Annual Report 2011

Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

The IVT in the year 2011

Prof. Dr.-Ing.
Kay W. Axhausen (1958)
1984 University of Wisconsin, Madison (M.S.);
1988, Universität Karlsruhe (Dr.-Ing.);
Since 1999 Full Professor for transport planning at the ETH Zürich

Dr. sc.
Balz R. Bodenmann NDS (1969)
1998 ETH Zürich (Diplom); 2003 ETH Zürich (NDS); 2011 ETH Zürich (Dr.);
firm location choice; land use models and simulations, spatial analyses

Emanuel Barth MSc (1984)
2006 Universität Basel (BSc);
2007 Cardiff University (MSc);
Public transport systems, Cross-border local public transport

Harald Bollinger (1956)
Laboratory

Dipl. Bau-Ing.
Franziska Baumgartner (1980)
2007 ETH Zürich (Diplom);
Skid resistance and road texture, tunnel lighting, lateral stability behaviour of vehicles in curves

Dipl. Ing.
Bernd Bopp (1977)
2004 Universität Karlsruhe (Diplom);
Infrastructures of public transportation; goods traffic and logistics

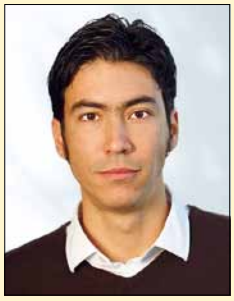
Dr. Ing.
Sonja-Lara Bepperling (1980)
2005 TU Braunschweig (Diplom);
2005 University of Rhode Island (MSc);
2008 TU Braunschweig (Dr.-Ing.);
Functional safety of railways

Dr. Ing.
Dirk Bruckmann (1971)
1999 Universität Duisburg-Essen (Diplom); 2006 (Dr.-Ing.); Logistics, rail freight and rail operations

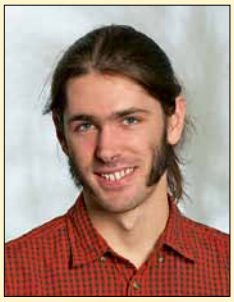
Ruth Bertschi (1951)
Secretariat

Dipl. Ing.
Jin Cao MSc (1988)
2011 Tongji University (MSc);
Traffic engineering; effects of parking time limits on traffic performance

The IVT in the year 2011



Nelson Carrasco, MSc (1980)
2003 Pontificia Universidad Javeriana, Cali (MSc); 2008 ETH Zürich (MSc); High quality urban public transport systems, combined mobility



Thibaut J. P. Dubernet, MSc (1988)
2011 Université de Technologie de Compiègne (MSc); Simulation of shared rides within agent-based micro-simulation

Dr. sc.
David Charypar (1978)
2003 ETH Zürich (Diplom); 2008 (Dr. sc.); Microsimulation of travel behaviour

Dr. sc.
Alexander Erath (1980)
2005 ETH Zürich (Diplom); 2011 (Dr. sc.); Transport planning, transport modelling, vulnerability of transport networks

Ing.
Francesco Ciari (1974)
2003 Università degli studi Firenze (MSc.); Modeling of innovative transport modes

Dipl. Ing. oec.
Olga Fink (1983)
2008 TU Hamburg-Harburg (Diplom); Reliability prognostics, predictive maintenance, neural networks; life cycle costing (LCC)

Dipl. Ing. (FH)
Christoph Dobler MSc (1982)
2005 Interstaatliche Hochschule für Technik Buchs NTB (Diplom FH); 2007 Technische Universität München (Msc); 2009 Hochschule Liechtenstein, Vaduz (Msc); Modeling of within-day replanning in agent-based micro-simulation

Dipl. Ing.
Patrick Frank (1983)
2007 Universität Stuttgart (Diplom); Operation and infrastructure of railway networks; Railway Operations Laboratory

Dipl. Math. Oec.
Robert Dorbritz (1981)
2005 TU Kaiserslautern (Diplom); Analysis of capacity, timetable stability and resilience of transport systems, modelling and simulation in transport

Tobias Fumasoli MSc (1983)
2010 ETH Zürich (MSc); Network access and governance, freight traffic and logistics

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Qiao Ge MSc (1983)
2008 Tsinghua University (BSc); 2011 Technische Universität München (MSc); ITS; traffic simulation and control

Martin Huber (1970)
Laboratory

Dr. sc.
Jeremy K. Hackney SM C. E. (1971)
1993 University of Colorado (BSc); 1997 Massachusetts Institute of Technology (MSc); 2009 ETH Zürich (Dr. sc.); Social network; agent-based travel demand modelling

Dipl. Ing.
Dietlind Jacobs (1982)
2008 Bauhaus-Universität Weimar (Diplom); Maintenance management of road infrastructure; level of service and capacity of pedestrian traffic

Ursi Hoerner (1951)
Secretariat

Dipl. Bau-Ing.
Boris Jäggi (1983)
2007 ETH Zürich (Diplom); Choice modelling

Dipl. Ing.
Silko Höppner (1981)
2008 TU Dresden (Diplom); Railway operating processes, railway operating laboratory hosting, passenger flow dynamics

Dipl. Geogr.
Veronika Killer (1978)
2006 Universität Zürich (Diplom); Spatial analyses of commuting

Dipl. Inf.-Ing.
Andreas Horni (1977)
2006 ETH Zürich (Diplom); Destination choice modeling for discretionary activities in agent-based travel demand micro-simiulation

Dipl. Ing. (FH)
Uwe Kirsch (1981)
2007 Westsächsische Hochschule Zwickau (Diplom FH); Investigation of pedestrian behaviour, micro-simulation of pedestrian flows, dwell time analyses

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Dipl.-Soz.-Wiss.
Matthias Kowald (1979)
2007 Universität Duisburg-Essen (Diplom); Social networks and travel decisions

Eng. CCP
Albert Mancera (1985)
2011 Universitat Politècnica de Catalunya (Eng. CCP);
Traffic systems operations

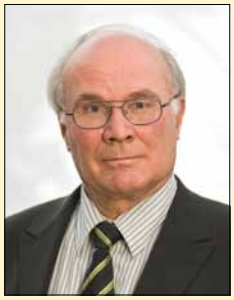
Dr. rer. nat.
Nicolas Latuske (1973)
2001 Universität Hamburg (Diplom); ITS; traffic flow and speeds in gradients

Fabian Märki MSc (1978)
2003 FHA Brugg-Windisch (Diplom FH);
2007 Stanford University (MSc);
Agent-based algorithms for the simulation of travel behaviour in large scenarios

Dipl. Bau-Ing.
Nicole Leemann (1983)
2007 ETH Zürich (Diplom);
Traffic safety; traffic engineering

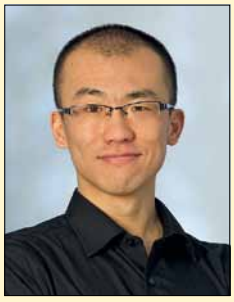
Dr.
Monica Menendez MSc (1976)
2002 University of Miami (BSc);
2003 University of California Berkeley (MSc); 2006 University of California Berkeley (PhD); Traffic flow theory and operations

Prof.
Hans Peter Lindenmann (1946)
1971 ETH Zürich (Diplom); Highway construction and maintenance



Dipl. Bau-Ing.
Stephan Moll (1979)
2005 ETH Zürich (Diplom); Freight traffic; track access charging systems

Ming Lu MSc (1982)
2009 Tongji University (MSc);
Traffic safety; reliability impacts on travel demand



Dipl. Bau-Ing.
Lara Montini (1985)
2008 ETH Zürich (Diplom); GPS surveys, modelling of travel behaviour

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Dipl.-Inform.
Kirill Müller (1979)
2006 Universität Karlsruhe (Diplom);
Population synthesis

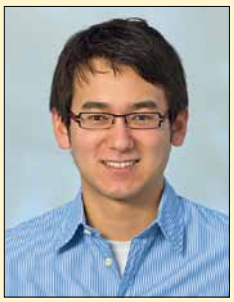
Dipl. Ing. (FH)
Enrico Puffe (1983)
2009 Westsächsische Hochschule Zwickau (Diplom FH); Quality and capacity of pedestrian traffic systems; pedestrian behaviour

Lorenzo Nägeli MSc (1985)
2008 ETH Zürich (BSc); 2010 (MSc);
Transport systems

Lic. rer. publ.
Markus Rieder MPA (1962)
2002 Universität St. Gallen (Licentiat); 2007 Institut de hautes études en administration publique (MPA); Regional rail transport in Belgium, France and Switzerland

Zainal Nur Arifin MSc (1963)
1988 Interkantonales Technikum Rapperswil (Diplom FH);
2000 University of Indonesia (MSc);
Transport planning; GPS survey and modelling of commuter behaviour

Dr. rer. nat.
Bernhard Riegel (1969)
1995 Universität Würzburg (Diplom);
1998 (Dr. rer. Nat.); IT coordinator



Hermann Orth MS (1985)
2007 Universität Karlsruhe TH (Vordiplom, Bauingenieurwesen);
2009 Northwestern University, Evanston (MS); Intermodal and freight transport, passenger transport operations

Edith Ringer (1952)
Secretariat

Javier Ortigosa (1982)
2006 Chalmers University of Technology (BSc); 2007 Universitat Politècnica de Catalunya (MSc);
Traffic flows and urban networks

Dr. sc.
Gerko Santel (1978)
2004 Universität Hannover (Diplom);
2011 ETH Zürich (Dr. sc.); Lateral driving behaviour, range of lateral movement and additional space for oncoming and overtaking traffic for different road types

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Dipl. Bau-Ing.
Milena Scherer (1980)
2005 ETH Zürich (Diplom); Level of service of public transportation and system-specific effects of public transportation on spatial development

Dipl. Ing.
Steffen Schranil (1984)
2009 TU Dresden (Diplom);
rail engineering and rail power supply; rail traffic and public transport; mobility and sustainability

Patrick Scherer (1978)
Webmaster

Dr. sc.
Nadine Schüssler (1979)
2004 Universität Karlsruhe (Diplom);
2010 ETH Zürich (Dr. sc.);
GPS surveys and analysis; behavioural modelling; agent-based travel demand modelling (GPS Erhebung, Verhaltensmodellierung)

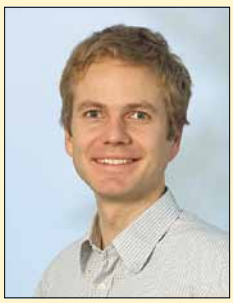
Dipl. Ing.
Frank Schiffmann (1975)
2002 TU Dresden (Diplom);
Infrastructure management; Road maintenance management; road construction

Dipl.-Ing.
Michael Schwertner (1979)
2004 TU Dresden (Diplom);
Public transport; railway safety

Dipl. Ing.
Patrick Schirmer (1979)
2006 Universität Karlsruhe (Diplom);
Shape grammars; Spatial analyses and urban simulation

Prof.
Peter Spacek (1946)
1974 ETH Zürich (Diplom);
Highway design; traffic engineering

Dipl. Ing.
Philipp Schmidt (1975)
2004 Universität Karlsruhe (Diplom),
Freight traffic; network access; railway noise



Dipl. UWIS
Basil Vitins MSc (1980)
2007 ETH Zürich (Diplom);
Transport planning; network design and optimisation; shape grammars

The IVT in the year 2011

Dipl. Inf.-Ing.
Rashid A. Waraich (1982)
2008 ETH Zürich (Diplom); Simulation framework for investigating the impact of (plug-in hybrid) electric vehicles

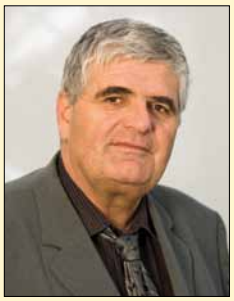
Sabrina Wiedersheim MSc (1985)
2007 ETH Zürich (BSc);
2009 (MSc); Operations research; automatic generation of periodic railway timetables

Prof. Dr.
Ulrich Weidmann (1963)
1988 ETH Zürich (Diplom); 1994 (Dr. sc.); since 2004 full professor of transport systems

Valérie Willimann (1960)
Secretariat

Dipl. Bau-Ing.
Claude Weis (1981)
2006 ETH Zürich (Diplom); Travel behaviour modelling

Dipl. Geogr.
Adrian Zaugg (1971)
2004 Universität Zürich (Diplom); IT coordinator



Dipl. Bau-Ing.
Jost Wichser (1947)
1973 ETH Zürich (Diplom); Track–rolling stock interactions; public transport funding; logistics and freight transport

Dipl. Ing.
Christof Zöllig (1981)
2007 ETH Zürich (Diplom); Spatial development; land use modelling

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March 2012

Abstract

This annual report describes the activities of the year 2011 in the context of the review of the years since the last departmental peer review in 2004 (for reference, see: http://www.ivt.ethz.ch/docs/reports/selfevaluation99_03.pdf).

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Annual Report 2011

Institut für Verkehrsplanung und Transportsysteme (IVT)

Photo: Lijun Sun

1 Mission

The mission of the Institute for Transport Planning and Systems (IVT) is:

- To generate new knowledge for the planning, design, safety, operation and maintenance of transport systems
- To transfer this knowledge through teaching, further education and applied research

The three current groups have defined their missions as follows:

Traffic Engineering (since 2010):

- The mission of this research group is to carry out cutting-edge research in the area of traffic flow theory and operations. The ultimate goal is to improve transportation systems and move them towards a sustainable state. The group believes in a multi-modal perspective, greener mobility patterns, information sharing, a more rational use of resources, and better employment of technology to achieve this goal. From a process perspective, the group uses both empirical and theoretical studies as well as an interdisciplinary approach.

Transport Systems (since 2004):

- The mission of the Transport Systems chair is to teach and conduct research on the planning, design, realisation, operation and maintenance of public transport systems. The aim of our research is to improve the delivery of public transport services so that they optimally cover market needs while minimising costs. Natural resources and the urban context are considered in addition to economic aspects and political goals. The chair's system-oriented approach brings together generic knowledge of transportation science and neighbouring fields of knowledge.

Transport Planning (since 1999):

- The mission of this chair is to generate new knowledge about the structures of spatial and especially travel behaviour through the advancement of methods for their observation, measurement, description and modelling on a micro and macro scale. Furthermore, our aim is to transfer this knowledge through teaching, further education and applied research, particularly through work on large-scale networks and demand models as well as on the parameters of cost-benefit analysis.

Photo: Alex Erath

2 Review: 2004–2011

The Institute for Transport Planning and Systems (IVT) was privileged to celebrate **125 years of Transportation Engineering** at the ETH Zürich in 2008 (Sandmeier and Axhausen 2008). Together with the Institute of Structural Engineering, the IVT shares the distinction of being the oldest institute of the Department of Civil, Environmental and Geomatic Engineering and of the ETH as a whole. In line with ongoing changes in the field, the IVT adjusted its focus when the opportunity arose with the retirement of Prof. Lindenmann and Prof. Spacek in 2011.

The department has for the last twenty years consistently **deemphasized transport and transport infrastructures** in its shift towards environmental engineering and geomatics. Instead of four full chairs as in 1991, the IVT currently has two chairs and a research group (see below). At the beginning of the review period, the institute still had the hope that the third chair in Road Transport could be filled again. The IVT proposed to redefine the chair and give it a focus on traffic safety with a special emphasis on new technological possibilities. This emphasis would have allowed the IVT to build a unique strength in the German-speaking world and respond to the policy drive both in this area of Europe and, more importantly, in emerging economies where the gap between car usage and the quality of the road system is widest. After a long decision process and in spite of strong outside support for our case, the department did not approve the chair and redirected the funds to a planned new chair of Urban Water Systems.

The department did, however, offer the IVT an alternative that is unusual at the ETH: We were allowed to retain and rebuild our **third research group** under the direction of a new member of staff, who was to be hired under "quasi-tenure track" conditions, i.e., with an initial six-year appointment followed by a permanent contract if successful. After a further successful 4–6 years, this person could then be appointed titular professor.

The advertisement for the post led to a very strong field of candidates which matched the quality of any assistant professorship recently offered by the department. The three short-listed candidates were interviewed by a panel of three non-IVT professors and two IVT professors. After the presentations and interviews, the panel chose Dr. Monica Menendez for her energy, enthusiasm and expertise in traffic engineering, especially traffic flow.

Traffic engineering is a field which the institute needs, and which Dr. Menendez should be able to cover with the reduced resources available to support her research. A chair would have needed a broader definition. We are very satisfied with her progress since her start in October 2010. The IVT will support her in all ways possible to enable her to obtain tenure.

This recent decision set the future **structure of the institute**. In addition to the two groups led by full professors, the IVT will continue to have a third research group:

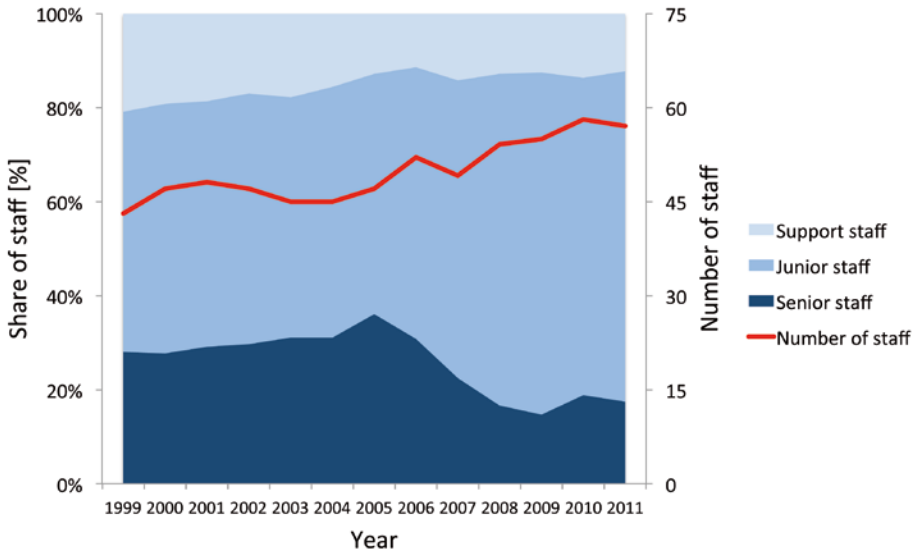
- **Individual Transport**, which had been chaired by Prof. Hans-Peter Lindenmann and Prof. Peter Spacek, was dissolved at their retirement in the summer of 2011.
- The **Traffic Engineering Research Group** has been headed by Dr. Monica Menendez since October 2010. Dr. Menendez will be appointed to a permanent post if her performance during her first six years at the ETH convinces the department that she will be able to deliver the results required for an appointment as titular professor.
- **Transport Systems** has been chaired by Prof. Ulrich Weidmann since his appointment in 2004.
- **Transport Planning** has been chaired by Prof. Kay W. Axhausen since his appointment in 1999.

Table 1 **Structure of the IVT**

Level 1 Demand	Travel and spatial behaviour Demand modelling		Transport Planning (Axhausen)
	Public transport	Individual transport	
Level 2 Supply	Network design Supply design Production planning Infrastructure operations Operations/Safety	Network design Infrastructure operations Traffic engineering Traffic safety	Traffic Engineering (Menendez)
Transport Systems (Weidmann)			
Level 3 Infrastructure	Infrastructure design Project management Infrastructure maintenance		

In spite of the uncertainty concerning the third chair, the IVT has been able to maintain and even increase its size, thus making it the largest coherent transport research group in Switzerland. The retirement of various senior non-professorial **staff** has led to a situation in which our management capacity is becoming dangerously thin. Recent appointments of senior assistants have reduced this pressure, but without a clear career path, this will not be a stable solution. These staff members need an early endorsement by the department and an acknowledgement of their status by the school as a whole, especially with regard to project acquisition, line management and thesis supervision. It seems obvious to the IVT that the opportunity given to Dr. Menendez should be offered to more candidates, with the same clear understanding of the necessary requirements on both sides.

Figure 1 **Share of staff by category**



The **organisation** of the institute matches the structure of the IVT. The head chairs the institute's board, which is composed of senior staff members. The board manages and plans the common affairs of the institute and especially co-ordinates the courses offered by the IVT. The three groups and the head are supported by a common secretary's office whose four staff members share an FTE of 2.8. The secretarial staff members have individual responsibilities, but they coordinate all tasks jointly.

A central IT administrator (0.8 FTE) is in charge of the central servers, disk storage and managing the normal office infrastructure of the institute. He manages the IT budget under the supervision of the institute's board. He supports, where needed, the groups' IT infrastructure, for example the large shared memory machines of the Transport Planning group.

The **publication record** is steady in terms of numbers per head, but there has been a distinct shift towards more peer-reviewed publications (see the attached full list of references). This trend will be reinforced by Dr. Menendez' strong academic orientation. However, our wish to report our results in German reduces our capacity to publish in English. The writing of official Swiss norms is a case in point, as this is a prime medium for making our results quickly available to practice. The care taken in writing norms in Switzerland is equal to that of any peer-reviewed publication, as it entails two independent rounds of about ten readers each and frequent repeats of those rounds. Equally, we need to be present in the local and national policy debate through talks to civic groups and interviews in newspapers and radio shows.

