TrafficQuest report

Study tour Austria – Switzerland May 31 – June 5, 2015

Report of the tour and main findings

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26 October 2015

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1.   Introduction

In The Netherlands traffic management is being considered a serious policy option to deal with traffic congestion and its negative impact on safety, economy and livability. Building new roads is often not feasible due to a lack of space and/or environmental or funding issues. Also, pricing the use of roads is not an option for the next couple of years due to political reasons. That leaves traffic management as the way to move forward to deal with the still increasing amount of mobility.

The purpose of traffic management is to inform, induce and, if necessary, direct road users towards a safer and more efficient use of the existing infrastructure, while safeguarding the quality of the environment of those living and working in the vicinity of the road network. This can be done using a number of traffic management measures, varying from a dynamic use of the infrastructure and signals to control traffic to information about the current traffic situation. All these measures have been widely implemented in The Netherlands and are used on a daily basis to manage traffic for recurrent and non-recurrent traffic conditions, such as extreme weather, road works and incidents.

1.1. Focus of the study tour – urban traffic management

From May 31st to June 5th, 2015 members of TrafficQuest (the Centre for Expertise on Traffic Management) visited Austria and Switzerland for a study tour to learn about the situation in these countries on urban traffic management. How should the cities handle the growth in traffic flows, both in normal situations and in situations where something special is going on? The following topics were seen to be relevant to discuss with our host organizations:

- Monitoring & Evaluation - Currently often lacking. Research on costs and benefits of measures needs to be introduced and this requires collecting (much) data. Special note: comparability of evaluation results and exchange of evaluation results.
- Management & Maintenance - Poor management and maintenance (M&M) can have major consequences for the functioning of a traffic management system. M&M will have to focus on the technical aspects of traffic planning (parameters, algorithms, scripts) as well as on organizational (cooperation between parties) and training components.
- Data - data is necessary to identify urban traffic problems and be able to demonstrate and evaluate measures. Openness, availability, and quality are important aspects in the collection, exchange and processing of data. Collecting and gathering traffic data and monitoring of openness, availability and quality has been addressed nationwide through the NDW / NDOV / NDP and via the data top 5 of Beter Benutten (Better utilisation of the available capacity). The question is whether and how this embedding matches the needs from urban traffic management.
- Visibility and effectiveness of urban TM - For policy makers, it is important to know what is the impact of the deployment of traffic management for the city, but also what happens if something is not being implemented. The road user should accept the measure and should be given

the opportunity to choose. For residents and businesses, it is important to explain what is happening and why this is happening.

- TM control approach - The TM control approach must be elaborated on strategic, tactical and operational level, resulting in a better understanding of how to steer and at what level. Possible discrepancies between policy objectives and operational objectives should thereby be kept well in mind.
- Organization - this requires an external (partnerships) and an internal elaboration (drafting common goals with corresponding tasks, responsibilities and competences).
- Expertise - The four large municipalities still have sufficient expertise in home and small cities rely on consulting firms. In medium-sized cities the preservation of sufficient traffic oriented expertise is a problem.
- Human behaviour - The success of behavioural measures depends on our knowledge of the choice behaviour of travellers. Possible measures can be formulated both in terms of 'carrot/reward' as of 'whip/road pricing'.
- Impact of e-society - ICT developments have a major impact on activity patterns but also on travel patterns, travel mode choice, route choice, etc. So far, little is known about the effect of these developments on throughput, safety and livability.
- Apps - A new application domain that raises many questions. Where does the data come from and what legal conditions for use of these data apply? What is the resolving power of an app for policy goals? Which demands does this imply for the app and the rollout? And what about the legal responsibility for all application-related advice and decisions?
- Dilemmas - Naming dilemmas (politics, technology, and organization) provides insight into possible solutions. A difficult issue regarding the prioritization of measures is that there is no legal framework for accessibility/throughput though there is for noise and emissions.

1.2. Program and delegates

In five days we visited three cities (Wien, Wattens and Zürich). Four organizations provided a program with lectures and site visits. The complete program is shown in Appendix A. The places we visited are depicted in Figure 1.

The Dutch delegation consisted of 7 persons from TrafficQuest (see Figure 2). From left to right : Ronald van Katwijk (TNO & TrafficQuest), Yufei Yuan (Delft University of Technology & TrafficQuest), Ben Immers (TrafficQuest), Henk Taale (Rijkswaterstaat, TrafficQuest & Delft University of Technology), Victor Knoop (Delft University of Technology & TrafficQuest), Isabel Wilmink (TNO & TrafficQuest) and Henk Schuurman (Rijkswaterstaat & TrafficQuest). Bio's of the members can be found in Appendix B.

Figure 1: Places visited during the study tour

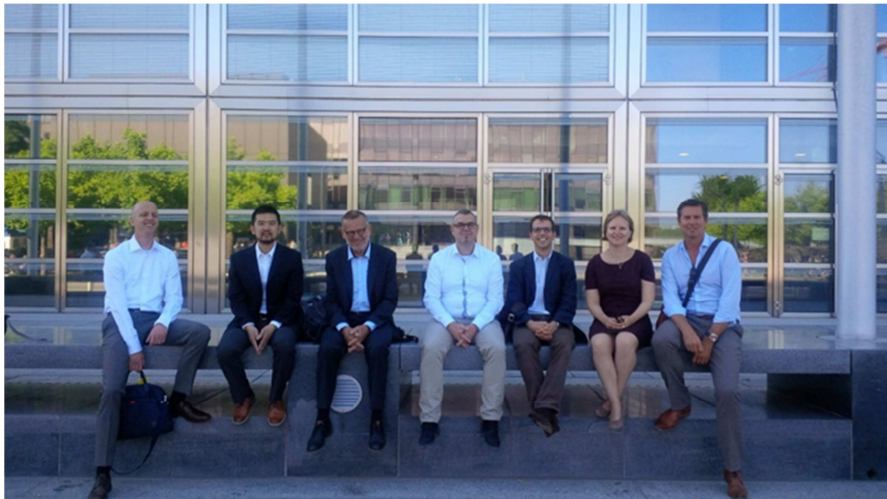*Figure 2: Members of the Dutch delegation*

1.3. This report

In chapter 2 a chronological overview is given. It contains the visits, the information provided by our hosts and the lessons learned. For each day the location is mentioned and per location the presentations are discussed. In chapter 3 the findings and recommendations are presented. Some background information is given in the appendices A and B.

2. Visits and sites

2.1. ASFiNAG Traffic management control centre – Vienna

On Monday June 1st, the TrafficQuest team visited ASFiNAG. ASFiNAG (short for "Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft" which is German for "Motorway and highway financing corporation") is an Austrian publicly owned corporation which plans, finances, builds, maintains and collects tolls for the Austrian motorways (autobahnen). ASFiNAG is fully owned by the Austrian State. Attendants were:

- Ms. Katrina Gotschewski – ASFiNAG (contact person)
- Mr. Thomas Greiner - ASFiNAG
- Mr. Michael Schneider - ASFiNAG
- Mr. Daniel Zielinski - ASFiNAG
- Mr. Wolfgang Ernst – SWARCO
- The TrafficQuest team

Introduction to TrafficQuest – Ben Immers
See presentation: "TrafficQuest Overview" by Ben Immers.

