fully causes and effects, that logic flows from specific to general and that knower and known cannot be separated because the subjective knower is the only source of reality" (Johnson & Onwuegbuzie, 2004, p. 14).

The majority of research on driver behaviour is determined by quantitative methods.

In order to illustrate why it can be important to combine qualitative and quantitative research when driver behaviour is investigated a study will be introduced that applied both, qualitative and quantitative methods. Within a five weeks naturalistic driving study 20 drivers were asked to drive twice a selected unfamiliar route. Drivers glance behaviour at intersections was investigated by a qualitative observation and by a quantitative analysis. Introduced results will highlight the relevance of both, qualitative and quantitative analysis.

Acknowledgement
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Title: Surrogate Safety and Behavioural Analysis of Roundabout Merging Zones Using Computer Vision

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Keywords: surrogate safety analysis, behaviour analysis, computer vision, roundabouts, large datasets, time to collision, gap time

Surrogate safety is a growing area of research within the field of road safety. Surrogate safety methods promise proactive diagnosis of road safety issues and detailed analysis of motorist, pedestrian, and cyclist behaviour by observing and analyzing the spatial relationships between road users at the microscopic level over large datasets. Relying on the assumption of the existence of a safety continuum ranging from ordinary behaviour to conflicts to accidents, the aim of these methods is to measure safety from the observation and characterization of non-collision traffic interactions, for example through the number of severe interactions ("conflicts") or the distribution of safety indicators such as time to collision (TTC). These measures can then be used to identify contributing factors in road design leading to safer and smoother traffic flow. However, despite recent advances, research is still needed in some key areas, particularly in the continued development of a more robust theoretical framework and collision probability modelling.

This work outlines some of the latest methodological developments in 1) motion (and collision) prediction, from constant velocity projection to naturalistic motion patterns, 2) in resulting surrogate safety measures, such as time-to-collision and gap time, and 3) in the spatial and temporal aggregation of indicators for interpretation.

This work is presented in a case study of 40 merging zones located across 20 different roundabouts throughout the province of Québec, Canada. The data consists of over 120,000 vehicles tracked over 600 hours of video data using computer vision techniques built specifically for the purposes of detailed automated traffic and road safety analysis over large datasets. A cross-sectional analysis is conducted across these 40 merging zones to study the effects on time-to-collision and gap time of various potential contributing factors, such as number of lanes, lane arrangement, flow and flow ratio, approach speed limit, land use, roundabout diameter, merge zone length, etc. The study determines that some of the factors provide conclusive evidence of safety benefits based on our current understanding of surrogate safety methods.
Title: Behaviour Analysis Using A Multi-Level Motion Pattern Learning Framework

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Keywords: surrogate safety analysis, motion patterns, scene interpretation, video analysis, motion prediction, time series

The increasing availability of video data, through existing traffic cameras or dedicated field data collection, paves the way for the collection and analysis of massive datasets about the microscopic behaviour of road users using computer vision techniques. Our work aims to propose an effective and generic framework for surrogate safety analysis and the understanding of collision processes. New algorithms for multi-level motion pattern learning are proposed that enable automated scene interpretation, anomalous behaviour detection and surrogate safety analysis. Firstly, a novel method used to detect interest zones (Entry/Exit zones, occluded zones, and noisy zones due to failures of the video analysis) through a Gaussian mixture model and the Expectation Maximization (EM) algorithm. These interest zones are used to identify static occlusion zones, filter trajectories, connect divided trajectories and speed up motion learning and prediction models. Secondly, motion patterns are extracted in two levels using spatial and temporal information. Finally, the learnt motion patterns are used to detect anomalous behaviour and predict future behaviour. The multi-level framework successfully learns the motion patterns and speeds up the processing run time.