Figure 2 Share of publications by category

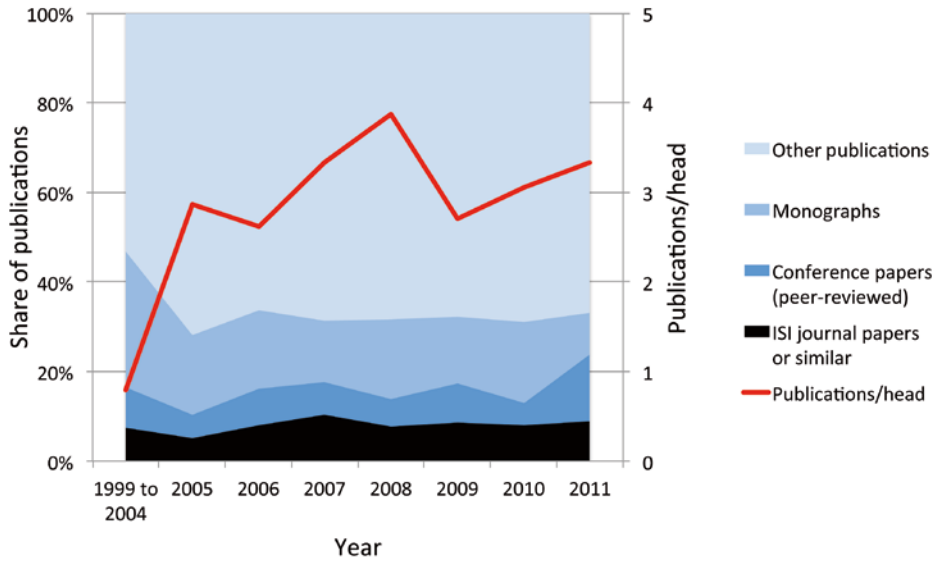


Table 2 Publications by type

Publications	2005	2006	2007	2008	2009	2010	2011
ISI journal or similar peer-reviewed papers	7	11	17	16	13	14	17
Peer-reviewed conference papers	7	11	12	13	13	9	28
Monographs	24	24	22	37	22	32	18
Other publications	97	90	112	143	101	122	127
Sum	**135**	**136**	**163**	**209**	**149**	**177**	**189**

Photo: Lijun Sun

3 Strengths, weaknesses and strategies

3.1 The Institute

The IVT in its current form and with its own style of operation is a cohesive academic institute offering a strong teaching programme to its students and well-informed counsel to policy makers based on outstanding research in its core areas. This link to policy and industry is a strength of the IVT, as it lends visibility to our research and garners feedback to keep the institute at the forefront of research and practice.

The institute's teaching programme, encompassing courses from across the school, is the largest transport engineering programme in Switzerland. While the IVT does not offer a formal lecture-based PhD programme as such, IVT doctoral students benefit from the range of skills and experiences of their colleagues throughout the institute.

The IVT is unusual in that its secretary's office, IT support and the administration of its ETH funds are jointly shared. This gives us the flexibility to deal with peaks in demand and ensures that the funds are properly used. The common IT budget is used to provide each member of staff with the computing power and facilities which she or he needs. Increasing our IT support would be desirable, but our current budget situation does not allow for it.

Coherence is also visible in a range of joint events throughout the year, including two meetings of all IVT members to inform and discuss current issues; an annual internal seminar offering a cross-section of presentations on current research projects; and a biannual field trip. The biannual Alumni Seminar with 150 attendees continues this approach and helps us maintain contact with our former students and colleagues.

The IVT offers an unusually large set of courses at the MSc level, thus enabling our students to obtain a comprehensive education in transport engineering. Due to the retirement of our last scientific permanent staff (Wichser, Lindenmann and Spacek) we have lost teaching capacity. The appointment of Dr. Menendez allows us to cover the crucial traffic engineering area, but for the remainder we will have to work with external lecturers and with some of our senior assistants. We have fortunately been able to find outstanding colleagues from the field, and in the case of Prof. Aday, a colleague from within the department.

The new Diploma of Advanced Studies (DAS) course in Transport Engineering and Transport Planning (as of 2011) fills an important gap in the German-speaking world. Its organisation and approval went smoothly, benefitting from the clear procedures established at the ETH. Collaboration with external colleagues allows us to offer the equivalent of a one-year Master's programme in Transport Engineering. We plan to teach it at that level, especially with regard to the students' homework and thesis topics.

The level and range of research at the IVT reflects the interests of the three group directors. In every case, research has benefitted from the strong links the institute maintains with professionals in the field, particularly in Switzerland, but also in Europe and the rest of the world. Fundamental research and more applied research are well balanced across the institute .

An obvious weakness of the IVT lies in its small number of permanent staff and its reduction to two chairs and one research group. We can bridge this gap through the appointment of senior assistants (Oberassistenten) and postdocs, but only to a certain extent, as such appointments are limited to six years. As described above, we are very pleased about the appointment of Dr. Menendez on a quasi-tenure track to a permanent post, and the IVT would welcome it if this approach were to be generalised and more widely adopted. That would give the department and the school a transparent mechanism to address research fields too small for a whole funded chair and to retain outstanding junior staff. It would also allow large chairs to divide their research programmes among multiple senior staff, thereby retaining the expertise they have built up.

In recent years, the department has focused on staff in its budget allocations. This has led to an imbalance with respect to running costs and IT costs, as many external funding sources have also reduced their support for running costs. We hope that the department will reconsider this bias.

The Master's course "Spatial Development and Infrastructure Systems", to which the IVT contributes heavily, has had a steady number of applicants and students and is well established. Nonetheless, the total number of students is unsatisfactory. Discussions are underway about merging this course with one of the other Master's courses in the department, but that might diminish its role as a gateway into the profession for students from outside the department. The IVT is open to these discussions but wants to retain the ability to integrate students from across disciplines and enable them to obtain the education needed for a career in transport engineering and planning. The IVT would like to increase the visibility of its teaching programme in any new format so that potential students can more easily recognise that that they can cover the coursework required for a "Master in Transport Engineering" elsewhere at the ETH.

As part of these discussions, we will have to address the question of the teaching language. Since the other courses in the department are taught in English, we will have to adopt the language as well. The IVT is not averse to this, but notes that technical vocabulary will be a challenge, especially in railway engineering. It might be worthwhile to test if switching to English would allow us to attract enough students to make the course sustainable.

3.2 Traffic Engineering

The Traffic Engineering Research Group was created in October 2010. It is therefore still very new and is in the process of development. Over the next few years, our objectives are to increase the size of the group and to further strengthen its research and teaching curriculum.

We now offer one BSc course and contribute to five MSc courses. We engage both internal and external lecturers in order to guarantee the highest level of academic and practical expertise on each of the subjects. In addition, the Traffic Engineering group is involved in advising and supervising projects for the MSc programme Spatial Development & Infrastructure Systems, the Theme A project for the Master's thesis for the Chair of Architecture and Urban Design, and the new Diploma of Advanced Studies (DAS) course in Traffic Engineering and Transport Planning. We hope to continue enriching the teaching curriculum over the next few years by including a more global perspective (i.e., not unique to Switzerland) on transportation and showing how the latest advancements in research translate into practice worldwide.

Within the research arena, the priorities of the Traffic Engineering group include:

- Developing models to better replicate real traffic conditions
- Improving our understanding of traffic phenomena
- Contributing to a better definition of the role of cars in cities while assessing their external costs and impacts
- Understanding and quantifying how different technologies and management strategies influence the performance of transportation systems
- Developing innovative solutions to improve traffic performance and reduce congestion both on highways and in urban networks
- Identifying new and efficient methods for using in-vehicle and infrastructure technologies to improve traffic conditions
- Optimising the operation of transportation systems from a multi-modal perspective

The bulk of the work during this first year has focused on the conception and creation of the group. This has included recruiting researchers, building professional connections, establishing a reputation at the local level, obtaining research funding, securing different types of collaboration at the national and inter-

national levels, and starting a few lines of research according to the priorities detailed above. We hope to continue this work over the next few years, along with expanding into the remaining research areas that fall within the intended scope of the Traffic Engineering group.

That the Traffic Engineering Research Group is still quite new presents a number of challenges and advantages. The challenges include personnel recruitment and development, turn-around times for publications, setting up projects, etc. As explained above, a good portion of the work during this first year was devoted to addressing these issues. Nevertheless, many of the results are not immediate and the outcomes will take some time to realise. We won four of the five proposals that we submitted in the first six months (in the past six months we submitted two additional proposals, but are still waiting for the decisions). The projects associated with the accepted proposals have either already commenced or will start soon. Publications from those research projects and potential funding from project extensions, etc. will follow.

The advantages, on the other hand, include a highly flexible team with new perspectives and fresh ideas. The Traffic Engineering Research Group benefits from a multiplicity of backgrounds and different research interests and approaches. Moreover, we also benefit from international network connections as well as some expertise in the European, American and Asian transportation systems. We plan to leverage all those relationships and knowledge to foster collaboration and to tap into transportation problems that extend well beyond the borders of individual countries. The overall idea is to channel all the energy of a new team into work on the issues and challenges already discussed.

3.3 Transport Systems

The chair selects its research topics according to following criteria: (1) high research and innovation potential; (2) of international—or at least European—interest; (3) relevance for Switzerland and its public transport industry; (4) and the availability of real-world laboratories in Switzerland. This last point refers to the heavily used infrastructures, the high quality and the reliability of passenger services as well as the good market position of rail and intermodal freight services in Switzerland.

Based upon these criteria, the research activities of the chair focus on four areas:

1. Passenger transport system evaluation and decision support: Despite past efforts to analyse and evaluate public transport systems, experience has revealed a clear lack of holistic methods. The long-term research question is: How can public passenger transport systems be adequately evaluated in a holistic way, encompassing economic, technical, operational, social and environmental aspects?

2. Integration of rail freight transport systems in logistic chains: Many research groups deal with logistics, but little work has been done in the field of goods transport. The special competence of the chair is its understanding of the operation and technology of rail systems. The long-term research question is: How should rail freight systems be improved at the conceptual, operational, technical and organisational levels in order to achieve a higher market share?

3. System performance and stability: Recent developments in data capture and computing systems allow for new approaches. Three subtopics are of special interest: (1) operations analysis of rail and urban public transport systems, based on the real-time data of dispatching systems; (2) investigation of the stability and robustness of networks in case of minor or major incidents; and (3) the automatic generation of schedules for entire networks (work in collaboration with the ETH Operations Research chair). The long-term research question is: How can the performance of a public transport infrastructure network be further improved with regard to its reliability and stability?

4. Railway infrastructure management: This new topic is a response to the steadily increasing demand for infrastructure research in Switzerland for the following reasons: (1) Switzerland's railways are in a period of network extension, driven by increasing demand; (2) infrastructure maintenance is proving to be more and more difficult and costly, and current renewal activities will not suffice in the long term; and (3) the experience of the chair has revealed a lack of evaluation methods for new infrastructure on a conceptual level. The long-term research question is: How can the costs of Swiss railway infrastructure be minimised in all phases of the life cycle?

A special field of research associated with the four mentioned above is the performance and level of service of pedestrian traffic facilities. Deepening knowledge of pedestrian characteristics that are relevant to transportation has always been an emphasis of the chair. For instance, a major, recently initiated study deals with the characteristics and performance of facilities for human-powered land transport, i.e., pedestrian and bicycle traffic. The goal is to develop a Swiss standard for the design of such facilities. Several other research and consultancy projects have been carried out in this area over the past years.

Due to the diversity of these research fields, various appropriate and accepted methods are applied. In two fields, the chair has developed special approaches which will be deepened and formalised in the coming years:

- Process analysis in general, but also on a very detailed level; this has been applied to production as well as to management processes
- Modelling public transport systems and identifying the qualitative and quantitative connections between the subsystems or neighbouring systems

Most of the chair's funding comes from relatively small projects, and no single big project has been carried out in recent years. Instead, the chair groups smaller projects around a common subject, e.g.:

Passenger transport system evaluation and decision support:

- The perception of public transport: The chair investigated the perception of different public transport systems by users and non-users, especially in the urban context. It identified not only differences, but also the main factors influencing perception. Besides emotional aspects, the existence of a right of way was revealed as crucial.
- The employment of various means of transportation in agglomerations: Based on a research project, criteria for the deployment of different urban transport modes have been developed. By using these reference values, it is possible to identify a set of adequate transport modes in a specific context.
- A mobility plan for the University area of the City of Zürich: In cooperation with the other chairs of the IVT, an analysis of the transport needs of a large university and hospital area in a central business district was carried out, taking the University area of the City of Zürich as an example. This study led to deep insights into the mobility patterns of such facilities and the optimisation potential of the existing means of transport.

Integration of rail freight transport systems in logistic chains:

- A research programme on freight transport: Within the Swiss framework programme on freight transportation, the chair investigates the reaction of forwarders to the quality of service, related rail freight production concepts and the necessary information flows. In particular, the willingness to pay for environmentally friendly transportation has been identified. It could be shown that such a willingness does exist, but on a very restricted level. The closer products are to the end customers, the more these are willing to pay.
- Sustainable freight transport at the local level: In collaboration with the University of St. Gallen, we investigated what sustainable delivery systems should look like and how they can be achieved. The project findings were based upon a dynamic system simulation including all relevant influences. It

was shown that promoting combined transport and trading emission certificates are the best policy instruments.
- SPIN-ALP: The goal of the SPIN-ALP project was to develop procedures, methods and instruments to promote the shift from road freight transport to intermodal transport. The main results of SPIN-ALP were the development of software for intermodal door-to-door transport planning and an electronic handbook for intermodal transport planning. Test applications with market players and public authorities have proven their practicability.

System performance and stability:

- The operation of heavily loaded urban and suburban public transport services: The chair deepened its knowledge of boarding and alighting times, taking into consideration the ticket-selling process. It analysed in detail the running times of buses in mixed traffic lanes. In doing so, it acquired quantitative insights into the main influences on running time and punctuality. It was shown that the extent to which buses in mixed traffic lanes are disturbed by other means of transport makes it impossible to maintain even generous schedules fully.
- The stability and robustness of railway networks: Ongoing research deals with the stability and robustness of railway networks in case of large- and medium-sized events. Algorithms were developed to calculate network robustness as a function of architecture. It was shown that different network shapes may be efficiently evaluated, taking power supply and signalling systems into account as well.
- The optimal use of capacity: The chair has investigated the optimal use of capacity in railway networks with respect to both political and economic goals. It estimated the costs for providing capacity on the one hand, and the returns on the used capacity on the other hand in a multi-criteria system. It was shown that—under the circumstances and regulations given —the maximal number of trains was equal to the optimal number. In addition, slot allocation systems proved to be an ineffective means of providing incentives to train operating companies.

Rail infrastructure management:

- Slot pricing in railways: The chair developed a new system to calculate slot prices, including aspects of capacity shortage, capacity usage, environmental friendliness, track usage, timetable structure, etc. Special emphasis was placed on noise reduction. The principles of the chair's proposition were recently accepted by the Swiss government and will be partly implemented.
- The stability of narrow gauge tracks: Rail welding is a technology commonly applied to the standard gauge network. In contrast, welding is generally prohibited for narrow gauge tracks for safety reasons, under the assumption that stability is not guaranteed, especially in case of small radii. An ongoing research project measures track movement at different locations of the Swiss narrow gauge network and gives new insights into the behaviour of tracks in curves under different temperatures and trainloads.
- The interaction between different types of rolling stock and the wearing of tracks: A steadily increasing number of trains, but also higher axle loads and speeds are leading to more and more wearing of the tracks. It is well known that the negative effects differ by type of vehicle. In order to limit maintenance costs, network operators are looking for ways to stimulate the construction and use of track-friendly vehicles. One way to encourage this could be to incorporate wearing effects in track allocation charges. This research project developed a suitable ranking of vehicle technologies.

The research field of the chair fortunately enjoys high public awareness. In addition, Swiss public transport services are still expanding, leading to many projects and political debates. The chair has repeatedly been asked to judge solutions, give advice on critical projects and draft new concepts. It has not engaged in regular consultancy, which can be carried out more efficiently by engineering companies.

The chair was invited several times to evaluate large-scale infrastructure projects and budget estimates, including:

- A new public transport system in Liechtenstein (CHF 1 bn)
- Reconstruction of the central railway station in Bern (CHF 3 bn)
- A strategic extension plan of the Swiss railway network (CHF 12 bn–21 bn)
- The Swiss Federal Railways' new Chestenberg line (CHF 2 bn)
- A city tunnel and S-Bahn system in Basel (CHF 2 bn)
- Two extensions of the tramway network in Bern (CHF 200 m and CHF 550 m)

In each of these cases, the chair supported the decision process by making a holistic evaluation. Its knowledge of transport systems and their interdependencies contributed considerably to this achievement. However, evaluating projects of this size within deadlines of only several months also required sufficient and highly qualified staff.

Consultancy projects will remain valuable for the chair, being (1) a link between research and industry, (2) a laboratory for methods and insights developed at the chair, (3) part of the personal education of scientific assistants by providing them with practical experience, (4) service for projects of public interest, especially in cases involving difficult decision-making processes, and finally (5) opportunities to obtain additional means for cross-financing research projects. As in the past, consultancy projects should be linked to the focal points of research in order to profit from the scientific point of view as well.

General relations to the public transport industry such as public transport companies, railway and rolling stock undertakings, the government, universities of applied science, etc. have been strengthened within the past years. Members of the chair are in contact with industry and governmental representatives in the most important dedicated institutions. In addition, close-to-research consultancy projects were and are a good opportunity to exchange knowledge and experiences. Finally, the chair supported the design and introduction of the Bachelor's course "Transport Systems" at the Zürich University of Applied Sciences (ZHAW).

The chair supports the ETH Zürich in mobility questions. The transport situations of the two campus sites of the ETH at Science City (Hönggerberg) and Zürich Zentrum have been studied in detail. Long-term perspectives have been developed for both sites, and a short-term proposition for a 20-minute shuttle service between the two sites was implemented in 2010. It has proved to be very successful, carrying up to 3,500 passengers per day. Based upon studies by the chair, the parliament of the Canton of Zürich has decided to consider building a tramway link to ETH Hönggerberg in the long term.

In 2006 OpenTrack Railway Technology Ltd. was founded as a spin-off company of the chair. OpenTrack started in the mid-1990s as an IVT research project. OpenTrack Railway Technology Ltd. develops and markets simulation tools for public transport systems, provides consulting services with respect to railway information technology and develops data exchange formats for railway applications.

Strengths of the Transport Systems chair:

- A comprehensive teaching programme covering the main areas of the field of public transportation
- Focused research activities in clearly defined areas
- Dr. Dirk Bruckmann, a new senior scientist who strongly supports freight transportation research and teaching and manages research projects
- Developing principles, planning and design processes on the subject of passenger and freight transport systems
- Conducting detailed process analyses of entire public transport systems
- An increased research focus on urban and bus transportation

- A high number of promising PhD candidates
- A high share of third-party funding
- Offering sought-after independent expertise on politically critical large-scale projects
- Being strongly embedded in the national context
- Active participation in public debates on public transport with the launch of new ideas and concepts
- Good visibility in the Swiss media and through presentations before political and industrial assemblies
- A Railway Operations Laboratory as a unique teaching tool with high visibility outside the ETH

Weaknesses of the Transport Systems chair:

- Insufficient publication activities, especially in scientific journals
- Absence at international conferences
- In contrast to the national level, insufficient visibility in the international academic world
- Insufficient visibility in the international professional community
- Not enough knowledge from consultancy projects transferred into research and teaching
- The lack of a suitable follow-up to several research topics

In 2004, the chair was repositioned with quite a different profile compared to its predecessor. Although formally succeeding an existing chair, the teaching and research activities had to be completely redefined. Therefore, it took time to settle on an appropriate research and PhD programme. In addition, developing and finalising the teaching programme have been more time-consuming than anticipated. Both strategic activities are now close to completion and the chair has already substantially intensified its publication of research results. Along with submissions to the few journals covering the topics, there are ongoing projects for scientific publications and textbooks. However, it should be noted that the citation tradition is not yet well established in the rail research community.

Outlook

In the coming years, the chair will further develop its strengths and work on the identified weaknesses by:

- Intensifying publication in international scientific journals and giving presentations at high-level conferences
- Strengthening the position of the chair in the international scientific and professional community
- Improving the transfer of new knowledge to teaching
- Speeding up the transfer of new scientific ideas and concepts to related projects

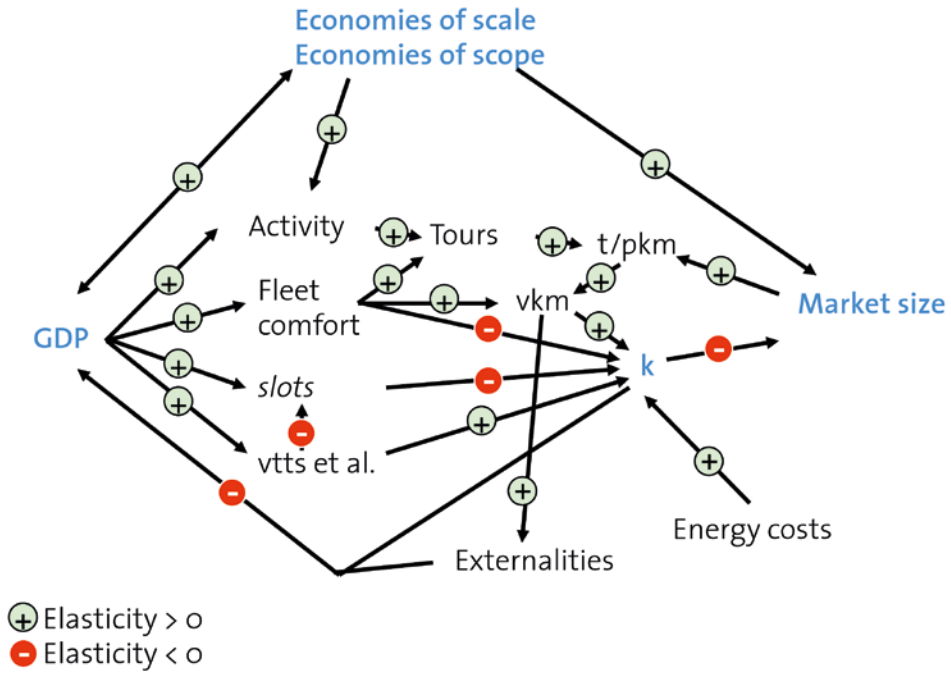
In parallel, research on rail infrastructure will be increased and the teaching programme will be consolidated. It should be noted in this context that the head of the chair is the designated head of department (D-BAUG) for the period from 2013 to 2017, which will inhibit an even stronger effort.