Overview ASFiNAG organization, tasks and responsibilities – Michael Schneider
Michael Schneider (from service department) gives an overview of ASFiNAG and what they do.

- ASFINAG is a state company responsible for the planning, financing, construction, maintenance, management and operation (toll) of the Austrian motorway network. ASFINAG is entitled to levy tolls on the Austrian HWN; these toll revenues are used to pay for all tasks related to the planning and operation of the HWN. Additional funding does not exist. Improving road safety is an important criterion for investment in the Austrian HWN.
- ASFiNAG was founded in 1982. There are three core areas of business: operation, construction and toll. A road network of 2183 km is in operation.
- There are four main targets in traffic management: improvement of traffic safety (with highest priority), optimization of traffic flow, increase of network availability, and national and international cooperation (main corridor in the centre of Europe for freight transportation and holiday travel)
- There are several core areas of traffic management: network management, information dissemination, tunnel control, traffic data analysis, road safety, incident management (4 cars in operation in Vienna area: 3 during daytime 1 during the evening), and the provision of an information platform for incidents and events.
- Only loop monitoring data are used for operational purposes (placed at exit-enter points of tolling sections, about 4-5 km at the regional level, 400-500m in urban areas); FCD data (e.g., truck GPS travel time information) can be provided to customers but is not used for operational/control purposes

- No real-time traffic model is available to support the choice of traffic management scenarios/measures: there was a trial, but it failed and was stopped in 2010.
- There are 8 regional traffic management centres and 1 headquarter in Vienna, organised in a hierarchical structure
- ASFiNAG has a close operational cooperation with the traffic police (special motorway policemen) and a strategic cooperation with planning/construction/maintenance parties. The traffic manager can play a role in operational traffic management, but leadership is taken by motorway policemen.
- There is a survey about efficient traffic management (including traffic incident management). First, it will be send to 5 founding countries for feedback, after that it will be sent to all countries in Europe.
- There are several traffic management systems in operation, including tunnel control systems, lane control systems, network control systems, construction site management systems (road work information broadcasting), etc. Investments in new / additional roadside systems are not foreseen
- In case of incidents in the greater Vienna region, a route guidance system (rerouting concept) is used to distribute traffic demand. But, due to the high traffic flow demand, there is no efficient solution yet. Furthermore, due to political considerations, the implementation of interesting available solutions is hampered.
- Collaboration between ASFiNAG and the city of Vienna is limited and confined to the following topics:
  - Planning stage (new roads, road works, events, planned restrictions, etc.)
  - Strategic level (rerouting concepts, road works schedule, etc.)
  - Incident management (Police, Traffic Manager, TMC, maintenance staff, etc.)
  - Traffic Information & data exchange (VMS, Verkehrsauskunft Österreich, ITS Vienna Region, etc.)
  - Linking public & private transport (Park&Ride, Park&Drive, information, etc.)

See also the presentations: "ASFiNAG Traffic Management", and "ASFiNAG CEDR-Task N6 both by Michael Schneider.

Roadside Telematics – Thomas Greiner
Thomas Greiner (from the management department) gives a presentation on roadside telematics in which he addresses the following topics:
- Road Construction Program: the tolling income should meet the costs of new construction and expansion. In 2015, it is expected to have a revenue of about 800 million euro from the tolling system.
- The application of traffic telematics started 10 years ago. The system is very flexible in deploying new technologies. For example, there are data stations collecting on-spot traffic data and transmitting the data to the data server. These data can be read via web-access/interface. There are also weather stations, pollutant measurement stations, and environmental data collection stations.

- To protect the environment the IG-L (Immissionsschutz Gesetz-Luft) system is applied on the Austrian motorway network. It is a speed-limit control system along motorway routes (about 250 km in length). The system is designed according to the air-emission protection law.
- There is only one ramp-metering installation which is located in Salzburg. It deploys the ALINEA algorithm. At present an ex-post analysis of the ramp-metering system is in progress; the system has been disabled to compare the performance of implementation. TrafficQuest has shown great interest in receiving the evaluation results.
- There is a GUI overview which shows all existing road-side telematics systems.
- The ASFiNAG video system comprises in total 5100 video cameras with 85 operator stations. Data will be deleted within 48 hours. Data sharing is available for tunnels and highways but, due to privacy issues, not for urban streets.

See also the presentation: "Roadside Telematics" by Thomas Greiner

Advanced Traffic Information System - Daniel Zielinski
Daniel Zielinski presented an advanced traffic information system in Austria. It is an integrated data hub with real time PT information, serving for the public. There is one data archive system to collect all the real-time traffic information from multi-modal traffic: public transport, car traffic, social media data. The information system can be accessed via the following links:
http://routenplaner.asfinag.at;
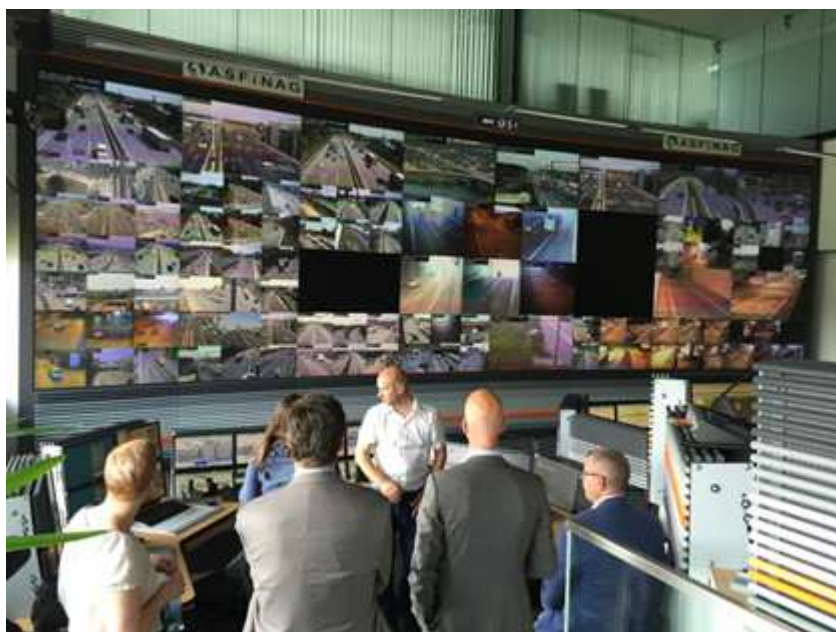http://www.verkehrsauskunft.at.

See also presentation: "Traffic Information Austria" by Daniel Zielinski.

Visit Traffic Management Control Centre
After the meeting, we visited the Traffic Management Control Centre (built in 2012) and got an explanation of all the systems available there.