For surrogate safety analysis, motion prediction methods are needed to identify whether two road users are on a collision course and to compute several continuous surrogate safety indicators such as the time to collision (TTC). The default and unjustified method used in much of the literature is prediction at constant velocity. We propose a generic framework to predict the road users’ future positions depending on different extrapolation hypotheses, for example sampling distributions of acceleration and direction and applying motion patterns learnt from observations. While the current interpretation of continuous safety indicators overwhelmingly relies on only one indicator value at a given time to qualify the whole interaction, e.g. the minimum TTC, we analyze the whole time series or profiles of the indicators to find similarities between interactions with and without a collision. We propose a new similarity measure for time series that is applied to surrogate measures of safety and other indicators characterizing road user interactions. The new similarity measure based on the longest common sub-sequence is paired with a custom clustering algorithm that does not require to set the number of expected clusters and remains interpretable through the use of prototype indicator profiles as cluster representatives. This framework is demonstrated on two real world case studies with different sources of noises.
Title: Computer and android based real-time video traffic detection and counting

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Keywords: video traffic and counting, android video counting, Viola Jones algorithm

Video traffic detection and counting systems in real time are not new, they have lots of developments and intelligent solutions through history. The main goal for these systems is to detect, track and count moving objects with minimum costs and enough accuracy to collect proper traffic data. Specific traffic data can be used for traffic control, traffic planning and better traffic safety. Nowadays systems are using many combinations of different algorithms for detecting, tracking and counting moving objects but they are still not available for Android operating system.

Methodological approach is to use one of the existing algorithms for video detecting and tracking moving objects (Viola-Jones algorithm) and modified it to counting, and also adjust it to work in different operating systems (Windows, Android). Moreover there are several issues connected with detecting moving objects in various weather or illumination conditions but even for them are up to now available some smart solutions (for example: shadow elimination algorithm).

Aim of present study is to count traffic in real time based on video data from camera or other video devices with high accuracy (more than 90 %) in different weather or illumination conditions. Even more the system must be adjusted for different operating systems, especially for Android.

Counting and detecting objects in real time based on video data is system which with implementation does not have impact on infrastructure itself and reduce costs to minimum. At the same time it has many possibilities for additional developments that can provide better traffic safety, control and planning. However it has some disadvantages like accuracy in different weather or illumination conditions and costs of maintaining camera lens but as mentioned above with some existing or new intelligent solutions this issues can also be partly or completely removed.

Last but not least, the research work, which will be present on the Workshop “is going on” under the student project, with close cooperation with SME, financed by EU and supervised under professors from our faculty and expert from SME.
Title: Traffic safety versus traffic flow on freeways - an empirical analysis

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Keywords: surrogate safety measure, accident rate, distribution of surrogate safety measure

For freeways, there is a well-known relationship between traffic flow and traffic safety. Roughly independent of the geographical location, traffic is fairly safe (measured in accidents per million miles) for intermediate traffic flows, while it is getting worse for very small or very high traffic flows close to congestion [1], [2]. Furthermore, the very nature of the accident type changes with traffic flow: while the peak at small traffic flow is due to accidents with one or with two vehicles, the peak at large traffic flow is from accidents where almost always two vehicles are involved [2]. An example which is similar to the results in [2] is presented in Figure 1.

Being known for a very long time (already in 1937 the work of Veh [3] demonstrates a weak relationship), there seems to be little effort required to find this effect also in surrogate safety measures (SSM). This will be dealt with in the paper. By analysing single vehicle data from a German freeway, some of the commonly used SSMs will be computed and their distribution analysed. Not surprisingly, these distributions seem to belong to the family of Generalized Extreme Value (GEV) type. Furthermore, by analysing the number of critical situations defined as the 97%-percentile of the corresponding distribution, at least the peak at small traffic flows can be reproduced with the SSM's analysed so far.

Title: A Comparative Study of the Effect of Mental Ability of motorcyclists on the Severity of Accidents

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Keywords: Traffic safety, Driving ability, Motorcyclists, Accident severity, Drugs and alcohol usage

Vehicle-related injuries are the biggest health problem among other health problems that have been neglected and effective and sustained action is needed to prevent it. Motorcycle used as the fast, accessible and flexible vehicle in many urban streets. However, instability, the type of driving, the driver's overall personality and psychic is such that the number and severity of its accidents are important than other vehicles. The driver capability has effects on increasing the risk of accidents. Although, previous researches show rate of accidents increases by use of drugs and alcohol, the results didn't mention how the above said states effect on increase of accident severity. So, the present study has examined the effect of mental state of motorcyclists on severity of accidents. Data are collected from other resources and are examined in a different point of view. The results show that mental condition of motorcycle riders affect the accident severity, but cannot be sure, that the unstable emotional state resulting from the drugs and alcohol usage has effects on the severity of the accident.