3.4 Transport Planning

The chair pursues two research programmes that are linked by their reliance on an in-depth understanding of travel and spatial behaviour. In addition, it plans to develop a third pillar in the coming years.

The first research programme is driven by the abstract model of travel demand dynamics described in figure 3 below. This model of the goods market has a match in the market for personal travel.

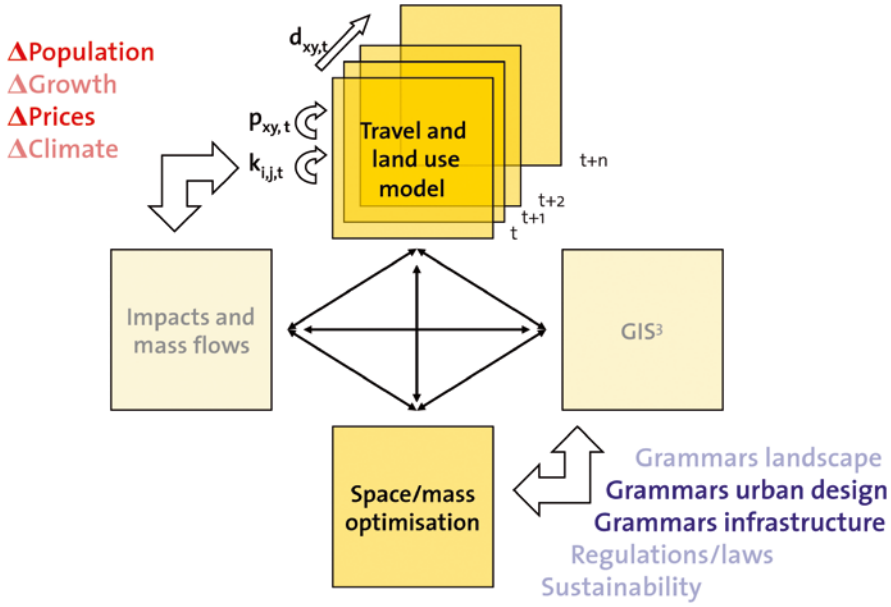
Figure 3 Dynamics of traffic growth in the goods and services market



The key question is to trace the link between the generalised costs of travel k with the overall productivity of society. The generalised costs in this abstract context are nothing but the accessibility that the transport system provides. The work of the past years has traced changes for the period from 1850 to the present at the municipal level. The intention is to continue our work on induced demand and complement it with work on the links between firm productivity and travellers' activity spaces.

The second research programme is on the integration of tools for space (capacity) and mass optimisation with agent-based models of travel behaviour and land use change.

Figure 4 Overall design of the Transport Planning toolkit



The focus of recent work has been to develop the agent-based travel demand toolkit MATSim (www.matsim.org), which is a joint undertaking with the TU Berlin and now involves colleagues from around the world. In addition, we have started to investigate network grammars and richer methods for designing motorway cross-sections and are commencing work on spatial regression models of travel demand/supply quality to reduce the massive computing times of joint equilibrium models of travel and land use.

Land-use modelling forms a necessary basis for our work, and we plan to continue with selected elements by integrating all of those capabilities needed to enable MATSim to make long-term forecasts of population development and distribution in space. Furthermore, our work on the grammars of urban design should enable us to give long-range forecasts a comprehensible form. Our existing collaboration with land-use modellers will be complemented by cooperation with computer graphics experts.

The third research programme will explore how much can be inferred solely from official statistical data, commercially available networks and points-of-interest information. We will formulate direct-demand models as geographically aware regression models to link network performance to the surrounding geographies of work, leisure and residences. The challenge will be to identify a range of policies that can be described in such an approach and to determine how well they are able to capture the elasticities of demand vis-à-vis infrastructure, services, price and quality changes.

The size of the chair provides it with the scope and the means to undertake the ambitious research programmes sketched above. Both MATSim and our work on the link between accessibility and induced demand define the state-of-the-art. The same holds for surveys that form the basis of modelling work to support large-scale model implementations such as MATSim in Switzerland and Singapore or the parcel-based UrbanSim in the Canton of Zürich.

The size of the chair is also its central weakness, as it removes the professor from many of the details of ongoing research. The increased number of senior assistants (Dr. Erath in Singapore, Dr. Schüssler on MATSim, Dr. Charypar on continuous demand simulation models, Dr. Bodenmann on land-use modelling, and as of 2012 [Dr.] Weis on survey methods and modelling) is the result of structural changes to keep the group manageable and productive. The lack of a senior scientist remains a weakness of the chair, and the current unwillingness of the ETH to define an open and competitive career path for senior scientists at the school level remains a hurdle for this chair and for chairs across the school.

Our focus on implementation and large-scale implementation has resulted in too little strictly methodological research. To fill this gap, we have integrated colleagues from around Europe who are making strong contributions in this respect and who could not otherwise demonstrate their methods on a large and politically relevant scale. The exception is our ongoing work on the equilibrium of agent-based networks and network design. Nevertheless, our research programmes are driven either by an explicitly theoretical model or by an overall design linking various elements into a coherent and testable or implementable whole.

Photo: Alex Erath

4 Teaching

4.1 Degree programmes

The IVT teaching is integral to a number of degree programmes of the Department of Civil, Environmental and Geomatic Engineering and across the school. In this section, we will introduce our main teaching commitments, but not the BSc in Environmental Science, the MSc in Applied Mathematics or the BSc in Geography of the University of Zürich, to which we also contribute.

The ETH has adopted the BSc/MSc system initiated by the Bologna Treaty. The six-semester BSc provides students with the foundations to continue their education at the ETH or elsewhere. The ETH does not consider this degree to be a full professional qualification.

4.1.1 Bachelor of Science in Civil Engineering

The BSc programme starts with a department-wide first year of foundation courses in mathematics, mechanics, geology, systems engineering, management and surveying. A small group project introduces students to professional questions and the challenges of teamwork. A comprehensive set of exams, which must all be passed, is scheduled for the summer of the first year and the other years as well.

The second and third years allow students to add depth to their understanding and to prepare for their later Master's degree. Courses in physics, hydraulics, structural mechanics, materials and computer science are complemented by civil engineering courses in structural engineering, geotechnics, hydraulic engineering and construction management. The IVT offers a set of three courses introducing transport planning, railway infrastructure and traffic engineering.

4.1.2 Bachelor of Science in Geomatics and Planning

This BSc programme offers the basis for a career in either geomatics or planning. It was revised in the academic year 2010/11 to better match these demands.

Students begin with the department-wide first year of foundation courses, but with fewer courses in mechanics. The second and third years allow students to add depth to their understanding and to prepare them for their later Master's degree. Depending on their preferences, the students can choose different paths, emphasising either geomatics or planning. The IVT offers the same set of three courses introducing transport planning, traffic engineering and railway infrastructure, of which only transport planning is compulsory for all students taking this degree.

4.1.3 Master of Science in Civil Engineering

The MSc in Civil Engineering offers students the choice of two out of six specialisations:

- Construction management
- Structural engineering
- Geotechnics
- Transport systems
- Hydraulic engineering
- Materials and mechanics

A rich set of courses gives students the opportunity to define their projects. A major project in the third term trains independent professional work, while the four-month MSc thesis focuses on scientific aspects of their training.

4.1.4 Master of Science in Spatial Development and Infrastructure Systems

This specialised Master's programme is open to students from across the engineering and social sciences spectrum and aims to give them a common language and understanding of these two fields. The programme is comprised of three required courses and a joint professional team project in the third term, which is expected to address current large-scale planning issues.

The courses are offered in the main by the IVT and the Institute of Spatial Development, but the students may choose from a wide-ranging list of approved electives in the fields of architecture, economics, mathematics and statistics, and they are encouraged to do so.

The students can either focus on one area, spatial development or transport engineering, or mix the two to give themselves a unique profile.

4.1.5 Diploma of Advanced Studies (DAS) in Transport Engineering

The DAS is an extension course worth 40 ETCS credits, comprising six five-credit modules and a ten-credit thesis. Each module requires five days in Zürich and a substantial amount of coursework. The course is intended for professionals who wish to expand their knowledge of and expertise in transport engineering. It entails a two-year commitment and is designed to allow students to combine it with their work schedules.

The modules are taught in German by members of the institute as well as by colleagues from the wider German-speaking area. Each module may also be taken separately by non-DAS students.

Table 3 DAS in Transport Engineering: Modules

Lecturer	Topic	Status
Axhausen and Friedrich, University of Stuttgart	Transport Planning	Required
Fellendorf, TU Graz	Traffic Engineering	Required
Weidmann	Public Transport Design and Operations	Required
Axhausen and Hess, ITS Leeds	Choice Modelling	Required
Friedrich, University of Stuttgart	Aggregate Demand Modelling	Elective
Lieb, ecoplan	Evaluation Methods	Elective
Menendez	Traffic Flow and Operations	Elective
Axhausen and Hess, ITS Leeds	Survey Methods	Elective
All	Thesis work	Required

4.2 Approach and strategy

The IVT had four chairs at the beginning of the 1990s, as mentioned above. Current IVT staffing clearly does not allow us to **teach transport and land-use planning** to the same extent as in previous years. Still, it is the ambition of the IVT to offer its students a broad and thorough education as they train to become system-aware and system-designing transport engineers. Our strong research base enables us to advance the field and its sub-fields, especially through the education of PhD-trained engineers and scientists.

Table 4 Supervision of dissertations

Degrees awarded	Year									
	99–03	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**04–11**
PhD dissertations	5	6	1	1	1	4	3	3	3	**22**
IVT members	2	6	1	1	1	4	3	2	3	**21**
External students	3	-	-	-	-	-	-	1	-	**1**
External examiner	6	3	7	6	-	2	6	6	7	**37**
MSc theses	65	14	8	13	12	7	4	10	13	**81**
D-BAUG students	34	6	6	8	11	5	3	10	12	**61**
Other ETH students	24	6	-	2	1	-	-	-	-	**9**
External students	7	2	2	3	-	2	1	-	1	**11**
MSc semester projects	65	30	9	12	15	19	34	29	5	**153**
D-BAUG students	61	20	9	12	15	19	34	29	5	**143**
Other ETH students	3	3								**3**
External students	1	7								**7**
D-BAUG Bachelor's degree theses		-	-	5	8	13	12	8	9	**55**

The overall goals of the IVT are: to further enhance its academic strengths and visibility both nationally and internationally based on the current thrusts of its groups; to maintain and extend its strong links and working relationships with policy makers and industry; and finally to make better known that the IVT offers a teaching programme that fulfils the requirements for a "Master of Science in Transport Engineering" degree within the department.

The IVT has always offered a strong selection of courses covering the core elements of transport engineering. The retirement of Prof. Lindenmann and Prof. Spacek gave us the opportunity to rethink our programme in light of any gaps and with regard to Dr. Menendez' interests and strengths. Prof. Aday, IBI, will henceforth teach road maintenance as it falls into his area of expertise, namely infrastructure management.

Starting in 2012, a set of additional courses jointly offered by IVT faculty and external lecturers will enrich the curriculum. A new course on walking and cycling will raise the profile of these important modes. The newly designed course on traffic safety will strengthen the teaching of safety statistics while maintaining engineering aspects in the tradition of the safety audit developed by Prof. Lindenmann.

Traffic engineering will be covered by four courses: an introductory BSc course followed by an advanced MSc course and parts of two jointly taught courses, "Transport Systems" and "Simulation of Transport Systems". A further course on agent-based simulation will give senior assistants a chance to develop their teaching skills and also reflects the institute's strong commitment to this topic. For the full list of courses see below:

Table 5 **Current and planned courses**

Level	Term	ETCS	Title	Lecturer	Status
BSc	4	3	Transport planning	kwa	Ongoing
BSc	4	2	Laboratory "Space and Transport"	Fröhlich	Ongoing
BSc	5	3	Railway infrastructure	wei	Ongoing
BSc	6	3	Road traffic systems	mm	Updated
MSc	1	6	Transport systems	kwa, wei, mm	Ongoing
MSc	1	6	System and network design	wei	Ongoing
MSc	1	6	Transport planning methods	kwa	Ongoing
MSc	1	6	Traffic engineering and management systems	mm	New
MSc	2	6	System design and capacity	wei	Ongoing
MSc	2	6	Simulation of transport systems	Balmer, wei, mm	Ongoing
MSc	2	6	Measurement and modelling of travel behaviour	kwa	Ongoing
MSc	2	6	Road design and construction	Müller	Updated
MSc	2	6	Slow modes	wei, kwa	New
MSc	2	6	Logistics and freight transport	db	Updated
MSc	3	6	Agent-based simulation	dc, nr, kwa	New
MSc	3	6	Systems operation, marketing and quality	wei	Ongoing
MSc	3	6	Safety and reliability of railway operations	wei, Montigel	New
MSc	3	6	Railway infrastructure design	N.N.	New
MSc	3	6	Transport system concepts	kwa	Ongoing
MSc	3	6	Transport safety	Leemann, Simma	Updated
MSc	3	6	Environmental impacts of transport systems	N.N.	New

kwa: Axhausen, dc: Charypar, mm: Menendez, nr: Rieser, wei: Weidmann

We intend to maintain our current MSc course design, offering fewer but substantial courses. The experience of the past years has shown that this combination of classroom teaching with substantial course work enables students to acquire in-depth knowledge and practical experience. The equally positive experience with our co-taught courses "Transport Systems" and "Simulation" has encouraged us to offer new courses ("Slow Modes" and "Agent-Based Modelling") in the same style.

4.2.1 Traffic Engineering

Courses offered (or partially covered) by the Traffic Engineering Research Group teach students fundamental concepts of road traffic design, safety, operations, management and control. The existing courses were inherited from the Individual Transport group (led by Prof. Lindenmann and Prof. Spacek). We are now in the process of updating them to fit the specific teaching goals of the Traffic Engineering group while maintaining the same standards of quality as before.

Prof. Lindenmann and Prof. Spacek provided their own textbooks for the lectures (i.e., scripts). The scripts are completely in German and are still being used in some of the courses. New and supplementary presentations, articles and sets of exercises have been developed to support new content included in the classes.

Our objective, as explained above, is to continue enriching our teaching curriculum over the next few years. This includes providing a more global perspective, information on new technology and its use in traffic management and control, as well as examples of direct applications of the latest transportation research in the practical arena.

Other goals include the supervision of Master's projects and theses in the area of traffic engineering. These could support some of our current projects or expand the number of topics we currently cover. In addition, students' work could promote our research interests among ETH students, becoming in turn a potentially valuable recruiting tool for PhD candidates.

Dr. Menendez currently shares the task of supervising PhD dissertations with Prof. Axhausen due to the current legal limitations associated with her position. There are currently four PhD students enrolled and pursuing research in traffic engineering. Since the group is new, it will take time for the first dissertation to be finished.

Table 6 **Teaching: Traffic Engineering Research Group**

Teaching	05	06	07	08	09	10	11
Courses *(no.)*							4
Semester hours *(SWS)*							9
Bachelor's thesis *(no.)*							
Diploma/MSc semester projects *(no.)*							
Diploma/Master's thesis *(no.)*							
Dissertations *(no.)*							

4.2.2 Transport Systems

Courses taught by the Transport Systems group provide students with the fundamental concepts of transportation systems, placing special emphases on rail- and road-borne public transport systems as well as on freight transport. The chair aims to foster a holistic and customer-oriented view of transportation. Therefore, our lectures follow the life cycle of transport systems including the main phases of (1) system design, (2) system dimensioning, (3) infrastructure planning and construction, and (4) operations and management. Strong attention is given to regulation, organisation and marketing.

The curriculum has been substantially expanded over the past years:

Table 7 Teaching: Transport Systems Chair

Teaching	05	06	07	08	09	10	11
Courses *(no.)*	5	2	5	7	7	8	8
Semester hours *(SWS)*	9	4	15	21	20	23	23
Student SWS							
Bachelor's thesis *(no.)*		3	6	12	12	8	9
Diploma/MSc semester projects *(no.)*	7	10	2	0	6	7	4
Diploma/Master's thesis *(no.)*	5	5	7	3	3	8	9
Dissertations *(no.)*	0	0	0	0	2	1	0

To deepen the students' knowledge of railway technology, an additional lecture in railway construction is being planned for the Master's level. Until now, the planning and construction of rail infrastructure have only been dealt with at the Bachelor's level. However, this has resulted in an unbalanced situation, as planning and operational matters are broadly discussed at the Master's level.

Textbooks (scripts) have been written for all lectures, now totalling 12 volumes of around 2,500 pages. These textbooks are essential because (1) standard textbooks cover only parts of the lecture content; (2) only local, customised textbooks allow us to thoroughly follow the key ideas of the syllabus; and (3) local textbooks can easily be adjusted to cover new knowledge and needs. The following table shows the structure of the textbooks and their main chapters:

Table 8 Content of the Transport Systems textbooks

Block	Volume	Content
1	1.1	Fundamentals of Public Transport, Public Transport Systems and the Planning Process
	1.2	Design of Public Transport Systems at the National, Regional and Urban Levels
	1.3	Freight Transport and Logistics; Intermodality
2	2.1	Fundamentals of Production Planning; Running and Stopping Times; Choice and Deployment of Vehicles and Staff
	2.2	Vehicle Strategies and Concepts; Traction; Energy Supply and Application; Running Time Calculation
	2.3	Fundamentals of Infrastructure Capacity; Capacity of Lines and Nodes
3	3.1	Fundamentals of Rail Infrastructure; Network Planning
	3.2	Design of Railway Lines and Nodes; Passenger Facilities
	3.3	Railway Construction; Track Technology, Putting Infrastructure into Operation; Maintenance
4	4.1	Management of Public Transport Companies; Regulation of the Sector
	4.2	Marketing and Quality Management
	4.3	Railway Safety; Dispatching; Automatic Operation of Trains and Infrastructure

As the lectures are given in German, all of the textbooks are in German. Even if the Master's courses should be changed to English, the textbooks would still be in German because a high-quality translation would be prohibitively time-consuming and expensive. German-speaking students would then be provided with the correct technical terms in their own language. We plan to publish at least some of the textbooks in a professional edition. The first book, on pedestrian transportation, should appear in 2012.

All of the lectures are additionally supported by comprehensive presentations, comprising around 5,000 slides. These presentations are also available to the students in order to provide them with additional information and to ease exam preparation. If the Master's courses change to English, all of the slides will be translated.

Table 9 Topics of recent Transport Systems theses

Students theses	Course/term	General aims	Examples of topics
Project	CE / 2nd sem.	Introduction to Public Transport	Strengths and weaknesses of public transport from personal experience Reproduction of the transport chain for the ETH cafeteria
Bachelor's thesis	CE / 6th sem.	Design of a Complex Public Transport Infrastructure	New tramway line to the ETH Hönggerberg campus Planning/ Design of the transport node Zürich-Örlikon Design of MAGLEV Transrapid lines Zürich-Bern / -Basel Upgrading the Zürich – Meilen – Rapperswil S-Bahn line New railway line from Zug to Oberägeri
Semester thesis, Master's programme	CE / 2nd or 3rd sem.	Challenging planning project or complex topic out of production planning	Productivity advantages of longer and heavier freight trains Monorail link for Kriens Use of cable cars in urban transportation Detour routes for freight trains to release capacity Design of Lake Geneva commuter boat service between F–CH
Master's thesis	CE and SD&IS / 4th sem.	Scientific question with real-world applications	Potential of tilting trains on the Swiss railway network Rail-connected demand systems for regional and tourist infrastructure provision Productivity enhancements in Swiss wagonload transport Pedestrian ways in the public transport system and their optimisation Influence of the vehicle fleet on asset maintenance needs

CE: Civil Engineering; SD&IS: Spatial development and infrastructure systems

In the future, there will be even more presentations of external real-world projects by project staff, as well as more site visits. Given our numerous ongoing projects on the Swiss rail network and the close contact of the chair with the industry, there will be plenty of opportunities.

4.2.3 Transport Planning

Our teaching approach has stayed unchanged for the BSc/MSc programmes. We offer a cycle of four lecture courses covering transport planning methods (introductory and advanced), survey methods and choice modelling, and project evaluation. The cycle is supplemented by contributions to the institute's courses on transport systems, simulation, and slow modes, and by a lab class that focuses on the standard four-step process.

In recent years, we have increased the programming and quantitative elements of the coursework to better prepare the students for the demands of current practice. We hope that we can enrich this element further through collaboration with other interested colleagues.

The chair designed and is co-ordinating a new Diploma of Advanced Studies (DAS) course in traffic engineering and transport planning (see http://www.ivt.ethz.ch/advancedstudies/das/index). The further education modules offered by the chair are now integrated into a larger whole with contributions from the other IVT groups and colleagues from elsewhere in the German-speaking world. In 2011, the DAS started successfully with seven students in its first cycle, which we hope to increase to 12–15 students in future biannual cycles. The DAS will fill a gap in the German-speaking academic world, as further training in this area has never offered before.