Highlights ASFiNAG

- Very interesting: Verkehrsauskunft Österreich (Traffic Information Austria, routenplan-er.asfinag.at; https://www.oeamtc.at/routenplaner/; http://www.vvt.at/; http://routenplaner.vor.at /; www.anachb.at/). Since 2014 a real-time, multimodal traffic information system (VAO) is available in Austria. In this web application (and smartphone app) road authorities, public transport operators, parking administrators work together and provide their real-time data with the aim to create a real-time, multimodal traffic information system (VAO). Depending on the company (ASFINAG, VOR, VVT, Land Salzburg, ÖAMTC, etc.) the user interface may vary and also different functionalities (front-end) may be offered, but the database (back-end) is identical for all web applications.
- Technology advancement: ASFINAG is a late adopter with regard to the deployment of ITS on the network. Consequently, they now have mature and standardized technologies.
- Technology advancement: along the entire network a fiber optic connection is available. This fiber optic network forms the backbone of the data collection and communication system
- Technology advancement - Level of automation: to support the management of traffic flows a range of control scenarios, including the rerouting of trucks can be applied
- Technology advancement: Currently one considers the introduction of C-ITS, in which all applications are positioned in the vehicle. But, in addition to that, the application of ramp metering and AID (Jam Ahead Warning) – both roadside applications – is in preparation.
- Technology advancement: Emphasis is on the maintenance of the existing (installed) technologies. Investments in new / additional roadside systems are not foreseen.
- ASFINAG itself predominantly sets the future course, with only minor involvement from the Ministry of Transport or politicians.
- The police is a serious partner in the management of traffic in tunnels and in incident management; they can overrule all parties.
- International orientation: Due to the many neighbours there is a strong international orientation, certainly in the field of traffic management. The situation in neighbouring countries

largely determines what happens on the Austrian network (border closed!)

- Urban Traffic Management: the application of Urban Traffic Management is figuring at a low level. At the operational level, there is hardly any collaboration ('much to our regret') between ASFiNAG and the City of Vienna.

2.2. SWARCO Headquarters – Wattens

On Tuesday June 2nd the SWARCO Headquarters in Wattens, Austria was the second to visit during our tour. We were received by a delegation consisting of:

Mr. Richard Neumann (Communication and PR),

Mr. Gino Franco (Head of R&D),

Mr. Manuel Milli (Program Manager Smart Cities),

Mr. Cees de Wijs (CEO SWARCO),

Mr. Rob van der Voort (Special Advisor SWARCO).

General introduction – Cees de Wijs

Cees de Wijs (CEO) gives a short presentation on smart cities. He emphasizes that cities are not only asking for a solution, but also for impact monitoring. SWARCO bought TransVer and in this way acquired knowhow on traffic planning, analysis and simulation. They also acquired the company Schlothauer & Wauer for their expertise in designing traffic signal control plans. Finally SWARCO is also involved in ITS: cooperation with BMW, Audi and Continental. On the European level SWARCO is an active member of ERTICO.

SWARCO and intelligent traffic management - Richard Neumann

Richard Neumann first explains why SWARCO has a demonstration room and after that he tells about what SWARCO does on ITS.

- 3-4 groups of visitors every week
- Capabilities of SWARCO are brought together in one room. Important are road markings as they still comprise 30 to 40% of annual turnover. There is special demonstration room for road markings.
- SWARCO (founded 1969) consists of 80 companies and has 2,700 employees. Annual turnover of € 500 million.
- Started in traffic management in 1993.
- LED development of traffic signals from 1994.
- SWARCO deploys the OMNIA platform for integration of all traffic measures (software as a service).
- Focus has since 2003 shifted from just selling products (as an OEM) to selling solutions.
- The traffic control center in Bucharest, Romania (170 intersections) is shown. They were able to generate a 20% reduction in travel times, and also a reduction in CO2 emissions.
- SWARCO also participates in the traffic control center in Hamburg (combining both harbor traffic and emergency traffic operations), the traffic management center in Kazan, Russia and the traffic management centers in Riyadh and Sochi.
- In a part of Rome, Traffic Light Data and HERE-FCD data are combined to give insight in the network's level of service.
- SWARCO's focus within Smart Cities is on system integration and content provision to service providers.

- Cooperative systems: a traffic light assistance system has been developed with Audi; this gives a speed recommendation to pass the next signal at green. As traffic signals are responsive, prediction is needed.
- The traffic management system in Rome includes FCD (from HERE).
- SWARCO is also involved in the ITS Corridor.
- Being able to sell an integrated approach and corresponding maintenance services often requires changes at the organizational level of the client as well. However the rigid segmentation within the client's organization is often prohibitive for such changes.
- Finally some products are shown, i.e. a street light system that can be dimmed depending on the presence of for instance pedestrian traffic. Experience shows that people do not notice that lights are dimmed with 30%. They only notice a change at the moment of dimming.
- SWARCO works with an eco-system of partners, instead being able to do everything themselves. In the demonstration area also products from partners are shown, such as ski data.

See also presentation: "SWARCO – Global player in Safety and Traffic Management" by Richard Neumann.

Traffic emissions at signalised intersections - Ronald van Katwijk
Ronald gives a presentation of how the traffic emissions at signalized intersections can be further reduced. He shows what can already be achieved with 'traditional' techniques and what further contributions can be made using V2I and I2V communication techniques.

The subsequent discussion reveals that, in comparison to Western Europe, in upcoming markets costs are less an issue if spent on a more advanced systems. In Western Europe there currently is more demand for simpler, more transparent systems. This is taken into account in the redevelopment of the SPOT-system. With respect to cooperative versus connected systems, SWARCO has not made a decision yet whether there is added benefit of having short range (DCRSC/Wifi-P)

communication next to long-range (cellular) communication for V2I applications, especially given the 0-day and 1-st day applications currently foreseen.

See also the presentation: "TrafficQuest - Reduce Traffic Emissions at intersections" by Ronald van Katwijk.

Introduction to TrafficQuest: Who we are? What we do? - Ben Immers
Ben Immers gives presentation on organization and work program TrafficQuest. What followed was a discussion on what TrafficQuest can do for SWARCO and vice versa: common interests were determined for impact analysis, monitoring of the impact and quality of the system. To be able to justify client's money spent on traffic management and control it is also necessary to monitor changes over time (traffic performance) and in what way TM&C contributes. It was agreed to keep each other posted on any national and international benchmark studies done in this subject-area.

See presentation: "TrafficQuest – Overview" by Ben Immers.

2.3. ETH - Institute for Transport Planning and Systems - Zürich

On Thursday June 4th the TrafficQuest team visited the Technical University of Zürich, Switzerland, and were welcomed by a large group of staff and students of the Institute for Transport Planning and Systems. The following people were present:

- Ms. Monica Menendez (professor at ETH),
- Mr. Mahnam Saeednia (ETH),
- Mr. Javier Ortigosa (PhD student),
- Mr. Thomas Riedel (consultant),
- Mr. Haitao He (PhD student),
- Mr. Oiao Ge (PhD student),
- Mr. Javier Digossa (PhD student),
- Mr. Jin Cao (PhD student),
- Ms. Mireia Roca Riu (visiting ETH from UPC),
- Ms. Olga Janssens (municipality of Zürich),
- Mr. Roland Honegger (municipality of Zürich),
- TrafficQuest team including Victor Knoop, who joined us.

Introduction to TQ: Who we are? What we do? - Ben Immers
See presentation: "TrafficQuest Overview" by Ben Immers.

Urban Traffic Management – Henk Taale
The session was started with a presentation of Henk Taale on Urban Traffic Management. Based on this presentation the following issues were raised:

- What is the share of bike traffic in urban areas and what is the impact of the introduction of electric bikes? Do electric bikes take away trips from public transport (in addition to taking them away from car use)? With such a high share of bicycle trips, how can the financing of public transport be justified? The TQ team does not have all the answers, but it seems that there is room for regular bikes, e-bikes and public transport with sufficient patronage in Dutch cities.
- What are Dutch experiences with compliance (traffic information systems). It was mentioned that studies on compliance in Munich showed that many people discontinued use (of services provided when they got only one bad advice. Is this also the case in Amsterdam?
- Especially the PPA pilot raised several questions - how did they use the service provided? how were participants approached? What was the incentive for them to participate? Unfortunately no answers can be given today – the evaluation of the PPA is ongoing, but GPS data from app users is available to study compliance.
- Regarding ramp metering: There will be a test with coordinated ramp metering on the motorway Geneva-Lausanne (a shoulder lane trial also seems to be planned). But ramp metering is not very popular because the first trial was not immediately successful. The reason for this was the location and the length of the on-ramp which were not ideal. A solution for the latter is to put the ramp metering further downstream, and increase the length of the merging lane. Also difficult: federal vs. canton vs. municipal level, because there are mainly federal level benefits. But actually, it should be emphasized that all road users benefit from ramp

metering, if you can avoid the capacity drop. Christian says there is also an interaction with land use - people who are closer to the city are "penalized" with ramp metering because they have to wait and people living farther away don't encounter ramp metering.

- Monica asks if it is known in Amsterdam what directions people are travelling in - are the right people targeted (penalized)? The answer is, we try to target the right people and predict bottlenecks so the metering can start before breakdown. It would be good to know more about the destinations of vehicles.
- In the PPA, only the green time is reduced, nothing else is changed, no extra-long red time. Sometimes information is given to explain why people are waiting (so they don't start running red lights).
- Another question concerns the FCD used: is it from multiple sources? This is the case, it concerns Vodafone and Here data, and data collected with the app.

The conclusion is that coordination should only be applied if needed, and to keep it local if possible. Otherwise too many vehicles are delayed. Another important issue is when to start and stop metering. Finally, the system should be maintained, including the underlying algorithms.

See presentation: "TrafficQuest – Urban Traffic Management" by Henk Taale

Overview of SVT research – Monica Menendez

After the break Monica presents what ETH is doing. There are three departments: transport planning (travel demand - prof. Kay Axhausen), transport systems (prof. Uli Weinmann), traffic engineering (Monica). Traffic engineering covers six topics:

1. Simulation and calibration techniques, for use with the Vissim model of Zürich. They developed a method for sensitivity analysis for traffic simulators (to tune parameters). This is a very general method, and can be applied to other optimization problems.
2. Intra-modal and multi-modal interactions, for urban and interurban roads. With an emphasis on improving public transport, in line with Zürich policy. They are looking at providing non-

traditional ways of giving priority to public transport. And there is perimeter control in the city - an innovative scheme to reduce congestion in the city by delaying the entrance of passenger cars and trucks into the city. Regarding interurban traffic, they look at weaving sections; for urban traffic, they look at complex intersections. For some intersections it was not possible to develop appropriate traffic control; for these intersections, Zürich leave the intersection uncontrolled during peak hours but deploys policemen who guide the traffic at the intersection – the policemen are used as a sort of traffic actuated control.

Another topic is public transport prioritization. There are traditional ways to prioritize PT, by taking lanes from the car traffic and allocating them for the PT. But there are also non-traditional, sometimes very innovative bus priority measures or strategies; however, these are not well documented. So ETH employees go and have a look at these strategies (reverse engineer them). In one situation, an additional traffic light was placed before the intersection (in Rapperswil, there is another one in Zug). Bus drivers can activate it and make the opposite lane into a temporary bus lane, so the bus can pass the queue. A difficult decision needs to be made about how close to the intersection the temporary lane is created. Closer to the inter-section means skipping more of the queue, but less space to buffer vehicles driving in the opposite direction. Other approaches include taking into account the number of people on the bus. Or there is a bus lane that needs to be discontinued in front of an intersection, but you don't want buses to suffer. So a pre-signal is put in. This means buses suffer a little bit, but the cars benefit a lot (even though they have to stop more) in terms of travel times (emis-sions have not been evaluated yet).
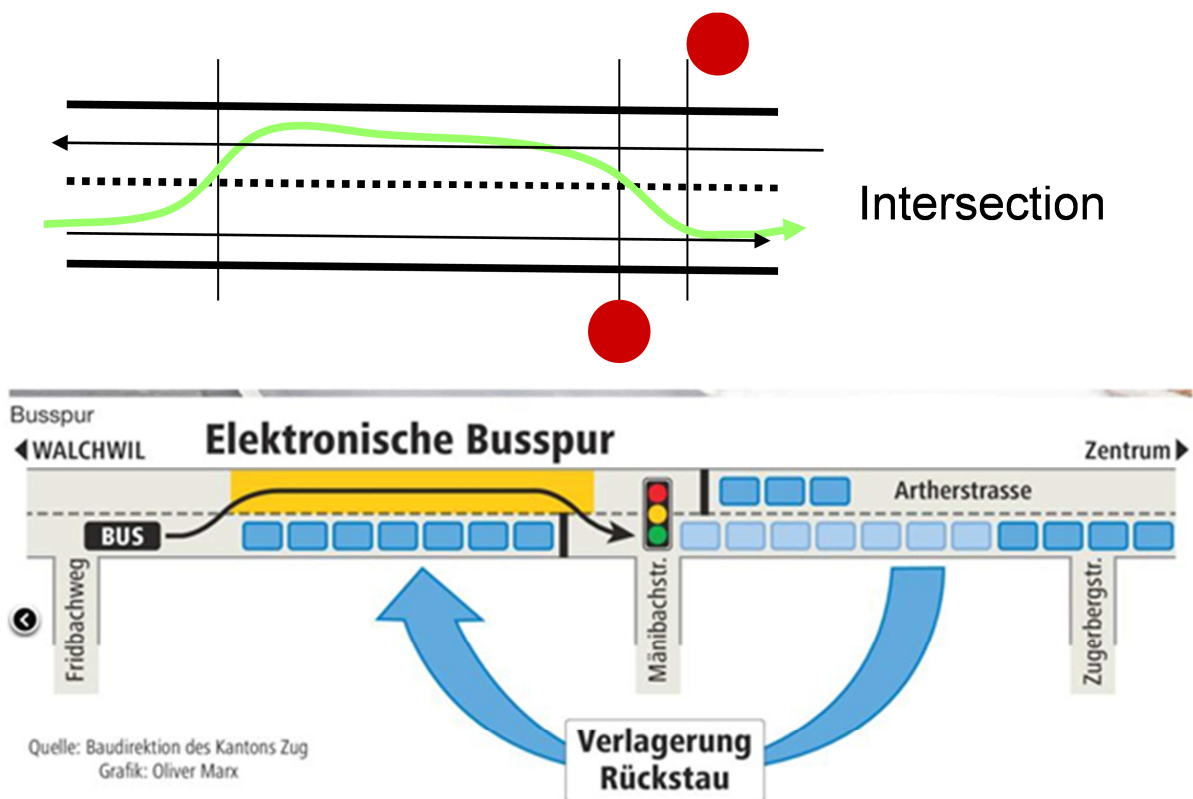

Figure 3: Bus priority in Zug – schematically[1]

[1] http://www.zug4you.ch/buses_to_be_given_the_green_light_on_city_road.html

Figure 4: Bus priority in Rapperswil – bus overtaking the queue at the traffic light[2]

3. Urban structure and parking: Subjects looked at include grid networks, link removal (restricting certain modes on certain links, incl. one-way streets and left-turn restrictions) and then looking at the performance of the network with fundamental diagrams etc. One-way streets only need one lane for motorized vehicles, the rest of the space (width of the road) can be used for other modes. Currently research is on-going about how demand is changed because of redesigning the road space (is there a mode shift?). A question regarding parking is how parking movement influence traffic. Most models for analyzing this are agent-based, and need a huge amount of data. At ETH a microscopic model for parking movements was developed.