Table 10 Teaching: Transport Planning

Teaching	05	06	07	08	09	10	11
Courses (no.)	5	5	5	6	6	7	7
Semester hours (SWS)							
Student ETC							
Bachelor's thesis (no.)				1			
Diploma/MSc semester projects (no.)	4	1	1	2	1	4	
Diploma/Master's thesis (no.)	3	5	2	2	1		5
Dissertations (no.)	1	1	2	4	2	5	3

4.2.4 Transport Systems–Motorized Transport

Table 11 Teaching: Transport Systems–Motorized Transport Group

Teaching	05	06	07	08	09	10	11
Courses (no.)	8	5	6	6	7	7	3
Semester hours (SWS)	13	10	19	19	21	21	7
Bachelor's thesis (no.)							
Diploma/MSc semester projects (no.)			2	2	21		
Diploma/Master's thesis (no.)				2			1
Dissertations (no.)							1

4.3 Current courses

The IVT currently offers the following courses, in order of the semesters they are taught in:

101-0510-00L 3 ETCS Müller	**First year project: Multi-agent simulation in transportation planning** A transport planning project is designed, simulated and analysed using MATSim-T, focusing on interrelationships between infrastructure, mobility requirements and individual preferences.
101-0414-00L 2 ETCS Vrtic, Jäggi	**Transport planning** Basic theoretical links between transport, space and economic development; basic terminology; measurement and observation of travel behaviour; methods of the four-stage approach; cost-benefit analysis.
101-0478-00L 2 ETCS Fröhlich, Vitins	**Laboratory on transport and spatial planning** This laboratory is a supplement to the lectures of the associated module. Using a small-scale example, the students implement a four-stage travel demand model and test different policy scenarios.
101-0415-01L 3 ETCS Weidmann, Höppner, Orth, Schranil	**Railway infrastructure** Fundamentals of railroad technology and interactions between tracks and vehicles; network development and infrastructure planning; planning of rail infrastructure and public transport infrastructure in roadways; planning and design of railway stations; construction and design of tracks; approval and beginning service on complex infrastructure facilities; maintenance under operation.
101-0416-00L 6 ETCS Lindenmann, Spacek, Menendez	**Introduction to road transport systems** Understanding the basic principles of individual transport system network design, operations, capacity choice and construction, as well as the maintenance of infrastructure and systems.
101-0467-01L 6 ETCS Axhausen, Weidmann, Menendez, Vitins, Carrasco	**Transport systems** Introduction to the basic principles of the design and operation of transport systems (road, rail, air) and the essential pathways of their impacts (investment, generalised costs, accessibilities, external effects).
101-0417-00L 6 ETCS Axhausen, Charypar, Märki	**Transport planning methods** Traffic generation; trip distribution and methods of updating; assignment (shortest paths, data and applications, dynamic assignment); choices and risks; discrete choice methods; rule-based systems; applications; iterative procedures; equilibrium.
101-0427-01L 6 ETCS Weidmann, Barth	**System and network planning** Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them.
101-0437-00L 6 ETCS Menendez, Ortigosa	**Traffic engineering and management systems** Fundamentals of traffic flow theory and operations; traffic control systems and parking management; Intelligent Transportation Systems (ITS) and telematics.

101-0428-00L
6 ETCS
Lindenmann, Spacek, Santel, Schiffmann

Highway design and construction
Knowledge and application of the basics and connections of geometric highway design; identification of construction risks; road construction and cross-section choice, including drainage systems; principles and certification of safety and serviceability.

101-0509-00L
3 ETCS
Adey, Schiffmann, Lethanh

Infrastructure management II
Knowledge and application of the basics and connections of geometric highway design; identification of construction risks; road construction and cross-section choice, including drainage systems; principles and certification of safety and serviceability.

701-0966-00L
6 ETCS
Axhausen, Hess, Kowald

Measurement and modelling of travel behaviour
Behavioural modelling and measurement; travel diaries; design processes; hypothetical markets; discrete choice models; hazard models; parameter estimation; patterns of travel behaviour; market segments; simulation.

101-0418-02L
6 ETCS
Weidmann, Frank

System design and capacity
Students will develop an understanding of all resources needed to produce market-oriented public passenger transport services, both on the train side as well as on the infrastructure side. They will acquire a general understanding of the trade-offs between the different resources involved, and they will be able to make use of the dedicated methods of resource design. They will learn the basic principles of traction technology.

101-0438-00L
6 ETCS
Weidmann, Balmer, Menendez, Höppner, Kirsch

Simulation of transport systems
Developing a basic knowledge of transport simulation methods, including transport demand, service supply, modelling transport facilities, facility design, facility performance and simulation quality control. Recognising the appropriate type of simulation model to apply and understanding the limitations of current simulation tools.

101-0439-00L
6 ETCS
Axhausen, Zöllig

Transport systems evaluation
The course presents cost-benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

101-0459-00L
6 ETCS
Weidmann, Fink

Management, marketing, quality
Comprehension of transport and administrative policy as well as the regulation of public transport companies. Students develop a full understanding of the three important public transport system operations management processes: (1) business management; (2) marketing; (3) quality control. The course will teach essential work techniques in each of these processes.

101-0479-00G
6 ETCS
Weidmann, Montigel, Fink

Safety and reliability of railway systems
Students learn to comprehend the main principles of safety and reliability for railway systems and to understand the basic concepts of command and control technologies for railways.

101-0459-00L
6 ETCS
Wichser, Moll

Logistics and freight traffic
Students learn to recognise and understand the relationships between logistics, market demand, service offers and operating processes in freight traffic for all means of transport (road, rail, combined traffic, sea and air).

101-0469-00L
6 ETCS
Simma, Leemann

Road transport safety
Introduction to the basics of road traffic safety with respect to design and statistics; safety audits.

4.4 BSc and MSc theses 2011

Table 12

Name	First name	Title	Supervising tutors
Projects 2nd sem.			
Schlatter	Christian	Determination of an adequate infrastructure for the operation of museum railways on the example of the Steam Railway Association Zürcher Oberland (DVZO)	Weidmann/Bopp, Wichser
Projects 3rd sem.			
Bäritswyl	Vincent	Prospects of a connected narrow gauge net between Les Brenets and Delémont	Rieder/Bopp
Bachelor's theses			
Eckenstein Furter Iten Künzli Kyburz Naef Schmid Sigrist Waldis	Daniel Christine Alex Olivia David Stefan Matthias Manuel Severin	Feasibility study for a road-independent public transport system Zug–Oberägeri (Machbarkeitsstudie für einen strassenunabhängigen öffentlichen Verkehr Zug–Oberägeri	Weidmann / Barth, Nägeli, Rieder
Projects 8th sem.			
Länzlinger	Daniel	Validation of a simplified approach to assess capacity of existing railway networks	Weidmann/Frank
Zündorf	Deborah	Einsatzbereiche von Bedarfsverkehrssystemen in der Schweiz	Weidmann/ Dorbritz
Projects 9th sem.			
Haas	Rafael	Schedule systematisation, operations and infrastructure concept for the Tösstal line (Angebotssystematisierung auf der Tösstalstrecke sowie Betriebs- und Infrastrukturkonzept)	Weidmann/ Schranil

Table 11 (continued)

Name	First name	Title	Supervising tutors
Master's theses			
Arnold	Tobias	Operational ability of different train concepts für commuter railway systems (Betriebliche Eignung unterschiedlicher Fahrzeugkonzepte in S-Bahn-Systemen – Untersuchung der Einflüsse auf die Streckenleistungsfähigkeit)	Weidmann/Frank, Kirsch
Birchmeier	Urs	Objectivisation supplements in the Swiss public transport tariff system (Objektivierung der Distanzzuschläge im Tarifsystem des öffentlichen Verkehrs der Schweiz)	Weidmann/Barth, Rieder
Dubernet	Thibaut	Introducing joint trips in a multi-agent transport simulation: From agents to clique replanning	Axhausen/Ciari
Ganitta	Ulrich	Gemeinschaftliches Wohnen ohne eigenes Auto – Haushaltsbefragung der ersten autofreien Siedlung in Bern	Weidmann/ Schirmer
Haas	Rafael	Dispatching concepts in case of rail operation disturbances (Dispositionskonzepte bei Bahnbetriebsstörungen)	Weidmann/ Schranil
Hirzel	Daniel	Erschliessung der Tourismusdestination Andermatt	Weidmann/Nägeli
Lehner	Manuel	Modelling housing prices in Singapore applying spatial hedonic regression	Axhausen/ van Eggermond, Erath
Mezdani	Youssef	Optimal tolls based on an agent-based model of travel demand	Axhausen/ Bierlaire/Flötterod, Erath,
Podstransky	Pascal	Zusammenhänge der Textur und Griffigkeit von Fahrbahnen und Einflüsse auf die Belagslärmemission	Lindenmann, Spacek/Baumgartner, Leemann, Schiffmann
Rauchenstein	Armin	Erhebung von Leistungsdaten im Bereich der Reinigung und des Winterdienstes am Beispiel der Stadt Zürich	Girmscheid/Koller, Schiffmann
Schorer	Olivier	System optimisation of the projected high-speed line "High Speed 2" in Great Britain (Optimisation du système de la ligne à grande vitesse projetée "High Speed 2" en Grande-Bretagne)	Weidmann/Barth
Sorg	David	BRT systems and beyond: Exploring the limits of a popular and rapidly growing urban transport system	Weidmann/ Carrasco
Steinle	Michael	Freizeitverkehr an Alpenpässen, Stated Preference-Befragung zu Steuerungsmöglichkeiten	Axhausen/Bodenmann
Wanner	Mathias	System analysis and improvement of urban bus services in Lucerne's central district.	Weidmann/ Carrasco
Zimmermann	Roman	Theoretical model for the estimation of the influence of a train run on the lateral track displacement in tight radii with continuously welded track	Weidmann/Bopp, Wicher

Photo: Lina Meisen

5 Selected research projects

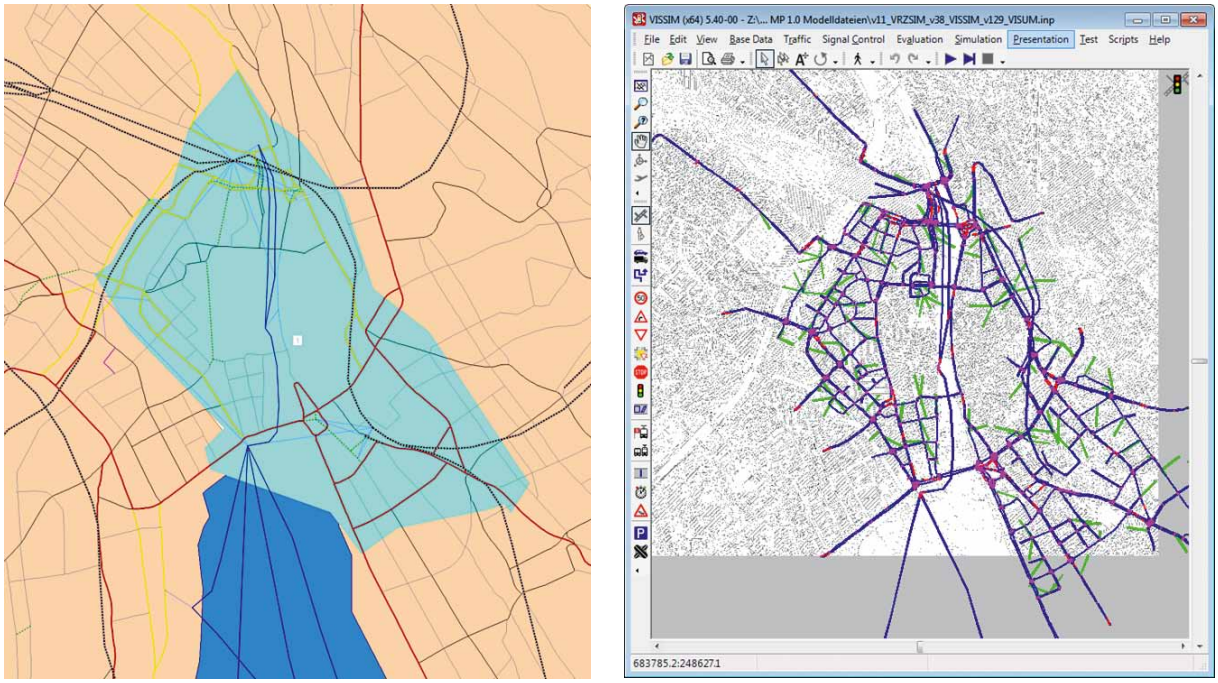
5.1 Traffic Engineering

5.1.1 Calibration study for VISSIM

Since July 2011, we have been involved in the cooperative project "Calibration Study for VISSIM" together with the Modelling and Simulation group from the Division of Transport of the City of Zürich.

The City of Zürich recently acquired "Verkehr In Städten—SIMulationsmodell" (VISSIM), a microscopic multi-modal traffic-flow simulation software, to effectively model traffic within the city. VISSIM is a widely used simulation software with many applications and high potential. However, like other commercial microscopic traffic simulation software, VISSIM has a very large number of input parameters, which makes the process of calibration rather difficult. In addition, the spatial scope of the network to be modelled is quite large, as even the initial network encompasses the inner city of Zürich (a complex urban layout with narrow streets, hills, mixed transportation modes, a large number of pedestrians, an adaptive signal control system, etc.).

Figure 5 **Study area**



a) Study area of the CSV project
Source: City of Zürich (2011)

b) Network of the study area in VISSIM

The object of this CSV project is to optimise the calibration process so that the City of Zürich can calibrate the VISSIM model in the most efficient way, tailored to its specific needs and requirements. The project has been divided into three phases:

Phase 1: Introduction. This phase includes familiarisation with and evaluation of software functions and capabilities, research and investigation of city characteristics for software implementation, and a review of different calibration procedures (advantages and drawbacks) from the literature.

Phase 2: Sensitivity analysis. This includes the selection of parameters for the subsequent calibration. It starts with the qualitative understanding and preliminary identification of the parameters relevant to

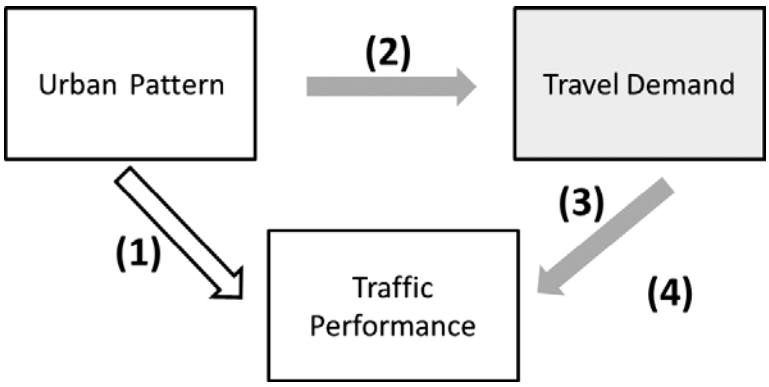
Zürich's inner-city traffic conditions and other characteristics. Further selection of the parameters is performed based on a review of the existing literature, common sense and our own experience. Quantitative analysis, including the evaluation and screening of selected parameters through sensitivity analysis (based on the Elementary Effects [EE] Method) is carried out in the final step. In order to improve the computational efficiency of the EE method, the Optimised Trajectories (OT) approach is used. Additional improvements have been obtained through a new modification, the quasi-OT approach (methodology developed within the context of this project) to further reduce the calculation time requirements. During this phase, the number of parameters for calibration has been reduced from 192 to five.

Phase 3: Calibration. This phase, performed in conjunction with personnel from the Division of Transport of the City of Zürich, uses real data to calibrate the model. Travel time measurement from GPS data and traffic volumes from loop detectors are employed in the calibration and validation of the model.

5.1.2 Urban patterns and traffic performance (UNIFORM)

Many recent studies have linked the geometric properties of urban networks to travel magnitudes (e.g., distance travelled, number of trips). They support the idea that urban patterns affect travel demand (figure 6, interaction 2). We believe, however, that urban patterns influence not only demand, but also traffic performance (interaction 1). The set of interactions is rather complex, as higher travel demand evidently translates into more cars on the streets, which in turn affects traffic performance (interaction 3). The opposite direction is valid too; the level of traffic performance might encourage (or discourage) people to use cars (interaction 4).

Figure 6 General interactions between urban patterns, travel demand and traffic performance



Source: City of Zürich (2011)

The purpose of this research is to assess the ability of a city to cope with traffic based on its urban patterns (interaction 1). Strategies for designing a sustainable city vary greatly among traffic engineers, transport planners, urban planners and architects. The proposed research seeks to integrate these different views.

We aim to develop some analytical formulations and numerical examples linking the static properties of networks (urban pattern descriptors for abstract networks) to the dynamic properties of traffic (traffic performance indicators). The transferability of these results to real cities will be evaluated in at least one case study (the city of Zürich). The idea is to reduce the complexity of the real network to the point that it will be possible to quantify its properties using the analytical formulations and numerical methods mentioned above. The results of this research are expected to influence the design of new cities and to support traffic management strategies for existing ones.

5.2 Transport Systems

5.2.1 Differences in the cognition of public transport systems: Does public image shape public behaviour towards urban public transport?

Different types of public transport systems have differential effects on demand. Light rail and tram services especially are credited with attracting more passengers than other modes under equal service conditions. This claim, known as the "rail factor", was the main impetus behind this research project. As there is hardly any evidence to support the existence of the rail factor in urban conditions and very little is known about factors leading to such an effect, this study is of special interest for transport policy.

To explain the assumed rail factor, our research question focused on the relationship between bus and tram system attributes and stakeholders' related perception of and reaction to these attributes. Therefore, the following issues were addressed:

1. Bus and tram system attributes: The relevant system attributes were identified and differences between bus and tram attributes were quantified.

2. The perception of system attributes by various stakeholders: Stakeholders of interest were identified and their perception of public transport systems and individual system attributes were investigated. The stakeholders included active public transport users as well as potential users among residents who lived close to stops. Different economic and psychological concepts were analysed and discussed to determine appropriate methods of measuring the stakeholders' perception of bus and tram services.

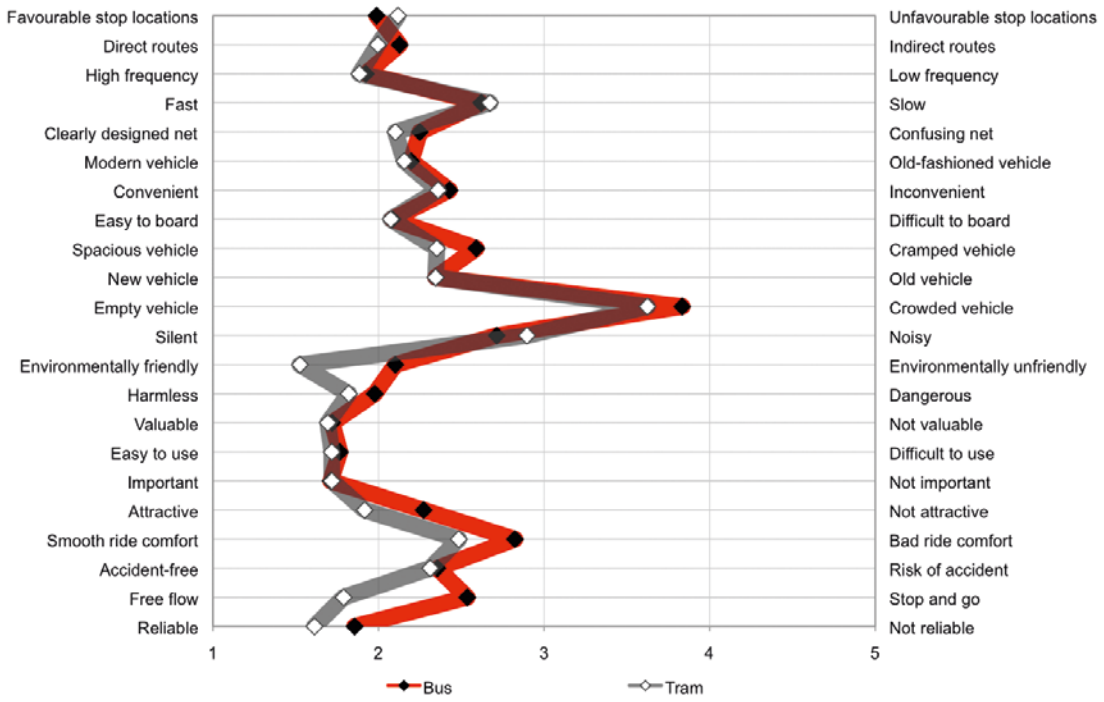
3. The mode choice behaviour of various stakeholders: Mode choice was analysed as a factor of public transport demand with reference to the availability of buses and trams.

Our in-depth analysis of the images of bus and tram services involved measuring the semantic differential to identify differences between ratings of bus and tram attributes. It was found that the general perceived images of buses and trams were surprisingly similar (compare figure 7). Differences increased with higher frequency of public transport use. To identify the impact of experience, images were compared according to the respondents' place of residence. The image of bus service was consistent across all three samples interviewed in the cities of Bern, Lucerne and Zürich. In contrast, the image of tram service varied widely. Moreover, inhabitants of cities with trams had a more positive image of trams than of buses, whereas inhabitants of a city served only by buses showed better ratings for buses than for trams.

A comparison of revealed mode choice behaviour in bus and tram corridors with equal public transport service characteristics showed no significant differences for commuting trips. It is assumed that aspects other than the public transport system itself were more important for mode choice decisions.

The assumption that different public transport systems cause differential effects on public transport demand is not supported by this research in Switzerland. Under the precondition that buses and trams are treated equally by traffic laws, a bus system can theoretically attract the same ridership as trams given the same service conditions. Thus, ridership numbers are limited by the capacity of vehicles and by the frequency of service.