4. Safety and traffic performance. This concerns for instance adapting a tool for motorway safety analysis for urban use.

5. Technology and management and control: A topic in this area is car-to-car communication, and how data that were transmitted can be used. ETH looked at what penetration rates are needed. The analyses also included automated vehicles. In a first step, only cars were considered. The next step is to look at arterials, and including other modes such as buses.

6. Urban traffic monitoring and control: This includes research into the (3D) Macro Fundamental Diagram (MFD), looking at data fusion techniques using e.g. Floating Vehicle Data, and looking at what are the minimum data requirements to find the traffic state.
The question was raised that given the large amount of data needed to use the MFD, would it not be preferable, if you have that that much data, to use another approach? It was argued that not that much data are needed. If you combine several inaccurate measurements, you can still get a quite accurate estimate of when congestion occurs in the network.

See presentation: "Overview of SVT research at ETH Zürich" by Monica Menendez .

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[2] http://www.svi.ch/fileadmin/redaktoren/dokumente/Publikationen/Merkblaetter_Leitfaeden/Merkblatt-2013-01_150901_de.pdf

NetCap: Intermodal capacity of networks – Javier Ortigosa

Javier presented about the 3D MFD. The question is how to find the aggregate capacity of a network. Using the VISSIM network of Zürich, they found that they can do a pretty good job with a limited number of sensors (using 5 minute intervals). So this is also relevant for cities with not that many observations. Networks do need to be a bit homogeneous, otherwise there is much more scatter. It is not known yet what percentage of links need to be measured for a good result. Another approach is to use a few sensors as indicators of problems such as congestion, and then take action based on that. But the idea is that the MFD can add a lot of information for not a lot of extra effort. And that action is then not taken too early.

A measure that can be based on either approach (using MFD or monitoring specific links) is metering the traffic into the city (perimeter control / gating). A new step will be to consider multimodal networks, with not just cars. The question is then how to include other modes (that compete for space with cars), especially public transport? In the current situation, the only way the public transport influences car traffic is in the controlled intersections; apart from that, the operations are independent. In addition to that, a wish is to model passengers (travelers) instead of vehicles in the future.

See presentation: "ETH – NetCap Intermodal Capacity of Networks" by Javier Ortigosa

2.4. Traffic Division (DAV), City of Zürich - Zürich

The final day of our study tour (Friday June 5th) we visit the Traffic Division of the City of Zürich. We are welcomed by ms. Olga Janssens and other attendees are:

- Mr. Roland Honegger,
- Mr. Thomas Riedel,
- Ms. Monica Menendez (ETH),
- Mr. Victor Knoop (Delft University of Technology),
- TrafficQuest team members.

Traffic Management in Zürich – Olga Janssens and Ronald Honegger

Olga gives a warm welcome. She distributes several booklets with some facts of the city of Zürich and information on the Zürich traffic management solution:

- Verkehrsmanagement für Zürich,
- The Zürich model,
- Adaptive traffic flow management.

First, Olga gave an overview over the city of Zürich (Traffic management in Zürich), including geographical information, transport network data, politics and law, city history, and the current state of practice in traffic management. Some interesting facts:

- In total 404,000 inhabitants, about 550,000 commuting trips per day.
- Modal shift: 39% public transport, 30% cars, 31% slow traffic (27 % pedestrians, 4% bicycles).
- The city has 400 junctions and 6000 traffic lights.
- The traffic division has 100 employees at the city municipality level, divided into four departments: Analysis & Planning, Regulation & Development, Mobility & Law, Implementation & Maintenance.

The government has given priority to public transport. The number of public parking spaces are not allowed to increase since 1996. In 2011, the Städte-initiative aims at encouraging modal shift to public transport, pedestrian and cyclist. Zürich aims at sustainable mobility (2000 Watt society). Several general traffic management measures deployed in the city are presented. They also try to apply on-line traffic prediction model for traffic management. Ronald Honegger (from traffic management centre) provided more details on urban traffic management and urban intersection control.

Traffic management in Zürich follows a hierarchical structure ("The Zürich Model"). The technical architecture is structured in the form of a pyramid with 4 levels (see Figure 5): control level, logic level, safety technology level and the sensors & actuators level. The communication occurs all via copper cable networks, which is very stable and executes the commands from the logic level fast. The traffic management strategy aims at finding the most appropriate solution for the city. Therefore the city is divided into 6 regions with a traffic control computer for each region. Each region will take responsibility of its own traffic network as well as collaborate with other regions. There is 1 central controller to collect info from the 6 regions.
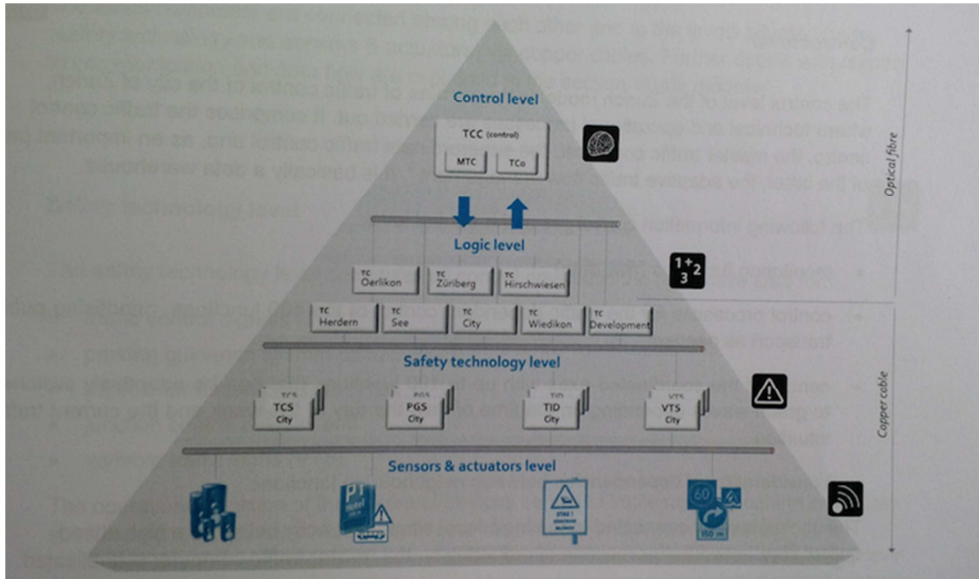
Figure 5: Technical architecture

In the city of Zürich there are in total 6000 traffic signals and many traffic signs placed all over the city. The system operates following a centralized control scheme, whereas each of the traffic controllers can operate locally. The traffic division takes charge of different traffic construction and maintenance projects. Simulation models are applied for planning (VISUM) and to simulate traffic management strategies (VISSIM). Traffic signs are used to smooth traffic with short cycle times. Tram lines have priority and always have alternative routes. Emergency vehicles have dedicated lanes. The city also gives many focus on traffic management during road construction, incidents and big events. They collaborate with traffic policemen in the city. For example, when road construction is planned, the related traffic controllers will be adjusted to meet the new situations (or replaced for long-term construction), and warning systems will be deployed, sometimes traffic is manually controlled by traffic policemen (see Figure 6).

Figure 6: Policeman in control

In case of incidents, the detection will inform the city and traffic operators make decision and try to find a solution. When big events take place (football matches in the national stadium), traffic information display (VMS) signs can be implemented to guide the traffic.

Most of the traffic operators in the control centre and in the field are trained on the job. Most of them have a software engineering/information technology background, with programming skills and basic experience with traffic systems (no traffic flow theory background, no incident management knowledge and experience).

See presentation: "City of Zürich – Traffic Management in Zürich" by Olga Janssens and Ronald Honegger.

Visit to Zürich Traffic Control Centre

Next, we visited the traffic control centre and the working place of the traffic control officers. Several screens gives traffic state information and most control parameters can be changed manually. Traffic data from loop sensor systems are displayed, including error messages (for example, error message from a failure junction). These data can be distributed to different control sections. Now, there is no direct access to the raw database, but there is a web-access. Universities or consultant can acquire real-time data via collaborated projects. Open data hub with aggregated data is under consideration by the statistics department. Besides traffic signal information, parking information is displayed (also distributed to the public via internet). The control room also monitors the main tunnels (there are about 20 tunnels in the city with real-time video cams). After the visit, Ronald presented his work on urban signalised intersections.

3. Conclusions

The conclusions are grouped for several aspects of traffic management: technology, data collection, dissemination of information, staffing and knowledge, collaboration, state of practise of urban traffic management, level of innovation and lessons learned for TrafficQuest.

3.1. Technology

- ASFINAG is a late adopter with regard to the deployment of ITS on the network. Consequently, they now have mature and standardized technologies, e.g. along the entire network a fibre optic connection is available. This fibre optic network forms the backbone of the data collection and communication system. To support the management of traffic flows a range of control scenarios, including the rerouting of trucks can be applied.
  Currently one considers the introduction of C-ITS, in which all applications are positioned in the vehicle. But, in addition to that, the application of ramp metering and AID (Jam Ahead Warning) – both roadside applications – is in preparation.
  Main emphasis is on the maintenance of the existing (installed) technologies. Investments in new / additional roadside systems are not foreseen.
- SWARCO: Focus has since 2003 shifted from just selling products (as an OEM) to selling solutions which encompass hardware and software components. The acquisition of dedicated companies (e.g. TransVer, Schlothauer & Wauer, TTS, and McCain Parking) is part of their approach to deliver the knowledge for integrated solutions; furthermore SWARCO works with an eco-system of partners, instead of desiring to be able to do everything itself. The application of DSRC (wifi-P) is still in consideration.
- City of Zürich: deploys an old but continuously upgraded traffic management concept, using high-tech copper cable for all communication purposes.

3.2. Data collection

- ASFiNAG: deploys a traditional approach i.e. loops in combination with a fibre optic network. The fibre optic network forms the backbone of the data collection and communication system.
- SWARCO: there is no standardized way in which the data of traffic lights can be accessed. This is due to the fact that the interface through which to access the data is different depending on the vendor of the traffic light and the requirements of the road operator. Both proprietary and open interfaces are in use. Furthermore, traffic control approaches – and the detector configuration it requires - can differ from intersection to intersection depending on the properties and the level of service required for the intersection.
- City of Zürich: deploys a loop-based approach in combination with a copper cable network.

3.3. Information dissemination

- ASFiNAG: Since 2014 a real-time, multimodal traffic information system (VAO) is available in Austria. In this web application (and smartphone app) road authorities, public transport operators, parking administrators work together and provide their real-time data with the aim to create a real-time, multimodal and nationwide traffic information system VAO – die Verkehrsauskunft Östenreich (verkehrsauskunft.at).
- SWARCO: focus has shifted from hardware to content, but the information dissemination part is seen to be the main responsibility of the service providers.
- City of Zürich: Provides web access for all employees and this information is also available for the outside world (although not well known)

3.4. Staffing and level of knowledge

All organizations exhibited a high level of knowledge. Both road authorities (ASFiNAG and the city of Zürich) rely heavily on in-house development. SWARCO acquires expertise (content related) by acquisition of dedicated firms. Urban Traffic Management is one of the focus areas of ETH research agenda. There was great appreciation for the underlying concept of TrafficQuest.

3.5. Collaboration

- Striking was the absence of collaboration between ASFiNAG and the City of Vienna (much to the regret of ASFiNAG); on the other hand there is much collaboration with public transport companies (VAO information system).
- SWARCO: establishes strategic alliances – shows much interest in further collaboration with TrafficQuest.
- City of Zürich: it is interesting to note that the visit of TrafficQuest was a major motivation for bringing together the city of Zürich and ETH – Institute for Transport Planning and Systems.

3.6. State of practise urban traffic management

- City of Vienna: unfortunately the City of Vienna was not in the position to meet with us. During our visit to ASFiNAG it was noted with regret that there was hardly any collaboration between the two organisations.
- SWARCO; more and more content oriented; innovation is predominantly realized by acquisition of content specific firms.

- Zürich: deploys an old concept for sustainable urban traffic management; this concept is continuously upgraded; as the system is highly appreciated by the users they see no reason to replace it.

3.7. Level of innovation

- ASFiNAG: late adoption of ITS technology generates a front position not suffering from old concepts and legacy systems.
- SWARCO: always has been an early adopter (with Manfred Swarovski as figurehead).
- City of Zürich/ETH: strong need for collaboration; wide scope of ETH research is much appreciated.

3.8. Lessons for TrafficQuest

- The creation of a platform for urban traffic management, where traffic management professionals from various cities and organisations can exchange knowledge and ideas, is widely regarded as a necessary step in addressing urban traffic problems.
- Having in-house expertise is a huge advantage! The city of Zürich is a nice illustration of this statement. Costs need to be weighed against benefits, though.
- Effective deployment of Traffic Management benefits from a close collaboration between research (research institutions, universities) and practice (road authority, control centre).
- Effective deployment of Traffic Management requires clear choices regarding the management concept (architecture, control strategies, etc.). The continuous management and maintenance of this concept (putting in sufficient manpower and expertise) is prerequisite for the necessary and gradual improvement of it.
- It is obvious that the role (tasks, responsibilities and competences) of governmental organisations is changing, but the same is true for the market. This calls for a two-sided approach to this development.
- Based on close cooperation between various parties it is possible to realize a user-friendly and effective real-time, multimodal traffic information system, much to the delight of both system operators and road users.