Figure 7 General image of bus and tram services: Overview



5.2.2 A method for the comparison of railway operating processes

Railway network operations require comprehensive and precise rules, directives and guidelines. The operational framework of the Swiss railways is mostly given by the Operating Regulations (Fahrdienstvorschriften: FDV) issued by the Swiss Federal Office of Transport (FOT/BAV). These must be updated regularly, following the needs of railway production and amendments to the regulations. At present, the European Railway Agency is attempting to standardise the operational rules of all European railway networks through its Technical Specifications for Interoperability (TSIs). In accordance with transportation treaties between Switzerland and the EU, the TSIs must be integrated into pertinent Swiss rules, including the Operational Regulations.

Adapting Swiss rules to the European TSIs is not trivial, and TSI contents cannot simply be transferred directly. Barriers against this include the different languages, different meanings of terms, different ranges of regulation, diverging structures of the rules in general and, last but not least, different ways to run a railway. Therefore, it was necessary to develop a method by which directives could be compared and adapted in a structured and transparent way. In this project, the IVT framed a method that takes all of the above-mentioned barriers into consideration.

The method was produced iteratively together with the Swiss Federal Office of Transport and was redesigned several times over the course of its development. Although it was created specifically for the comparison of the TSIs and the Swiss Operating Regulations, it is also applicable to other purposes, even in non-railway sectors.

The method comprises five main steps (see figure 8): (1) clarifying the initial conditions; (2) determining the general structure, (3) working out the detailed structure; (4) adjusting each regulation as needed; and (5) the final check. The main features will be explained in brief:

The editors start by clarifying the initial conditions in order to examine their own state of knowledge, check each of the guidelines for consistency, fix the direction of transfer by defining the main document, and specify the glossaries.

After that, the general structure is determined. This entails defining the geographical framework and fixing both the time range of validity and the overall content for each guideline. The main work in this step consists of structuring the content according to general lists without analysing the texts in detail. The main aim here is to develop a new general structure as a foundation for content translation and adaptation.

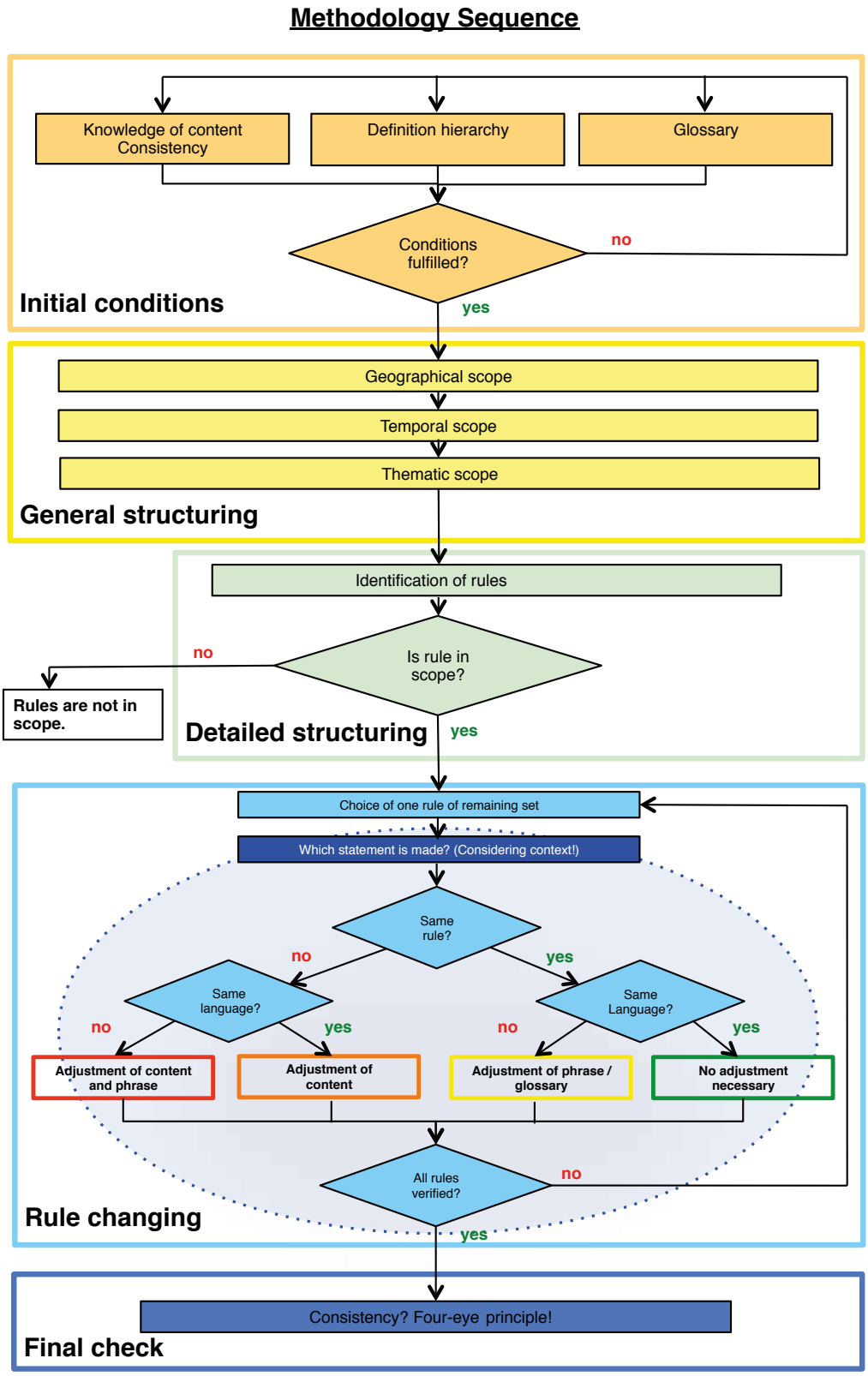
Then the detailed structure is worked out by scrutinising every rule and its requirements. The result is a detailed overview of all the rules that must be considered in the adjustment process.

The next labour-intensive step involves rule changing. Every single group of rules defined in the previous detailed structuring step must be compared. Upon comparison, the editor will have four choices: (1) changing content and phrasing, (2) changing content only, (3) changing phrasing only or (4) doing nothing in the case of matching rules.

Finally, the revised guidelines must be read by a second person, who was not involved in the work before (following the four-eye principle) in order to examine the rules for correctness and consistency.

In summary, the method is a top-down approach that systematically enriches and deepens the content. By grouping the rules, editors are easily able to recognize differences between guidelines regarding content, language and message. This method helps to merge rules from directives and laws of mostly different structures, ranges of regulation and backgrounds.

Figure 8 Overview of the approach

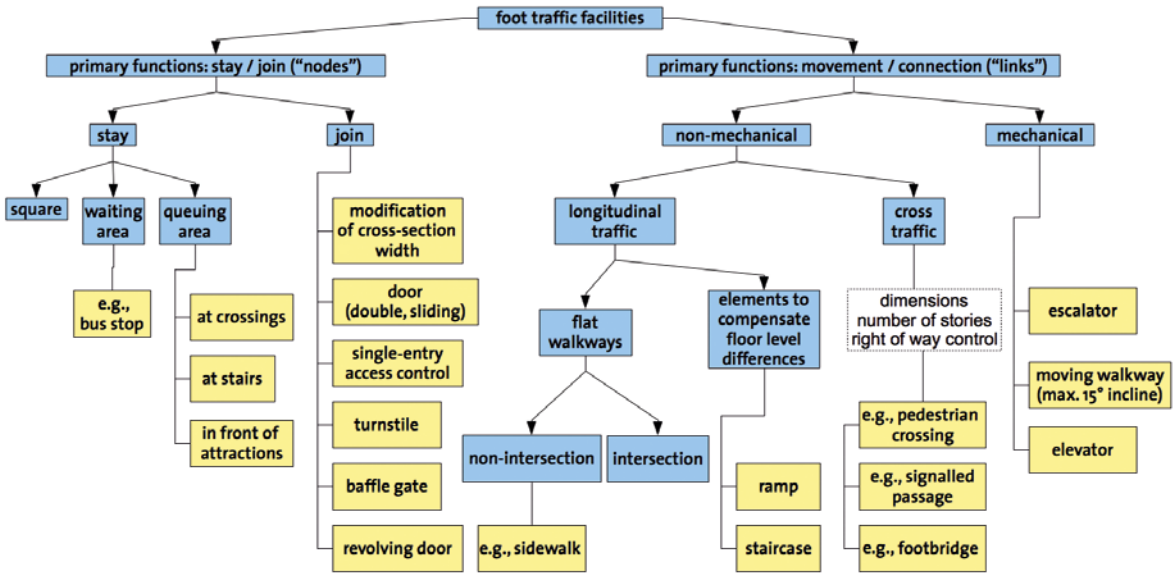


5.2.3 Performance and level of service of facilities for human-powered land transport

Until recently, Swiss industrial standards— in the sense of technical design guidelines—within the transport sector have only been used or introduced for motorised vehicles. Therefore, the Association of Swiss Highway Engineers (Vereinigung Schweizer Strassenfachleute: VSS) initiated a research project to address the need for corresponding technical guidelines dealing with facilities which are used only by pedestrians or cyclists or both.

We are currently carrying out this study in cooperation with an external project partner that specialises in cycle traffic. The goal of this project is to investigate the parameters and relevant factors for the level of service as well as the performance and capacity of such traffic facilities. Eventually, these investigations will support the development of an overall evaluation procedure which is capable of assessing the performance of traffic facilities such as road and street segments, crossroads, etc. The preparatory work for this final step involves identifying the relevant parameters for all design elements of the transport network, including public transit and motorised as well as non-motorised individual transport modes.

Figure 9 Foot traffic facilities (top) and a microsimulation of a signalised pedestrian crossing (bottom)



Developing a generic system overview of all pedestrian facilities has been the starting point of this project. Figure 9 (top) shows the categorisation of the basic design elements that form a pedestrian network. The main distinctions have been made based on the primary function of the corresponding elements, i.e., whether they are used as nodes or links. Squares play a bit of an ambiguous role in this system. Various methods are being employed to generate the data needed to prepare future Swiss standards documents on human-powered land transport.

Several facilities and their parameters have already been well documented in scientific literature in Switzerland, other European countries and elsewhere in the world, but these have not yet been translated into easily applicable standards. In those cases, the relevant information must be extracted and condensed to a standard-ready format after being double-checked for general correctness and suitability according to the system of basic network elements. Foreign data must be validated for traffic situations typically observed in Switzerland. To achieve this as well as to obtain data on design elements for which there is no, very little or uncertain information, real-world observations and microsimulation studies are being undertaken (figure 9, bottom). Pedestrian data has been collected on the movement of people on heavily used escalators (Zürich, main train station) and at strongly frequented signalised pedestrian crossings (downtown Zürich). Further observations will include high-performance elevator installations (Bern, main station). Later on, different load scenarios can be efficiently analysed using microsimulation tools for pedestrian flows. Compared to real-world observations, changes within the infrastructure environment can be modelled relatively easily and subsequently evaluated with respect to performance and level of service.

5.2.4 "Stabil Mobil" Conference

In June 2011, the third interdisciplinary all-day symposium "Stabil Mobil—Stability of Public Transport Networks" took place at the ETH Science City campus. Like previous events in the "Society—Mobility—Technology" conference series, the conference was organised by an interdisciplinary committee of transport engineers from the Institute for Transport Planning and Systems (IVT, ETH Zürich) and historians from the Institute for Economic History (FSW, University of Zürich). The series started in 2007 and has included three events.

The first event, "Is There a Future for High-Speed Rail?", took place in June 2007 and focused on challenges for and the history of high-speed railway operations. The programme attracted over 130 participants and took place at the ETH Zürich.

In June 2009, the second event, "Automation and Transport", took place at the University of Zürich, analysing the history of transport automation as well as current and future conditions and how they relate to social, economic and technical conditions since the 1950s. About 110 persons attended.

For the third event, Urs B. Wili of Furrer+Frey AG joined the organisational committee. The organisers decided to focus on the stability of public transport systems, which is a matter of great recent importance. On the one hand, the development and availability of automation techniques and their integration into public transport operations increases systems' ability to cope with increasing transport demands. On the other hand, the stability of transport systems is challenged by various events that could turn stable systems into unstable ones, threatening not only service quality but also its availability.

The conference started with a review of the history and characteristics of large-scale transport systems, with an emphasis on stability aspects. The second part analysed recent challenges in the field of complex public transport networks. The third part highlighted future developments and potential solutions for improving the stability of public transport networks in order to address future transport capacity problems. A final panel discussion included video input and gave the audience the opportunity to discuss with the speakers (see figure 10).

The event "Stabil Mobil—Stability of Public Transport Networks" attracted about 140 experts from politics, the transport engineering industry, government, universities and the media, who engaged in an interdisciplinary debate on transport issues. Attendees agreed that the conference series provides an excellent opportunity to exchange and discuss information on highly relevant topics and enables participants to think outside their normal specialities. Due to the positive feedback of the participants, the conference series will be continued in 2013.

Figure 10 Impression of the final discussion in the afternoon

Panellists (from left to right): Joos Bernhard (DAV Zürich), Renate Mayntz (Max Planck Institute for the Study of Societies), Gian-Mattia Schucan (SBB AG), Anita Schöbel (University of Göttingen), Fritz Busch (Technical University Munich)

5.3 Transport Planning

5.3.1 Assessment of induced travel demand

Induced travel demand, a phenomenon that is here defined as additional demand for transport services as a result of improving travel conditions, has been a topic of research for many years. The focus has often been on assessing the side effects of measures that bring about such improvements.

The goal of our work was to analyse the effects that changing the generalised costs of travel had on the generation of travel demand, both on the aggregate and the disaggregate (individual) levels. The demand effects that were of interest were considered on an individual and on a cohort level. These effects included: the likelihood of participating in out-of-home activities, or being mobile, on a given day; the number of trips and journeys conducted; the resulting total time spent outside the home location; and the distances travelled.

Our research on the aggregate level tackled certain limitations of previous research on the topic by considering a substantially longer period and a larger spatial context than had previously been the case. Accessibility measures were used as a central predictor for demand changes, as political discussions about transport projects often centre on them. A *structural equation model (SEM)* was used to model the effects with a *pseudo panel* data set, which was constructed from historical data going back to 1974 and covering all of Switzerland.

The results obtained confirm the hypothesis that travel can be considered a normal good for which lower (generalised) costs bring about higher levels of demand. It was shown in particular that reductions in the generalised costs of travel induce a higher mobility of cohorts. The demand elasticities were substantial for the variables describing the generalised costs.

In the second part of the study, short-term effects of changes to the transport infrastructure and the resulting changes in travel times were assessed. A five-day travel diary survey was conducted, based on which the general conditions for carrying out a particular daily schedule were modified. Thus, new generalised costs for the schedule were implied. The respondents were then asked to adapt their schedules progressively to these new conditions in an interactive survey software environment (figure 11).

The respondents to this *stated adaptation survey* did adapt their behaviour in large part, but they proceeded very selectively in doing so. The predominant adaptations of their reported schedules were limited to the departure time from the home location (figure 12) to ensure timely arrival at their various destinations. Another popular means of compensating for the lost or gained time implied by the scenarios was to adapt the trip durations themselves by changing destinations and/or travel modes.

Overall, the second part of the study confirmed the results of the aggregated analysis in the first part, which showed substantial effects from changing generalised costs. However, it was demonstrated that the measures necessary to bring about those effects, that is, to increase general accessibility levels significantly, would be onerous in terms of budgets and political effort.

Figure 11 Screen shot of stated adaptation interview software

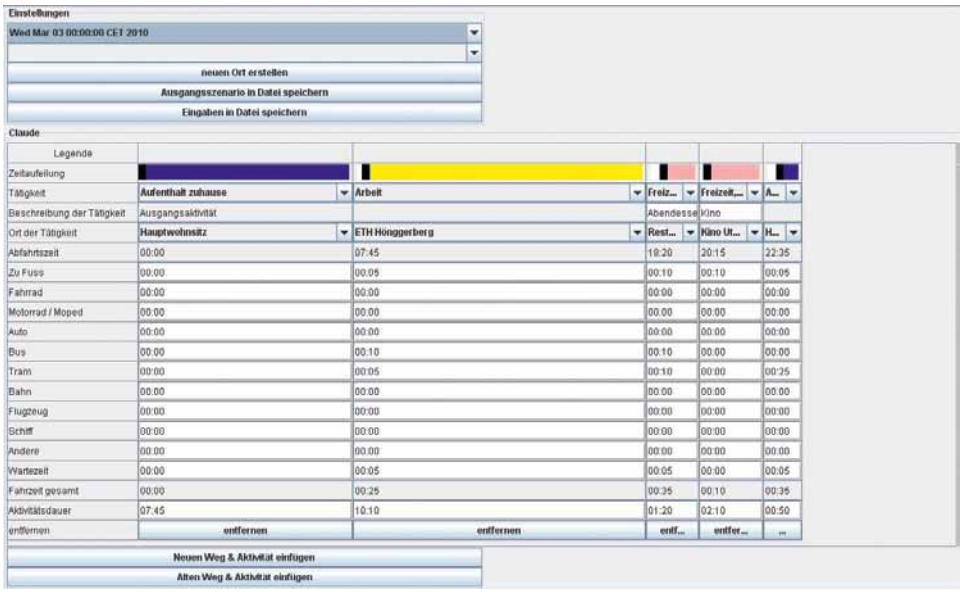
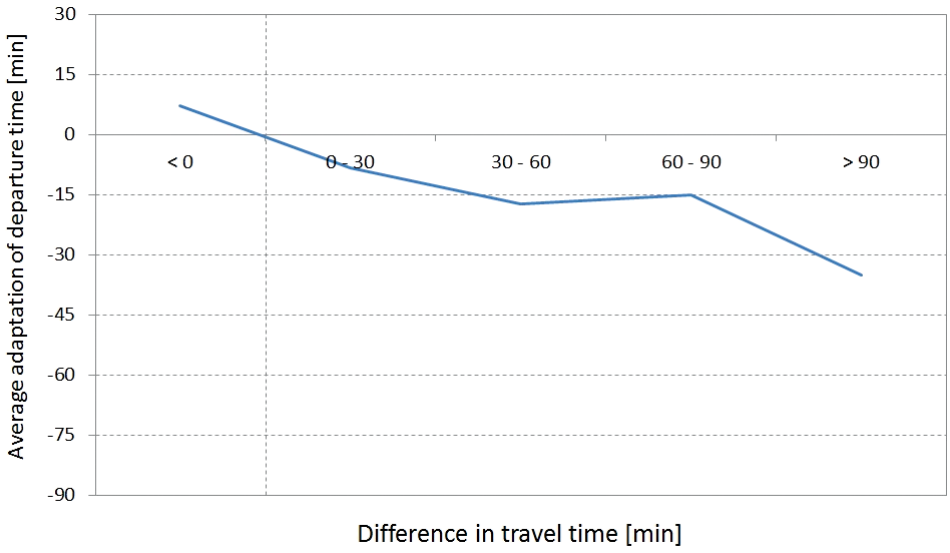


Figure 12 Average change in departure times as a function of travel time changes



5.3.2 MATSim Singapore

The Future Cities Laboratory (FCL) started in 2010 as the first research programme of the Singapore ETH Centre. The research project on mobility and transportation, one of nine modules of the Future Cities Laboratory, is being carried out by a core team comprised of one senior researcher and six PhD students (four from the ETH Zürich and two from the National University of Singapore: NUS), all based in Singapore. The demands of this research project derive from managing, planning and optimising the flow of people and goods at different time scales and from its interaction with all elements of the future city. The project is presented from two perspectives, medium- and long-term, and is built on agent-based transport demand modelling. The basis of this research project is a full implementation of the multi-agent-based travel demand simulation program (MATSim) for Singapore, the development of which was the focus of the work in 2011.

In line with the activity-based approach, MATSim is founded on the idea of the 24h daily activity schedule of an individual as a basic behavioural unit. MATSim employs fully integrated traffic flow simulations of both individual motorised and public transport to calculate the generalised costs of travel implied by the schedule. In addition, MATSim is designed for speed and scale, which allows it to address large-scale and finely detailed scenarios (for example Singapore, a city of about 5 million agents, 80 thousand links, 70 thousand destinations and 310 public transport service lines), and to find a stochastic user equilibrium with acceptable computing effort. Moreover, MATSim can fully integrate Singapore's time-based Electronic Road Pricing (ERP) system, since it simulates daily activity plans and explicitly accounts for the times of day and ERP gantry locations.

Our central aim in developing the MATSim implementation for Singapore is to achieve a fully integrated, modular design of the demand modelling process that allows the seamless integration of new data and further sub-models later in the project as well as thorough validation. Special attention has been given to creating additional sub-models, which became necessary due to the limited availability of key data required for agent-based transport demand modelling.

In absence of a full population census, the agent population was generated by using hierarchical iterative proportional fitting (IPF), including both the household and the individual levels. In lieu of a publicly accessible microdata sample with matching marginal sums, data from a national travel diary survey (Household Interview Travel Survey, HITS) which constituted of a 1% sample of Singapore's permanent population was combined with publicly available breakdowns of Singapore's most recent census. Due to the inconsistency of the scope of the two data sources, the modular framework of the population synthesis was highlighted and a thorough cross-validation with independent data was performed.

Then the agent population was enriched by adding driving license and car ownership models, both based on HITS data. The first was applied at the individual level while the latter included information from the first, but was based on the household level. These sub-models were again cross-validated with independent data originating from the driving license and car registry.

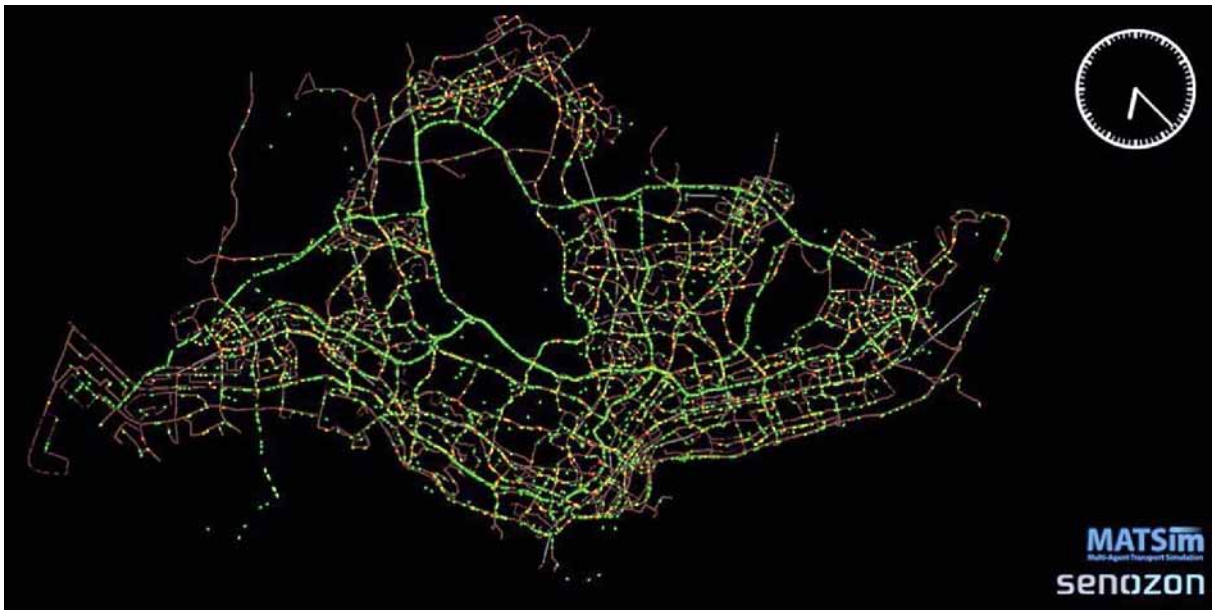
In absence of a central building register, various web sources, commercially available information on points of interest and building footprints as well as web-based services for geo-referencing were exploited to build a comprehensive facility database. This database was then used to distribute the population among residential buildings, detect work locations and define potential places for shopping and leisure activities. Based on a gravity model, each agent's home location was linked to a work/education location depending on the agent's sociodemographic profile. The destination choices for shopping and leisure activities were based on a sampling of alternatives from within a time-space prism that spans home and work activities and allows us to account for heterogeneous taste preferences among the agent population.

Mode choice was modelled on a sub-tour level and includes the options of public transport, using a car, walking and taking a taxi which, given its price and availability, is a relevant transport mode in Singapore. Results from a recent stated preference survey on mode and route choice were incorporated, including the valuation of ERP. A highly detailed road network and public transport schedule was used for time-dynamic routing. Taking advantage of the highly detailed yet high-performing MATSim public transport simulation, interactions between cars and buses sharing the same road and interactions between buses (i.e., bus bunching) were considered. The transport network model combines data from two different networks and includes schedule information that was accessible in the General Transit Feed Specification (GTFS). The process of merging these different data sets into a single network will be outlined in an upcoming detailed report.

To include traffic that is not endogenously modelled, such as light goods vehicles, freight and border crossing traffic, information from existing and available aggregate transport models was integrated via additional agents. Finally, the model was validated against traffic counts both for cars and for public transport.

Furthermore, the ability of the model to forecast demand reactions induced by a substantial public transport infrastructure extension, namely the opening of the final stage of a new mass rapid transit line, was tested by comparing simulated and observed ridership data.

Figure 13: Video still of the MATSim Singapore simulation



5.3.3 Within-day replanning for evacuation modelling

After events like the terrorist attacks on September 11, 2001, the disastrous tsunami that hit coastal regions around the Indian Ocean in December 2004, or the devastating earthquake and subsequent tsunami in Japan in March 2011, interest in large-scale evacuation simulations has grown enormously. In transport planning and traffic management, this creates the necessity of simulating scenarios in which unforeseeable, exceptional events occur. This requirement conflicts with traditional simulation approaches that equilibrate traffic demand using an iterative approach. They work under the assumption that a typical situation is simulated in which agents can rely on their experience from comparable situations, like previous iterations.

A best-case analysis was performed using an unrealistic user equilibrium approach to modelling evacuations. This absolute lower bound on the time needed to evacuate an area has to be low enough so that an evacuation request is a feasible path for the authorities at all. After a suitable test with a large-scale example, the project was continued to see if an evacuation request was still a feasible option under more realistic conditions.

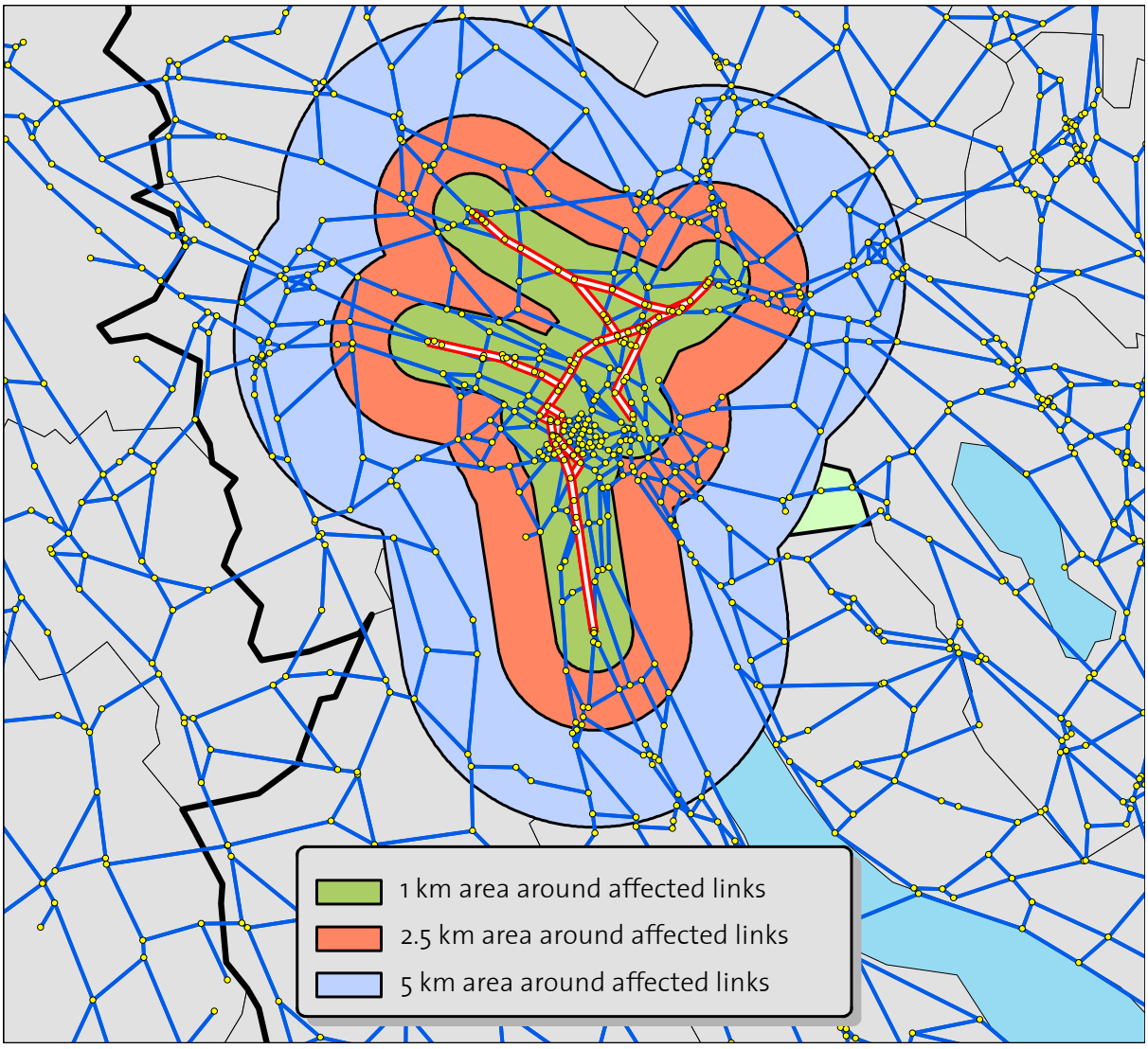
Applying an iterative solution approach to a scenario with unexpected events results in problems like illogical agent behaviour, producing false and misleading results. The current goal of the ongoing research is to develop an approach that allows scenarios containing such events to be simulated in a logically consistent way and implemented into MATSim, a multi-agent traffic-flow simulation framework.

In the second step of the project, a suitable within-day replanning approach was developed. This approach simulates only a single iteration, which avoids problems resulting from an iterative simulation process but also requires a more detailed behavioural model for the simulated agents, since the agents cannot learn from iteration to iteration to optimise their behaviour. The implementation of this approach and its application to a sample scenario was described by Dobler et al. (2012).

An aim of the current project phase is to add a flexible behavioural model to the simulation framework. First, studies on large-scale evacuations were reviewed to get familiar with evacuations and related behavioural patterns (Kowald et al. 2011). Second, findings from that review were validated by conducting expert interviews. A last step is to conduct a nationally representative study for Switzerland, which is currently underway. On the one hand, findings from all three steps will be used to identify and define the behavioural model's requirements. On the other hand, they will be used to calibrate and validate the model.

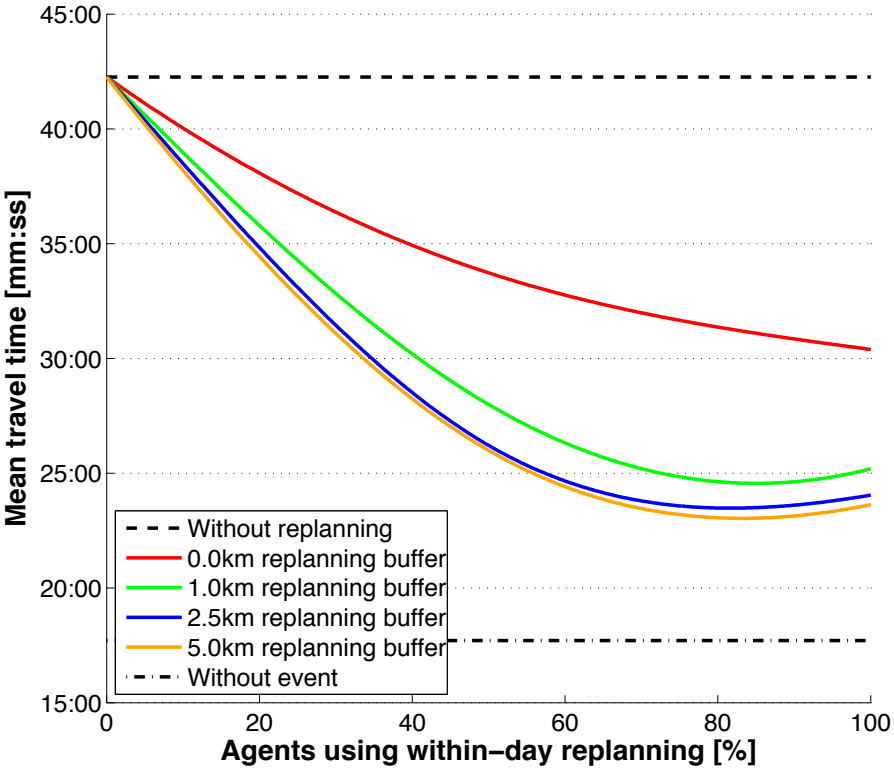
Finally, the model has been used to simulate a fictional incident in the city centre of Zürich and will be applied elsewhere in Switzerland where an evacuation of an affected area may be required. Figure 14 shows the study area and blocked links, while figure 15 illustrates how replanning reduces the travel times as expected, but also that they depend on the size of the area informed and the share of drivers with access to the information.

Figure 14 Study area and blocked links in the replanning validation experiment



Source: Dobler and Axhausen (2011)

Figure 15 Interaction between replanning, average travel times and information provision to the drivers



Source: Dobler and Axhausen (2011)

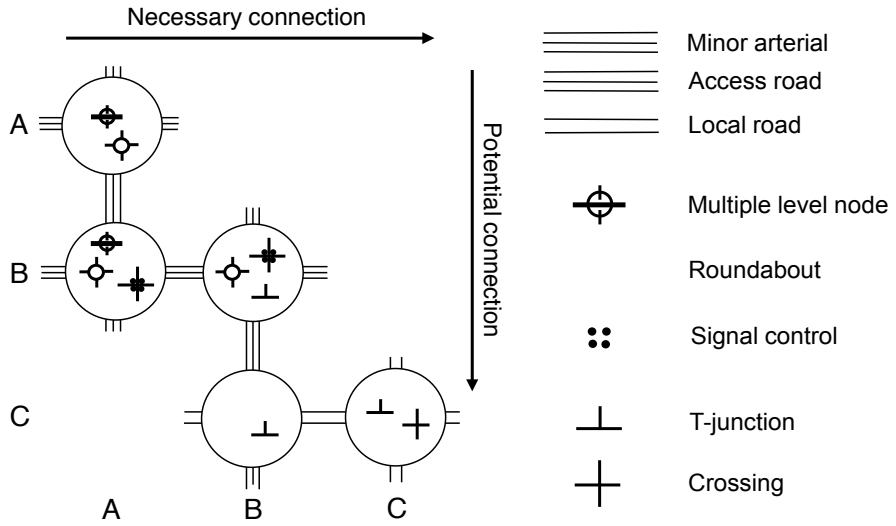
5.3.4 Shape grammars for network design

Transportation network design remains ubiquitous. New development sites must be accessed and existing infrastructure needs to be improved, renewed and redesigned due to demand changes. Worldwide, the population in urban systems is expected to double between 2005 and 2050 (UN 2009). New and renewed urban systems require sound transport infrastructure and corresponding technical standards.

However, when we looked at various technical handbooks on network design, no preferred suggestions for network layouts could be found. For instance, the street layout standard in Switzerland (VSS 1994) recommends strong hierarchical network element distribution. Other standards, e.g., in Germany, favour an adaptive hierarchical network design. In the USA, after 1950 a transition took place from gridded layouts to increasingly more dendritic networks, as recommended by the authorities of the time (Southworth and Ben-Joseph 2003). Overall, the investigated handbooks and standards lack a fundamental research basis with which to identify the benefits and costs of their rules and suggestions.

Our work aims to provide such a research basis, and it relies on the idea of shape grammars, which can be advanced for standards and other applications. Shape grammars in the form of rules describe how different types of network elements are added to each other, e.g., if a highway can be crossed by an arterial road or if local roads can be joined to larger intersections of high capacity (figure 16). The rules depict how an existing state can be extended and modified into a more desirable state. Additionally, shape grammars may include land use issues (see Marshall 2005) and therefore cover many urban planning applications. Shape grammars already play an increasing role in current urban planning and urban simulation software.

Figure 16 Hierarchical link and intersection shape grammars



Source: after Marshall (2005)

This research has evaluated shape grammars for hierarchical network design (Vitins, Schüssler and Axhausen 2012). Virtual networks were designed on featureless planes so as not to bias the outcome and evaluation. The virtual networks were evaluated according to the generalised costs of travel, and the infrastructure costs were assessed within a budget constraint. A sample of networks was statistically analysed.

The results show significant differences between the shape grammars applied in the optimal network design. Network designs with strong hierarchical link alignment reduced network performance compared to network designs where no rules were applied in the design process. This finding was expected, since less flexibility in design should lead to a decrease in network efficiency. However, the impact of hierarchical link alignment was remarkably low. Therefore, network performance was only slightly affected by the application of strong hierarchical link alignment rules.

Moreover, the distribution of intersection types considerably affected network performance. Strong rules on the allocation of intersection types decreased the average network performance significantly. The findings show that the distribution of intersection types is essential. Therefore, shape grammars for intersection allocation are of major importance. This finding is especially relevant because investments in new intersection types are less often discussed than investments in new roads.

Our current research focuses on intersections and their role in urban design. Future studies will incorporate land use and parcel distribution as well as network growth and land use development.

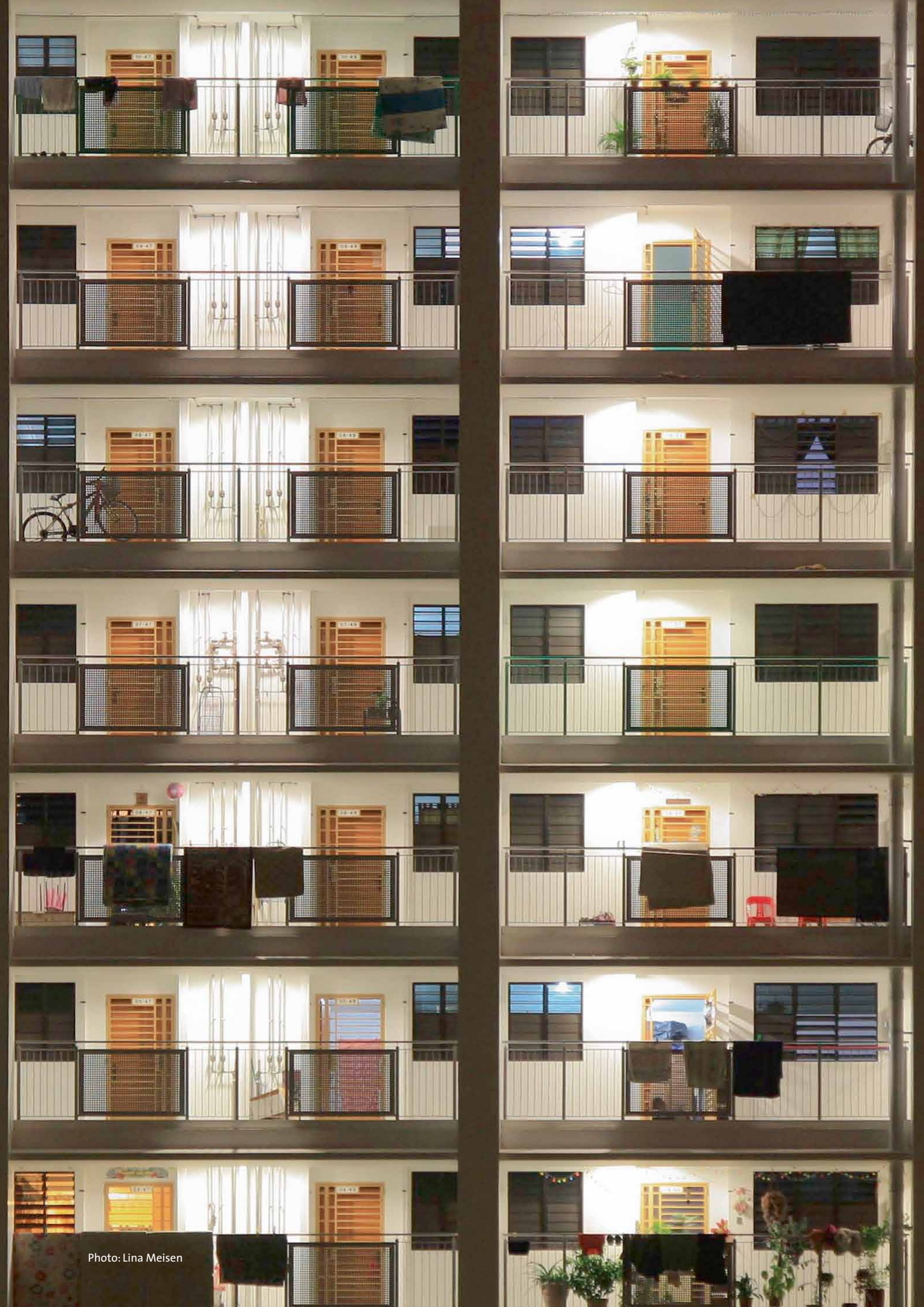


Photo: Lina Meisen

6 Doctoral dissertations

6.1 Ongoing dissertations

Barth, Emanuel
Local public transport in cross-border agglomerations
Supervisor: U. Weidmann; external examiner: R. Juchelka (University of Duisburg-Essen)

This PhD thesis explores the structural differences that render the development of cross-border local public transport more difficult as compared to domestic local public transport. Systematic approaches to tackling these difficulties are formulated. The spatial focus of the work lies on densely populated cross-border agglomerations in Europe.

Baumgartner, Franziska
Lateral stability behaviour of vehicles in curves
Supervisors: P. Spacek, U. Weidmann; external examiner: J.S. Bald (TU Darmstadt)

By analysing the lateral stability behaviour of vehicles, correlations between trajectory types and accidents are developed. Thresholds derived from the frequency of the trajectory types can be used to point out reconstruction requirements of potential accident black spots in curves.

Bopp, Bernd
Stability of continuous welded tracks (in narrow gauge railways)
Supervisors: U. Weidmann, J. Wichser; external examiner: P. Veit (TU Graz)

This work aims to improve knowledge of the components of lateral track resistance and their interaction. The focus is on the measurement and explanation of rail behaviour (respiratory behaviour) in tight curves.

Cao, Jin
Effects of parking time limits on traffic performance
Supervisor: M. Menendez; external advisor: to be appointed

Parking pricing and time limitations are two of the most widely used parking control strategies. Depending on the context, they can influence car usage, parking turnover and other travel behaviour patterns. On-street parking time controls in particular may also influence traffic performance. This research project looks into that question with the use of dimensional analysis, probability theory and conventional kinematic wave theory. The object is to provide a foundation for developing and implementing new strategies and/or policies that aim to modify not only travel behaviour, but also traffic performance at the local level.

Carrasco, Nelson
The improvement potential of public transport systems' reliability under different urban and cultural conditions
Supervisor: U. Weidmann; external examiner: P. Furth (Northeastern University)

Reliability measures the degree to which a planned service adheres to service delivery. It is a critical system attribute for both service providers and users. This works seeks to increase service reliability at the tactical and operational levels within systems and relate those improvements to the systems' unique contextual situation.