Appendix A Program

Program overview:

Date	Activity
Sun 31 May	Arrival at Vienna
Mon 1 June	ASFiNAG, Traffic Management Control Center, Klingerstr. 10b, 1230 Wien
Mon 1 June Ev	Travel to Innsbruck
Tue 2 June	SWARCO, Blattenwaldweg 8, A-6112 Wattens
Wed 3 June	Travel (by train) to Zürich
Thu 4 June	ETH Zürich, Institute for Transport Planning and Systems (IVT) "Traffic Engineering Group"
Fri 5 June	Zürich, Traffic Division (DAV) at the City of Zürich, Mühlegasse 18, Zürich
Fri 5 June Ev	Departure to The Netherlands

Monday June 1st

ASFiNAG

ASFINAG	Holding Katrin Gotschewski	Date:	**27.05.2015**
Security status:	Public	Nr.:	-

Agenda

Visit TrafficQuest

Subject			
ASFINAG VMZ, Klingerstr. 10b, 1230 Vienna	**01.06.2015**	10:00 – 13:00 Uhr	
Place	Date	Time	

Prof. Ben Immers
Dr. Ir. Ronald van Katwijk
Dr. Victor L. Knoop
Ir. Henk Schuurman
Dr. Ir. Henk Taale
Ir. Isabel Wilmink
Dr. Ir. Yufei Yuan
Katrin Gotschewski – ASFINAG
DI (FH) MSc Thomas Greiner – ASFINAG Bau Management GmbH
Dipl. Ing. Michael Schneider – ASFINAG Service GmbH

Participants

Topics	Responsible
1. **ASFINAG – Welcome & short introduction**	K. Gotschewski All
2. **ASFINAG Traffic Management** Organisation, Responsibilities, Systems in Operation, etc.	M. Schneider
3. **Roadside telematics** Building Program ASFINAG BMG, Core areas of traffic telematics, Working progress of TCU, on-board telematics	T. Greiner
4. **CEDR Activities Task Group N6 (Harmonized Network Operation Services)** Goal & Objectives of CEDR TG N6, Austrian Example of integrated traffic management (TM Salzburg)	M. Schneider
5. **Verkehrsauskunft Österreich (Traffic Information Austria) Activities on Cooperative Systems**	T. Greiner
6. **Presentation TrafficQuest**	TrafficQuest
7. **Tour Traffic Management Control Center** 8. **Discussion**	M. Schneider All

Tuesday June 2nd: visit to SWARCO

Programme SWARCO

09.00-10.00	Visit to SWARCO TRAFFIC WORLD
10.00-12.00	Meeting/discussion about Smart Mobility and Smart Roads. SWARCO will be represented by Gino Franco (Director R en D) and Manuel Milli (Solution Manager Smart Mobility and Smart Roads)
12.00-13.00	Lunch at SWARCO
13.30-15.00	Visit Kristallwelt. www.swarovski.com/kristallwelten
15.00	Departure to Innsbruck

Wednesday June 3rd: Traveling

Traveling by train from Innsbruck to Zürich.

Departure time Innsbruck: 11.44

Arrival time Zürich: 15.20

ÖBB Personenverkehr AG	FAHRSCHEIN Zugbindung	Yuan Yufei 01 ERWACHSENE(R)
CIV 1181	KEIN UMTAUSCH/KEINE ERSTATTUNG	
HF 03.06.15		

DATUM	ZEIT	VON -> NACH	DATUM	ZEIT	KLASSE
03.06	11:44	INNSBRUCK HBF -> ZUERICH	03.06	15:20	2
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ÜBER --> <1181>BUCHS(SG)<1185>SARGANS**

01 SparSchiene Schweiz

Zug -> RJ 160

	PREIS	EUR 69.00
	INKL. UST.:	

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Thursday June 4th – ETH - Zürich

Programme:

09.00 – 09.30: Introduction to TQ: Who we are? What we do? - Ben Immers.

09.30 – 10.30: Urban Traffic Management – Henk Taale

10.30 – 11.30: Overview of SVT research at ETH Zürich – Monica Menendez

11.30 – 12.30: NetCap: Intermodal capacity of networks – Javier Ortigosa

Afternoon: Traffic Participation Tour Zürich

Friday June 5th – Zürich – Traffic Division (DAV) at the City of Zürich

Programme:

08.30 Uhr   Begrüssung/Einführung - Olga Janssens

08.35 Uhr   Filmvorführung Dienstabteiiung Verkehr - Olga Janssens/C. Galli

09.00 Uhr   Verkehrsleitzentrale/Verkehrsmanagement - Roland Honegger

09.30 Uhr   Verkehrssteuerung - Roland Honegger

10.00 Uhr   Präsentation TrafficQuest Signalized Intersections – Ronald van Katwijk

10.30 Uhr   Fragen - Olga Janssens/Roland Honegger

11.00 Uhr   Verabschiedung - Olga Janssens

Afternoon: Flight back to The Netherlands

Appendix B Dutch CV's

Prof. Ben Immers

Ben Immers Consultancy
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http://www.traffic-quest.nl/

Ben Immers graduated as Civil Engineer at the Technical University of Delft. He started his professional career as research fellow at the Netherlands Institute for Transport Research. In 1976 he accepted a post as lecturer in Transportation Planning and Transportation Modelling at the Technical University of Delft. In 1985 he became associate professor at the same department. In 1992 he was appointed as secretary-director of the Delft Research School for Transport, Infrastructure and Logistics (TRAIL). From 1993 to 2009 Ben Immers worked as senior research fellow at the Netherlands Organisation for Applied Scientific Research (TNO).

In 1996 Ben Immers accepted a position as part-time university professor in transportation planning and highway engineering at the Catholic University of Leuven (Belgium). In 2009 he joined the Centre for Expertise on Traffic Management, a partnership between the Dutch Ministry of Transport, TNO and Delft University of Technology. Since 2010 he combines these jobs with a professorship in Traffic, Infrastructure and Logistics at the Technical University of Delft. In the same year he was also appointed as scientific director of TRAIL research school.

After retirement (January 2013) prof. Ben Immers remains active in the traffic management and infrastructure planning field as an independent consultant and as a member of Traffic Quest.

Dr. Ir. Ronald van Katwijk

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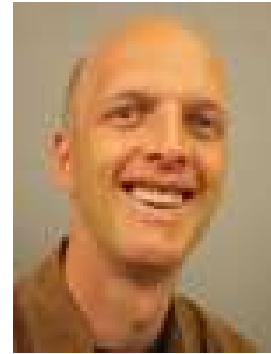
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Ronald van Katwijk (1973) obtained his MSc in Computer Science at the Delft University of Technology, faculty of Computer Science, The Netherlands. As part of his specialization in Knowledge Based Systems his Master's Thesis involved the creation of an Expert System for the classification of anomalies as found in the infrared reflections of the Dutch Railway's overhead wires. After his graduation he has been working as a researcher at TNO, the Netherlands Organization for Applied Scientific Research, since 1997. At TNO he has been responsible for the development of both microscopic and macroscopic traffic and transport models, real-time data analysis and processing algorithms (e.g. for forecasting travel time based on detector loop and floating car data), and various decision support systems. He furthermore contributed to the creation of various architectures amongst which the European RIS (River Information System) architecture and the Dutch Architecture for Traffic Management.