Ciari, Francesco

Extensive use of flexible transport systems as a means of rescaling the usage of privately owned cars: Concepts, solutions and a simulation for the Zürich area

Supervisor: K.W. Axhausen; external examiner: K. Hironori (Tokyo University)

In this dissertation, a new concept is proposed: A Flexible Transport (FT) system which could replace a substantial part of private car travel. The work focuses on car sharing and Demand Responsive Transport (DRT) and includes a simulation of such a system for the Zürich metropolitan area.

Dobler, Christoph

Travel behaviour modelling for scenarios with unpredictable events: Methods and implementation

Supervisor: K.W. Axhausen; external examiner: K. Nagel (TU Berlin)

The object of this dissertation is to develop concepts and methods that allow scenarios with unpredictable events to be simulated. Based on this model, various use cases like road accidents and car sharing are analysed.

Dorbritz, Robert

Railway network stability and the spreading dynamics of disastrous events which cause system-wide blockades

Supervisor: U. Weidmann; external examiner: M. Haag (TU Kaiserslautern)

This study shows how structural and operational consequences of large disturbances can be measured and that the two kinds of consequences significantly differ. Hence, operational aspects have to be considered when analysing the resilience of railway transport. A newly implemented approach measures and visualises these impacts.

Fink, Olga

Applying artificial neural networks in reliability prediction and analysis for railway rolling stock

Supervisor: U. Weidmann; external examiner: J. Andrews (University of Nottingham)

This dissertation analyses and evaluates the potential scope of applying artificial neural networks to reliability prediction for railway rolling stock and its subsystems. The application potential is theoretically evaluated based on selected practical case studies in different application fields with several types of neural networks.

Frank, Patrick

A method of estimating the efficiency of capacity-increasing activities

Supervisor: U. Weidmann; external examiner: to be appointed

This dissertation will show that a consistent assessment of capacity and an estimation of efficiency are possible at an early stage of planning, and it will explain how these can be made. Conflicting aims stemming from the requirements of network users and optimal network utilisation will be analysed in depth.

Ge, Qiao

The value of information on road merges

Supervisor: M. Menendez; external examiner: to be appointed

The development of communication technologies has brought great benefits to vehicle and road users. This dissertation will investigate the value of information on different types of highway merges. It will include qualitative and quantitative analyses of empirical traffic data as well as microscopic traffic simulations.

Höppner, Silko

A generic description of railway operation processes

Supervisor: U. Weidmann; external examiner: J. Pachl (TU Braunschweig)

This thesis will provide a generic description of railway operating processes based on a newly developed set of universal rules. The purpose of these rules is to develop a harmonised code to improve international rail traffic.

Horni, Andreas

Destination choice modelling for discretionary activities in agent-based micro simulations of travel demand

Supervisor: K.W. Axhausen; external examiner: D. Scott (McMaster University, Hamilton)

In this dissertation, a facility-fine destination choice module for discretionary activities (i.e., shopping and leisure) is generically developed and implemented into the existing MATSim system. Methodological advances presented in this work encompass implementation issues for large-scale scenarios as well as conceptual improvements to discrete destination choice models, for instance with regard to the specification of destination choice sets.

Jäggi, Boris

Short- and long-term choice modelling approaches for household budget allocation

Supervisor: K.W. Axhausen; external examiner: to be appointed

In this thesis, several household budget allocation models are developed. Short-term models describe trade-offs between consumer goods and travel costs, while long-term models treat investments in car fleets and private housing. The models are based on household budget surveys.

Killer, Veronika

Spatial modelling of commuting linkage

Supervisor: K.W. Axhausen; external examiners: C. Rozenblat (University of Lausanne), C. Holz-Rau (TU Dortmund)

The increasing numbers of commuting linkages are the focus of this thesis. Nation-wide commuting effects are analysed with regard to different levels of aggregate and individual behaviour, and the resulting adaptation of existing models with explicit spatial representations is explored.

Kowald, Matthias

The link between spatial mobility, leisure acquaintances and social interaction in leisure travel

Supervisor: K.W. Axhausen; external examiner: A. Diekmann (ETH Zürich)

This thesis is based on a unique snowball survey that collected data on the link between social networks and leisure travel. By employing an ascending sampling strategy, the author aims to obtain a detailed picture of the spatial spread of social contacts in personal and population-wide networks.

Lu, Ming

Predicting dynamic adaptations of travellers' mode-based choices

Supervisor: K.W. Axhausen; external examiner: M.G.H. Bell (Imperial College, London)

This dissertation investigates the effects of travel-related variables on trips and then predicts mode choices by using artificial neural networks to compare different series of choice variables. Mode choices are regarded as a classification problem in which different combinations of variables lead to different mode choices. Based on the structure of the neural network, the goal is to identify typical variables that capture unobserved factors better and thus explain travel behaviour.

Märki, Fabian

Continuous travel behaviour simulation

Supervisor: K.W. Axhausen; external examiner: T.A. Arentze (TU Eindhoven)

The aim of this thesis is to show how it is possible to generate and schedule activities continuously (i.e., on the fly and with an open time horizon) under the constraints of behavioural realism and algorithmic efficiency.

Moll, Stephan

Productivity improvements for freight railways through collaborative transport planning

Supervisor: U. Weidmann; external examiner: W. Stölzle (University of St. Gallen)

The main objects of this thesis are to identify and explain the information available to rail freight customers, to analyse its potential to improve the productivity of operational rail freight processes, and finally to investigate the feasibility and mutual profitability of closer collaboration.

Montini, Lara

Automated trip purpose imputation from GPS data

Supervisor: K.W. Axhausen; external examiner: to be appointed

The goal of this dissertation is to develop post-processing routines for longitudinal GPS data. The methodology will consider travel patterns and activity locations to identify trip purposes.

Müller, Kirill

A generalised approach to population synthesis

Supervisor: K.W. Axhausen; external examiner: to be appointed

Transport planning uses agent-based micro-simulation for traffic flow and demand simulation models. Ideally, the agent population is a large sample with multi-level structures and many attributes. This thesis aims to develop an appropriate methodology and to implement it as an open-source toolkit for population synthesis based on known and novel approaches.

Nur Arifin, Zainal

A commuter route choice model based on GPS tracking data

Supervisor: K.W. Axhausen; external examiner: K. Mohammadian (University of Illinois, Chicago)

This dissertation will analyse commuter behaviour in Jakarta, Indonesia based on GPS data. It includes the identification of commuter trip patterns, route patterns and route choice patterns. Algorithms for handling huge GPS datasets and deriving information on commuter behaviour will be explored. Finally, a commuter route choice model will be developed.

Ortigosa, Javier

Urban patterns and traffic performance

Supervisor: M. Menendez; external examiner: to be appointed

This dissertation studies the ability of a city to cope with traffic based on its urban pattern. The results could be used to improve the design of new cities as well as to manage existing ones in order to use them more efficiently (from an urban and traffic perspective). The planned work involves the creation of several models of urban patterns which, although abstract, represent real cities (in terms of their structure as well as their demand features). In these models, numerical and traffic analysis tools will be employed to find the relationship between urban pattern descriptors and traffic performance indicators.

Scherer, Milena

System-specific effects of urban public transport systems on spatial development and the perceived quality of service

Supervisor: U. Weidmann; external examiner: C. Ahrend (TU Berlin)

System-specific effects of urban public transportation on travel demand and spatial development are investigated based on a new survey. Public perception of various system-related attributes that form images of buses and trams and how this perception affects demand is of particular interest.

Schiffmann, Frank

The planning and optimisation of highway work zones

Supervisors: H.P. Lindenmann, G. Girmscheid (IBB ETH Zürich); external advisor: R. Hajdin (IMC GmbH Zürich)

The aim of this research is to analyse and evaluate methods for planning highway work zones to minimise their impacts on road users, both on the motorway and on the secondary road network. The evaluation will be based on real-life case studies.

Schirmer, Patrick

Using variables of shapes and spaces in urban simulation processes

Supervisor: K.W. Axhausen; external examiner: M. Batty (University College, London)

This dissertation focuses on deriving variables from geometries to represent spatial qualities of the urban landscape (buildings, parcels, networks, etc.) inside integrated land use transport simulations. The variables are extracted from vector maps using GIS tools and will be tested in discrete choice models of agents and objects.

Schranil, Steffen

Forecasting the duration of rail operation disturbances; dispatching and incident communications

Supervisor: U. Weidmann; external examiner: A. Stephan (TU Dresden)

This dissertation aims to improve the management of rail operation disturbances and support the return to the scheduled timetable. For this purpose, correlations and circumstances of rail operation disturbances are analysed. The results are made available to dispatching operations, and a forecasting process is constructed. These ideas could just as well be employed for adapted incident communications.

Vitins, Basil

Shape grammars for transport network design

Supervisor: K.W. Axhausen; external examiner: D. Levinson (University of Minnesota)

First, shape grammars are generated and evaluated for the design and optimisation of public and private transportation networks. Second, shape grammars are developed for land use interactions and network growth. Third, shape grammar recommendations are derived for design standards.

Waraich, Rashid

Simulation framework for investigating the impact of (plug-in hybrid) electric vehicles

Supervisor: K.W. Axhausen, external examiner: T.A. Arentze (TU Eindhoven)

This thesis focuses on simulating potential future electricity consumption by electric and plug-in hybrid electric vehicles as well as their spatial and temporal distribution. The use of digital technologies such as smart/controlled charging and vehicle-to-grid (V2G) charging are also part of the research.

Weis, Claude
Activity-oriented modelling of the short- and long-term dynamics of travel behaviour
Supervisor: K.W. Axhausen; external examiner: H.J.P. Timmermans (TU Eindhoven)

Various hypotheses about travellers' reactions to changing generalised costs of travel are tested in this thesis. As in all activity-based studies, travel is considered a demand that is directly derived from individuals' need to participate in activities. The effects are modelled in the context of whole days, or activity schedules. The thesis is based in part on a new stated-adaptation survey.

Wiedersheim, Sabrina
Algorithms and methods for the construction of conflict-free macroscopic railway timetables
Supervisors: U. Weidmann, H.J. Lüthi (ETH Zürich); external examiner: K. Nachtigall (TU Dresden)

This dissertation addresses the development of algorithms and methods to support operating processes for timetabling preparation and infrastructure planning. A conflict-free, macroscopic timetable will be computed and optimised out of functional requirements and infrastructure restrictions.

Zöllig, Christof
Urban transformation: Focusing on real estate developers
Supervisor: K.W. Axhausen; external examiner: P. Waddell (University of California, Berkeley)

In this dissertation, the behaviour of real estate developers as central players in the process of spatial development is examined. Qualitative and quantitative analyses are combined to improve existing models that capture the interaction between land use and transport.

6.2 Finished dissertations

Bodenmann, Balz R.
Location choice of firms with special emphasis on spatial accessibility
Supervisor: K.W. Axhausen; external examiners: T.A. Arentze (TU Eindhoven), F. Schweitzer (ETH Zürich)
Exam: 06/11

Land use models play a decisive role in different domains: They allow demographic trends to be estimated, enable comparisons between spatially relevant projects, facilitate the dimensioning of public infrastructure, and help to answer various other questions regarding the future development of our built environment. Due to the tight interdependence between resident populations and economic activities, location choices of firms play an important role in land use models. However, there has been little research on this topic, especially regarding the destination decisions of relocating firms. Based on data from the commercial registers of the Swiss cantons of St. Gallen and Appenzell, the aim of this thesis is to fill this gap.
First, firmographic events such as business establishments, closures and migrations were analysed. Complementary analyses focused on the destination choices of relocating firms. The effects of variables such as local taxes, business friendliness and accessibilities were quantified. Finally, scenarios with different options for public authorities were tested in simulations. The aim was not only to show the effects of the authorities' interventions, but also to detect potentially negative side effects.

Erath, Alex

Vulnerability assessment of road transport infrastructure

Supervisor: K.W. Axhausen; external examiner: M.G.H. Bell (Imperial College, London);
Exam: 04/11

The overall aim of this dissertation was to develop a methodology that allows the assessment of indirect consequences of road network failures. On the one hand, the notion of network vulnerability should be used to enhance the infrastructure management system; on the other hand, the methodology should be performed with reasonable computational effort. To this end, the dissertation focuses on three different issues:
First, a meaningful typology of links with respect to their potential to induce failure was obtained based on a cluster analysis for the links of the Swiss National Transport Model. For each cluster, a separate strategy for assessing failure consequences was developed. This substantially decreased the computational effort required for network-wide assessment.
Second, a statistical model to evaluate failure consequences was developed based on the variables' shortest detour, link type, network density and volume.
Since the assumption of single link failures is rather restrictive and is especially challenged by threats that are caused by one extreme natural event, the third aim was to address the potential for joint link failure. By applying a gradual approach to evaluating the impact of single link protection measures, it was demonstrated that the prioritisation of failure protection measures generally differed very little from solutions obtained by considering only single link failures.

Meister, Konrad

Contribution to agent-based demand optimisation in a multi-agent transport simulation

Supervisor: K.W. Axhausen; external examiners: P. Waddell (University of California, Berkeley); M. Balmer (Senozon AG, Zürich);
Exam: 06/11

In this thesis, for the first time a criterion for measuring the identification of an agent-based stochastic user equilibrium was defined. It was subsequently demonstrated and analysed in a series of case studies employing MATSim.
The second part of the thesis describes the design of a mode and departure time optimiser for an agent-based travel demand model, which was founded on a subtour definition of the daily activity chain. The implementation was tested with the Zürich scenario of MATSim.
Finally, the thesis reports on the application of MATSim for the population of Switzerland. This is the largest known application of agent-based models in transport, both in terms of agents as well as in terms of the resolution of the network and the destinations.

Santel, Gerko

Lateral driving behaviour

Supervisors: P. Spacek, K.W. Axhausen; external examiner: C. Lippold (TU Dresden);
Exam: 07/11

The speed dependence of the range of lateral movement and the additional space for oncoming or overtaking traffic, as contained in the existing Swiss standard, could in principle be confirmed through new empirical measurements. Some considerable differences between the measurement results and the reference values of the standard were found. Moreover, the results show that it is necessary to distinguish between the categories "passenger cars" and "heavy goods vehicles" for the derivation of the range of lateral movement and the additional space for oncoming or overtaking traffic. It was found that the equality of the additional space for oncoming traffic and the additional space for overtaking, as it is contained in the existing standard, is not correct.

Table 13 List of completed doctoral theses (2004–2011)

Year	Name	Title	Supervisor(s)	External examiner(s)
11/04	Jermann, J.	Konzept zur Modellierung von Einzugsbereichen auf Bahnhaltestellen	Brändli	Axhausen (IVT, ETH Zürich), Giger (IPG, ETH Zürich)
11/04	König, A.	Messung und Modellierung der Verlässlichkeit des Verkehrsangebots: Experimente mit Schweizer Befragten	Axhausen	Zumkeller, University of Karlsruhe
09/04	Schäffeler, U.	Netzgestaltungsgrundsätze für den öffentlichen Personennahverkehr in Verdichtungsräumen	Brändli, Weidmann	Bovy, TU Delft
04/04	Schlich, R.	Verhaltenshomogene Gruppen in Längsschnitterhebungen	Axhausen	Timmermans, TU Eindhoven
09/04	Ullius, M.	Verwendung von Eisenbahnbetriebsdaten für die Schwachstellen und Risikoanalyse zur Verbesserung der Angebots- und Betriebsqualität	Brändli	Zehnder, Widmayer (ITI, ETH Zürich)
10/05	Heimgartner, C.	Systemdynamische Simulation von Verkehr und Flächennutzungen – Evaluation nachhaltigkeitsfördernder Massnahmen	Axhausen	Scholl, University of Karlsruhe
12/06	Schönfelder, S.	Urban rhythms: Modelling the rhythms of individual travel behaviour	Axhausen	Bhat, University of Texas, Austin
04/07	Balmer, M.	Travel demand modelling for multi-agent traffic simulations: Algorithms and systems	Axhausen	Nagel, TU Berlin
02/08	Beige, S.	Long-term and mid-term mobility decisions over the life course	Axhausen	Maggi, USI, Lugano; Wegener, Spiekermann & Wegener, Dortmund
07/08	Bernard, M.	Entwicklung eines Bemessungskonzepts von Verkehrsnetzen unter Berücksichtigung der Zufallsgrössen Verkehrsstärke und Kapazität	Axhausen	Brilon, University of Bochum
10/08	Charypar, D.	Efficient algorithms for the travel behaviour microsimulation of very large scenarios	Axhausen	Nagel, TU Berlin; Mahmassani, Northwestern University, Evanston
07/08	Fröhlich, P.	Änderungen der Intensitäten im Arbeitspendelverkehr von 1970 bis 2000	Axhausen	Bell, Imperial College, London
10/09	Fries, N.	Market potential and value of sustainable freight transport chains	Weidmann	Jong, ITS Leeds; Hellweg, IfU, ETH Zürich
11/09	Hackney, J. K.	Integration of social networks in a large-scale travel behaviour micro-simulation	Axhausen	Miller, University of Toronto
09/09	Lüthi, M.	Improving the efficiency of heavily used railway networks through integrated real-time rescheduling	Weidmann	Hansen, TU Delft
06/10	Alt, B.	Investigation of space–time structures in public transport: Networks and their optimisation	Weidmann	Friedrich, University of Stuttgart
11/10	Löchl, M.	Application of spatial analysis methods for understanding geographic variation of prices, demand and market success	Axhausen	Miller, University of Toronto

Year	Name	Title	Supervisor(s)	External examiner(s)
06/10	Schüssler, N.	Accounting for similarities between alternatives in discrete choice models based on high-resolution observations of transport behaviour	Axhausen	Bierlaire, EPFL; Hess, University of Leeds
06/11	Bodenmann, B.R.	Location choice of firms with special emphasis on spatial accessibility	Axhausen	Arentze, TU Eindhoven
04/11	Erath, A.	Vulnerability assessment of road transport infrastructure	Axhausen	Bell, Imperial College, London
06/11	Meister, K.	Contribution to agent-based demand optimisation in a multi-agent transport simulation	Axhausen	Waddell, University of California, Berkeley; Balmer, senozon, Zürich
07/11	Santel, G.	Lateral driving behaviour	Spacek, Axhausen	Lippold, TU Dresden

Table 14 List of external examinations (2011)

Name	Title	External examiner	Supervisor
Bosse, G.	Grundlagen für ein generisches Referenzsystem für die Betriebsverfahren spurgeführter Verkehrssysteme	Weidmann	Pachl, TU Braunschweig
Dessemontet, P.	Changes in employment and accessibility: The case of Switzerland between 1939 and 2008	Axhausen	Schuler, EPF Lausanne
Ishaq, R.	Development of flexible model structures for discrete choice models	Axhausen	Shiftan, Technion, Haifa
Le Vine, S.	Strategies for personal mobility: A study of consumer acceptance of subscription drive-it-yourselves car services	Axhausen	Polak, Imperial College, London
Winkler, C.	Ein integriertes Verkehrsnachfrage- und Bewertungsmodell	Axhausen	Lohse, TU Dresden
Zemp, S.	Nachhaltige Positionierung von Bahnhöfen	Weidmann	Scholz, ETH Zürich

Photo: Alex Erath

7 Projects

7.1 Finished projects

Activity-oriented analysis of induced travel demand (SVI 2004/012)
Weis, Axhausen
Sponsor: SVI;
10/2007 to 08/2011

Induced travel demand, a phenomenon that is here defined as additional demand for transport services caused by improving travel conditions, has been a topic of research for many years. In contrast to previous studies on the topic that focused on specific and localised changes such as the construction of new roads or rail lines in given corridors and the assessment of their side effects, the research described in this thesis chooses a different approach.
Aggregate effects on traffic generation produced by changing the generalised costs of travel were assessed in this project. The dimensions of demand that were of interest were the generation of travel on both the individual and the cohort levels, including: the propensity for participating in out-of-home activities, or being mobile, on a given day; the number of trips and journeys conducted; the resulting total times spent outside the home location; and distances travelled.
It was shown that decreasing generalised costs induced a higher mobility of travellers in general. This was demonstrated by the model results and especially by the significant effects of increased accessibility levels that were used as a proxy for generalised costs. The substantially induced demand effect on these upper levels of demand generation is certainly an interesting finding which, to the authors' best knowledge, has not been shown before in this form.
The increases of general accessibility levels that can be expected from local projects are quite small. Thus, although a significant induced demand effect was shown in the model's results, it was found that the measures that would be necessary to bring about changes to the transport system substantial enough to trigger the aforementioned effects in a broad spatial extent would be onerous. The effects might very well be visible in a local context, however.

Advancement of ErZu—Requirements for Deviation Management
Schranil, Weidmann
Client: SBB Infrastruktur;
02/2011 to 08/2011

In spite of best efforts, it has never been possible to operate a rail system without delays or disturbances. The management of smaller schedule deviations is therefore important. From this consideration, it is essential to know who needs what information at what time and in which granularity. Concerning the needs of the final customers (passengers or freight agents), there are three important aspects to consider:
- just-in-time information in case of an action demand
- reliable information in case of an estimated action demand
- no unessential information

These aspects are reflected in the following approach to the aims of deviation management:
- continuing rail operation management
- providing customer information
- improving (intermediate-term) operations planning
- analysis and statistics (mentioned as an application rather than a discrete aim)

Therefore, it is important to analyse the technical and operational impacts of schedule deviations.