The Dutch Architecture for Traffic Management defines a structured approach through which the cooperating road operators can formulate their joint objectives and ultimately determine the operational traffic management instruments needed to attain these objectives. His research has since focused on how to further operationalize the Dutch Architecture of Traffic Management (i.e., how to bridge the gap between traffic management and traffic control). It was during his work on TNO and the projects that he was involved in that he developed the basic ideas and notions that inspired him to pursue a PhD on the subject of multi-agent traffic control. This ultimately led in 2003 to a part-time position at the Delft Center for Systems of Control of the Delft University of Technology, where he has been working on traffic control, multi-agent systems, and optimization. In 2008 he obtained his PhD on the subject of Multi-Agent Look-Ahead Traffic-Adaptive Control.

Dr. Victor L. Knoop

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Victor Knoop is assistant professor in the Transport and Planning group of the Delft University of Technology. His focus lies on traffic dynamics. Recent interest are multi-lane traffic modelling, as well as urban traffic flow modelling. On this scale, neighbourhoods are the base elements of which the traffic dynamics are tracked (rather than vehicles or roads). A dynamic model using these base elements has been developed for on-line usage at traffic management center of the The Hague. In his latest efforts, he includes pedestrians in the description of traffic operations.

Victor Knoop combines the research with teaching. He is responsible for the master course "traffic flow theory and simulation", and teaches traffic flow theory in the bachelor of the civil engineering program. Several master and PhD students work under his supervision.

Victor Knoop holds a MSc degree in physics from Leiden University and a PhD degree from Delft University of Technology. Victor Knoop studied and worked abroad, in Lausanne (EPFL), Lyon (University of Lyon/IFSTTAR), London (Imperial College), Bristol (University of Bristol), and Berkeley (University of California at Berkeley).

Ir. Henk Schuurman

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Henk Schuurman graduated as Civil Engineer at the Technical University of Delft. From 1991 to 1996 he worked as a researcher and assistant lecturer at the Transportation Planning and Transportation Modelling department at the Technical University of Delft. His main research topics were Traffic Flow Theory and Simulation. In 1997 Henk joined the Center for Transport and Navigation at Rijkswaterstaat. He is a senior consultant on the field of Dynamic Traffic Management and ITS. In 2009 he joined TrafficQuest. TrafficQuest is a joint venture between the Dutch Ministry of Transport, TNO and Delft university of Technology.

Recent Activities:

- Dutch representative for the EU C-ITS platform
- Head of RWS knowledge domain Road Traffic
- Coordinator monitoring and evaluation of the Dutch Optimising Use Programme at the Ministry of Infrastructure and the Environment. In this programme (2011-2014) the Dutch government, regions and businesses are working together to improve road, waterway and railway accessibility. ITS is one of the possible solutions. The programme spent an estimated 1,1 billion euros on around 350 practical measures
- Advisor for the Dutch Optimising Use Programme 2015-2018 at the Ministry of Infrastructure and the Environment
- Member project team A58 (Connected and Cooperative Services on the Dutch A58 motorway)
- Member ITS team RWS (Platform for knowledge exchange on ITS in NL, contribution to various ITS activities: Easyway Deployment Guidelines, Country Report/Progress Report 2010-2014 "ITS in the Netherlands", C-ITS corridor NL-D-AT)
- Member Programme Executive Board CEDR Technical Research Group Traffic Management (call 2013) and Mobility & ITS (call 2014)
- Member Coordination Group LVMB (National Traffic Management Consultative Committee). LVMB is a national consultative body for Traffic Management, consisting of RWS, Provincial Government and municipalities.

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Henk Taale is a senior consultant employed by Rijkswaterstaat. He has almost 25 years of experience in the fields of traffic management, traffic models and evaluation and was project manager for numerous projects in those fields. To name a few:

- assessment of tools for dynamic traffic management, such as ramp-metering;
- assessment of the UTC-system SCOOT in the city of Nijmegen;
- development, validation and maintenance of the microscopic simulation tool FLEXSYT-II-;
- development and application of a tool for sustainable traffic management (Regional Traffic Management Explorer);
- several assessment studies, including road maintenance on the ring road of Amsterdam, cross-border management, a pilot on the use of floating car data and measures taken by the traffic police;
- development of guidelines for assessment studies and model validation studies.

Currently, he is responsible for the coordination of evaluation studies and for bringing together the knowledge on traffic management impacts, also on a European level. Furthermore, he is responsible for ITS Edulab, a cooperation project for master students between Rijkswaterstaat and the Delft University of Technology. And for Rijkswaterstaat he is the coordinator of TrafficQuest.

Since 2011 Henk is appointed a part-time assistant professor at Delft University of Technology, where he supervises master students and PhD's in the field of traffic management,

Dr. Taale has a Master of Science degree in Applied Mathematics from Delft University of Technology and finished his PhD in December 2008 on the subject of anticipatory control of road networks. Anticipatory control deals with the interaction between road users and road managers and with the question how to find an integrated control plan for networks taking into account the route choice behaviour of road users.

Ir. Isabel Wilmink

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Isabel Wilmink obtained her Master's degree in Civil Engineering in 1995. Since then, she has worked as a traffic and transportation researcher at TNO. Since 2009, she is also a member of the operational team at TrafficQuest, the "Centre for Expertise on Traffic Management", a cooperation between TNO, Delft University of Technology and Rijkswaterstaat, the Dutch National Road Authority. She has experience with national and international projects in the areas of traffic modelling, scenario and evaluation studies, and the assessment of environmental effects of transport policies.

Isabel currently works on several projects focusing on the evaluation of the effects of in-car and cooperative systems (including automated driving) and traffic management (e.g. evaluation of the impacts of an app for departure time and route advice in the Practical Trial Amsterdam, impact assessment of eco-driving support systems in the ecoDriver project). Other EU projects she worked on include eCoMove, ECOSTAND, AMITRAN, euroFOT and eIMPACT. Recent national projects include a second opinion on mobility and traffic management measures proposed for a tunnel renovation in Rotterdam, a review of impacts of mobility and traffic management measures on CO_2 emissions, a quick scan into the effects of traffic measures on shockwaves, the development and evaluation of variable speed limit schemes for air quality, noise and traffic safety purposes, and the development of guidelines for the evaluation of traffic management measures.

Dr. Ir. Yufei Yuan

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Yufei Yuan is a researcher at Delft University of Technology. He received the M.Sc. degree and the Ph.D. degree in transport and planning from Delft University of Technology in 2008 and 2013, respectively.

His research interest lies with traffic flow theory and simulation, data processing and mining, traffic state estimation and prediction, network traffic management and analysis under evacuations, intelligent transportation systems in general. He has been involved in several contract research projects for the Dutch Ministry of Transport, as well as working as a teaching assistant for a number of postgraduate courses and student supervision, and acting as a reviewer for international conferences and journals. In 2014, he joined Traffic Quest, where he would like to link his research to practice.