Advisory opinion for the "Tram Region Bern" project
Nägeli, Scherer, Schranil, Weidmann
Project partner: ewp Verkehrsplanung
Client: Canton of Bern, Administrative Office for Public Transport;
01/2011 to 05/2011

In the "Tram Region Bern" project, bus line 10 (Ostermundigen–Köniz) is to be converted to tram operation. The preliminary project has shown that the costs will be considerably higher than previously thought. For this reason, an intermediate phase was initiated so that the project could be evaluated by external experts.

Alternatives for freight traffic in the Canton of Aargau
Moll, Wichser
Client: Traffic Department of the Canton of Aargau;
11/2010 to 02/2011

Aargau is geographically attractive for logistics, production and distribution companies. This leads to high transport volumes on both roads and rails, which is further increased by significant transit volumes. The consideration of freight traffic is therefore a relevant political issue in Aargau. In view of this, the Traffic Department of the Canton of Aargau asked us to identify and evaluate their general scope of activities in the field of freight traffic.
The analysis has clearly shown that freight-relevant transport infrastructure rests mostly in the competence of the federal government. The decision-making power of cantons primarily lies in spatial planning, the operation of cantonal roads and in consultative participation in national traffic infrastructure projects. The analysis revealed that the Canton of Aargau has already done a lot within its range of possibilities. This particularly applies to cantonal spatial planning and legislation. The canton's specification of industrial development areas pays close attention to ensuring rail access, and the canton encourages or even obliges companies to invest in feeder tracks whenever possible. Further, inter-cantonal collaboration in spatial planning has been pursued for several years, enabling the coordination of freight traffic measures. Untapped potential still exists in conversions of industrial areas. The canton should work towards ensuring that areas well suited to activities generating high freight traffic volumes are not used for other purposes, and that existing feeder tracks remain in use. Furthermore, the canton can apply efficient procedures for approving new feeder tracks and provide supportive information to industry and local communities so that the strengths of rails and roads are exploited as efficiently as possible.

Application areas of various means of transportation in agglomerations
Dorbritz, Orth, Scherer, Weidmann
Project partner: Spacek, ETH Zürich
Sponsor: ASTRA;
08/2005 to 05/2011

The development of agglomeration transport systems in Switzerland has led to today´s high-quality and high-capacity systems, contributing significantly to the attractiveness of the agglomerations and cities. As society and the economy are in a constant, dynamic flux, transport systems need to be constantly improved as well. In this improvement process, it is critical to be aware of the individual strengths and weaknesses of different modes of transportation. This creates both the opportunity and the need to re-evaluate transport in the agglomerations before new situations are literally cemented for the next decades.
The underlying hypothesis for this work is that the current state of transport systems and the deployment of transport modes in Switzerland are the result of an evolutionary process, meaning that unsuitable uses of transport systems have been discontinued while highly suitable ones have found widespread application. While this view is a momentary one, it displays exactly those options that are applicable for current planning horizons.

In line with the stated hypothesis, an inventory of transport systems in Swiss agglomerations was compiled. At the same time, a number of agglomeration characteristics were studied, especially with respect to their connection to transport mode deployment. Furthermore, key transport mode characteristics were assessed in terms of capacity and impacts.
The interactions between these key characteristics were studied. Suitable areas of deployment for the various transport modes were then determined, and ways to link the modes to achieve an efficient and attractive overall system were put forward. Moreover, numerical thresholds of a number of characteristics that may be used for quick assessment in the initial phases of planning were developed.

A second opinion on the further development of supply and on further railway infrastructure extensions (Bahn 2030)
Barth, Frank, Wichser, Weidmann
Clients: Bau und Verkehrsdepartement Basel-Stadt, Bau- und Umweltschutzdirektion Basel-Landschaft;
10/2010 to 11/2011

On 1 September 2009, a new federal act on the future development of railway infrastructure (ZEBG; SR 742.140.2) came into effect. Apart from the intended extensions of railway infrastructure, amounting to CHF 5.4 billion (1999 prices), the Federal Council was commissioned by the Federal Parliament to submit a legislative proposal on the further development of the offer and of railway infrastructure extensions (Bahn 2030). The Federal Council decided in December 2008 that two railway concepts of different sizes with investment volumes of CHF 12 bn. and 21 bn. should be detailed.
Based on the forecast by the Federal Department of the Environment, Transport, Energy and Communications (UVEK) for Swiss passenger and goods transport until 2030, the development of regional and national demand was estimated by means of transport models. With this data, it was determined which transport offer would be required to satisfy demand. The transport demand was projected onto the railway network in order to reveal future bottlenecks and to deduce extension requirements.
The task of the Institute for Transport Planning and Systems (IVT) was to provide an external second opinion examining the SBB's and BAV's approach to the further development of the offer and to extending railway infrastructure (Bahn 2030). The defined regional modules and national concepts were to be included in the assessment. Due to successive amendments of the basic information that was to be examined by the IVT, it was determined that the detailed analysis of the regional modules should be abandoned. The IVT's input therefore focused on the national transport market and on infrastructure development.

Assessment of vehicle door configurations and luggage storage
Höppner, Kirsch, Weidmann
Client: Rhätische Bahn;
06/2011 to 08/2011

This project answered questions about enhancing travel comfort and creating a better luggage storage situation in passenger cars of a metre-gauge railway. The railway operator, Rhätische Bahn, plans to order a new set of passenger cars for regional transport and for the popular "Glacier Express". In both cases, cars with an adequate door width and well-arranged entry areas are required. The passengers must have a clear overview of the interior and must be able to recognise the luggage storage areas quickly. These areas must have different attributes for summer and winter travel. In the summer season, space is needed for suitcases, bicycles and water-sport equipment. In the wintertime, the main season of Alpine tourism, additional room is needed not only for suitcases, but also for winter sports gear like skis, snowboards and sledges. These characteristics are offered by multi-modal luggage racks that are visible from the travellers' seats. The panorama cars of the Glacier Express constitute a special situation. Because of the glass roof, there is no possibility for overhead storage. The results of the study will help to create optimal requirement specifications with a focus on passenger comfort.

Augmentation of the SBB long-distance travel load factor to optimise general economic efficiency
Weidmann, Baudys, Moll, Schranil
Client: SBB Personenverkehr;
07/2010 to 02/2011

The load factor is one of SBB's key corporate management metrics. Its improvement may not degrade other metrics. One of the project aims was to determine and evaluate useful metrics for passenger rail companies and to study their interactions. Five metrics were proposed, among them the load factor. These metrics were discussed and compared to those of a number of other large European railways, especially with regard to their interaction with schedules, the ticket system and ticket fares.
The SBB's IC service from Romanshorn to Brig via Zürich was evaluated for reference. This service exhibits a broad load factor range caused by the line section Zürich—Bern during the week and the large number of tourists at the weekends. In Switzerland, there are integrated synchronised timetables and an open fare system. Under these circumstances, it becomes very difficult to obtain consistently loaded trains over the whole day. However, some ways to increase the Swiss load factors were proposed.

Comparison methodology for railway operating processes
Höppner, Weidmann
Client: Federal Office of Transport (BAV), Bern;
03/2011 to 10/2011

The IVT developed a methodology for comparing directives in case of rule adjustment. The background for this was the adoption of EU interoperability guidelines for railway operations and the subsequent changes to existing Swiss national directives. The methodology provides suggestions for a structured identification and comparison of rules. The main difficulty consists of variations in text structure, term definition, scope and the meaning of content. This methodology was developed for the Federal Office of Transport in Bern and may be used for different types of guidelines, not only within the transport sector.

Feasibility study for the implementation of a generic process for managing the life cycle costs of railway rolling stock
Fink, Schranil, Weidmann
Project partners: Cideon Schweiz AG, Siemens Schweiz AG, SBB AG
Sponsor: Commission for Technology and Innovation;
06/2010 to 11/2011

The feasibility and practical implementation of a generic process for managing the life cycle costs (LCC) of railway rolling stock were investigated in this project. Within the generic process, the focus of the study was on knowledge management and monitoring reliability, availability and life cycle costs.
In the first step, the hierarchical goal system of the main stakeholders in the individual life cycle phases was determined and evaluated. For this purpose, a life cycle phase model adapted to the interests of the individual stakeholders was developed. In addition, specific essential requirements and characteristics of a life cycle costing model were derived.
The process steps prioritised for further investigation include knowledge management and monitoring reliability, availability and life cycle costs. The hypothesis was tested in a case study, and it was found that it is possible to identify patterns between diagnostic data and failure events and use them to predict further technical failures. The case study was conducted using data from SBB double-decker trains (RABe 514) for the Zürich S-Bahn, supplied by Siemens. The case study was performed on the subsystem of the entrance doors of the rail vehicles. Data mining methods, especially in the field of classification, were applied. The established working hypothesis could be confirmed and the functional specification of the IT application was derived.

Integrated modelling and the analysis of energy and transport systems
Waraich, Axhausen
Project partners: PSL, ETH Zürich
Sponsor: ETH Zürich;
06/2008 to 06/2011

In this project, the possible future influence of electric and plug-in hybrid electric vehicles on power systems was researched. This was performed by integrating agent-based traffic simulation and vehicle charging with a power systems simulation. As part of this work, three different charging schemes, including smart grid charging and vehicle-to-grid (V2G) charging, were investigated based on test scenarios. The outcome of the project is now being applied to real-world scenarios in other projects, such as the ARTEMIS project, in which the possible impact of plug-in hybrid electric and electric vehicles on the electric grid of the City of Zürich is being investigated.

Modernisation of the IVT Railway Operations Laboratory
Frank, Fries, Höppner, Weidmann
Project partners: SBB, Siemens Schweiz AG
Client: SBB, Siemens Schweiz AG;
09/2008 to 08/2011

After 20 years of use without any investments in signalling or in its model railway, the IVT Railway Operations Laboratory needed improvements to make it fit for the next decades. Furthermore, the requirements for training SBB staff as well as ETH students have changed over the past years, especially since the launch of new signalling systems and modern interlockings, including those run by remote control. A new train control system that realistically shows the driving characteristics of the trains has been installed.

National Stated Preference survey on travel behaviour
Weis, Erath, Axhausen
Project partner: IG Modus
Client: Federal Office for Spatial Development (ARE), Bern;
03/2010 to 04/2011

To improve the appraisal of travel behaviour reactions to changes in transport supply, including travel times, fuel prices, toll costs, public transport ticket prices, connection frequency and reliability, comfort, and other attributes describing private and public transport mode and route alternatives, the Swiss Federal Office for Spatial Development (ARE) commissioned a Stated Preference (SP) survey with the support of a number of cantons and the Swiss Federal Railways. With SP surveys, possible travel behaviour changes of the respondents are analysed by presenting them with different choice scenarios of varying attributes. Every five years the Swiss Federal Offices for Statistics (BFS) and Spatial Development (ARE) carry out the mobility and transportation Microcensus, a survey that is representative of the Swiss population in terms of trip characteristics and of the persons sampled. In 2010, the possibility arose for the first time to combine the Microcensus with a Stated Preference (SP) survey in which data on mode and route choice behaviour were collected.
The respondents to the SP survey were recruited from among the participants in the Microcensus. The SP surveys, which were designed as Stated Choice (SC) experiments, were based on trips reported by the respondents during Microcensus Computer-Assisted Telephone Interviews (CATI). Discrete choice models estimated from data from the Microcensus (Revealed Preference, or RP, data) as well as data from the SP survey will be used to develop the national individual transport model further as well as to establish and extend cantonal models. Test models based on just the SP data were estimated to assess the validity of the data. They yielded the expected results, both in terms of model quality and in terms of the modelled effects. The results will have to be consolidated using a joint RP/SP approach before being used in forecasting models.

Operational options of an intra-train communication system: A study in the context of the agreement between SBB Cargo AG and the Federal Office of Transport about compensations for single-wagonload traffic
Bruckmann, Fumasoli
Client: SBB Cargo;
07/2011 to 11/2011

The SBB Cargo AG was given the task to examine innovations for single-wagonload transport (SWL) and especially possible applications of an intra-train communication system as part of the compensation agreement for single-wagonload traffic that it made with the Federal Office of Transport (BAV) in 2011. The BAV initiated the study with the goal of investigating technical innovations that would lead to more economical and qualitatively better single-wagonload traffic. The BAV wants to avoid problems of past technology migrations like the planned introduction of automatic couplers in Europe, which had to be performed within a few days. SBB Cargo expanded the remit to include further points such as the potential for technical, organisational and regulative innovations for rail freight and their suitability for the SWL network in Switzerland. Furthermore, the innovation process for SWL as a whole was examined.

Optimal network utilisation and the effectiveness of instruments to steer usage
Frank, Fumasoli, Moll, Weidmann
Client: SBB;
04/2010 to 10/2011

The SBB expects strong growth in demand over the next twenty years. By contrast, investment funds are getting more and more limited. Therefore, economic and regulatory steering instruments were analysed to enable the full utilisation of existing capacities and to further optimal network usage. Consequences regarding capacity and investment allocation were derived.

Railway landscapes of Switzerland
Orth, Schmidt, Wichser, Weidmann;
09/2009 to 05/2011

The 1999 Swiss railway regulation reform produced the current situation that is somewhere between the classic fully integrated state railway system and a fully liberalised railway market. This situation has a number of drawbacks, including putting the federal government into a position of conflicting interests, as it has the dual role of being a railway regulator and a railway owner. Furthermore, this situation does not comply with the legislative environment in the European Union and may particularly threaten the smaller private railways of Switzerland.
An analysis of the current situation shows that neither a rollback to the classic state railway model nor the present railway regulations have a long-term perspective, and that neither can satisfy political and legislative requirements. This leads to the conclusion that another, more fundamental reform of the railway sector is to be expected within the next decade. Therefore, possible future regulative and organisational models for the Swiss railway infrastructure must be evaluated and their opportunities and risks assessed. The evaluation conducted during the course of this study first built a system of goals based on the different parties involved in, or affected by, the organisation of railway infrastructure. Then a number of organisational models fulfilling the critical requirements were developed. These models cover a wide gamut of viable options, ranging from separate regional infrastructure operators to a single unified national infrastructure operator, and from giving infrastructure operators almost full individual responsibility and decision-making powers to highly regulated models in which they merely execute decisions made by regulative bodies.
The models were then evaluated in the system of goals to assess the different parties' respective gains or losses . The aim of this analysis was to identify models that are not only beneficial overall, but that also favour the different parties evenly to avoid disproportionate benefits or disadvantages.

SPIN-ALP: Scanning the potential for intermodal transport on Alpine corridors
Moll, Wichser
Project partners: Rapp Trans, PTV, ECONSULT, ATL
Client: ASTRA;
06/2008 to 01/2011

The main goal of the SPIN-ALP project was to develop procedures, methods and instruments to help estimate the potential shift of road freight transport to intermodal transport. The project was carried out on behalf of the European research initiative EUREKA and within an international consortium composed of partners from Germany, Austria and Switzerland. SPIN-ALP's concept offers a comprehensive model that consists of the following products:

- SPIN-ALP Manual: An electronic handbook for planning intermodal transport and for developing strategic decisions, with basic information on intermodal transport. It contains both methodical basics and concrete examples that were collected through an international exchange of experience.
- SPIN-ALP Planner: Software for intermodal transportation planning. It calculates time- and cost-optimised intermodal routes from door to door, based on available offers and timetables in Europe.
- SPIN-ALP Trainer: A supporting handbook for users to implement and apply the SPIN-ALP software.

With the aid of these SPIN-ALP products, modal shift analysis can be carried out in a target-oriented and efficient way on both the macro and the micro levels. Test applications with market players and public authorities have shown their practicability. A widespread use of SPIN-ALP products should lead to a sensitisation of concerned market players for intermodal traffic, and thus to an increased shift from road haulage towards intermodal transport.

STEP study about HSL Chestenberg
Bruckmann, Frank, Höppner, Weidmann
Client: BAV;
07/2011 to 11/2011

The Institute for Transport Planning and Systems (IVT) conducted a study on behalf of the Federal Office of Transport (BAV) on the NBS Chestenberg rail infrastructure upgrading project. The study is an external second opinion on a request by the Swiss Federal Railways (SBB) that the government build the Chestenberg tunnel between Rupperswil and Gruemet (Canton of Aargau) as part of the next railway network expansion step by 2025. The IVT concludes that there is no compelling need for this tunnel before 2030, particularly because the SBB's forecast for passenger traffic on the Zürich–Aargau corridor is at the upper end of the expected development scale, and also because substantial travel-time savings cannot be realised with the new line. Instead of constructing the Chestenberg tunnel, the IVT recommends investments of around 100 million francs in various technical measures to ensure the stability and flexibility of the timetable in the Zürich–Aargau corridor while using the existing line. Then there would be enough time to review various options for major expansion in the Zürich–Olten railway corridor. The institute proposes a new line between Zürich and Olten south of the existing corridor with a first stage between Zürich and Gexi (Lenzburg) as an alternative to the Chestenberg tunnel.

Strategic network planning for tramways in the region of Basel for 2020: Phase II
Barth, Wichser, Weidmann
Clients: Bau und Verkehrsdepartement Basel-Stadt, Bau- und Umweltschutzdirektion Basel-Landschaft;
10/2010 to 11/2011

The tramway network of Basel, consisting of infrastructure belonging to different owners and operated by two transport companies, has—apart from a few exceptions—neither been considerably extended nor reduced for a considerable amount of time. Recently, a new desire for network expansion has arisen. For example, an extension to Weil am Rhein is already under construction and several further extensions are

planned or at least under political discussion. Therefore, a strategic plan of the tramway network taking account of these circumstances and offering an overview has become essential.
The task of the Institute for Transport Planning and Systems (IVT) was to accompany and facilitate this planning process by offering professional advice. This notably included setting up guidelines, jointly defining an evaluation methodology, as well as verifying an evaluation of different approaches for further development that had been carried out by the offices of the cantons involved.

Study of passenger flow at the line m1 station "EPFL"
Höppner, Kirsch, Weidmann
Client: Transports publics de la région lausannoise;
01/2011 to 05/2011

Transports publics de la région lausannoise, the local transport provider of the City of Lausanne, plans to modify the "EPFL" light rail station. The reason is the planned construction of a congress centre for concerts, fairs and various major events, together with a number of residential units. Today the station is mainly frequented by students and staff members of the Swiss Federal Institute of Technology in Lausanne. It follows that the walkways and platforms could become overcrowded during peak hours. The IVT analysed different scenarios using the commercial microsimulation software SIMWALK to determine the best solution for designing the surrounding area.

Support for developing a preliminary maintenance programme plan and a logistical model
Fink, Weidmann
Client: Siemens Schweiz AG;
02/2011 to 04/2011

To prepare a tender for an ETCS equipment supply project, several predictions and preliminary concepts were required. The IVT provided scientific support for the development of a preliminary maintenance programme plan. Furthermore, the IVT developed a logistical model for the spare parts supply and made calculations for the planned required stock size for spare parts based on the history shortages, lead times and the availability of the required spare parts.

TESS—Intermodal Solutions for Trans-European Temperature-Sensitive Shipments
Orth, Schmidt, Wichser, Weidmann
Project partners: KTH Stockholm, TFK Borlänge, HERRY Consult, HGU Gothenburg
Client: Swiss Federal Office of Energy (SFOE);
04/2007 to 05/2011

The work conducted and reported on is part of a transnational project bringing together research institutions from Austria, Sweden and Switzerland. The goal was to study rail as a solution to ever-increasing transport volumes of temperature-sensitive goods. In order to achieve full competitiveness in this market, rail transport will have to overcome a number of challenges. In addition to speed, flexibility and cost-efficiency, perishable cargo requires special procedures and equipment. On the other hand, rail can provide significant benefits with regard to the sustainability of transport, and road transport costs are on the rise, creating a viable perspective for a modal shift.
The IVT´s task within this project was to evaluate different transport corridors from northern Italy, a typical starting point for fresh produce transports, to Scandinavia, a major region of consumption. The routes considered included a number of rail and road corridors through Switzerland, Austria, Germany and Poland including ferry links to Scandinavia where needed. After a number of viable options were determined, they were evaluated in detail with respect to transport time and cost, based on transport units and processes suitable to handling temperature-sensitive goods. The evaluation of the rail routes included, among other factors, grades, maximum train lengths, traction demand and track path fees, and it was based on a standardised intermodal train for the transports studied.

Not surprisingly, a major factor for rail competitiveness is the long travel distance of a large and reasonably stable transport volume. This also means that any additional trans-shipment processes, e.g., those needed for ferry passages, decrease rail competitiveness considerably. Consequently, it was found that transporting intermodal units by rail is a viable solution if the transport covers the whole distance between production and distribution hubs in a single leg, offering very competitive costs and travel times that are well within the range of fast road transport.

Tram evaluation 2020, BVB
Höppner, Kirsch, Weidmann
Client: Basler Verkehrsbetriebe (BVB);
04/2011 to 06/2011

The urban public transport provider Basler Verkehrsbetriebe released a call for tenders on new tram vehicles. The company received various offers from different rolling stock manufacturers. The IVT supported the BVB in its evaluation with a focus on dwell time. Calculations were made for different situations of crowded trains and platforms using analytic methods. The IVT developed a ranking based on passenger dwell time aspects and pedestrian flow usability.

7.2 Ongoing projects

Table 15 Ongoing projects (2011)

Title	Group	PI	Researcher	Start	Client, Sponsor
A calibration study for VISSIM	SVT	Menendez	Ge	07/2011	City of Zürich
A second opinion on the Heitersberg slab track	VS	Weidmann	Nägeli	03/2011	Swiss Federal Office of Transports
An analysis of mode choice effects in different scenarios simulated with MATSim	VP	Axhausen	Dubernet, Horni, Schüssler, Vitins	03/2011	Volkswagen AG
An assessment for the development of public transport around Winterthur	VS	Weidmann	Nägeli, Schwertner, Wachter	08/2011	Regional Planning Body of Winterthur
An investigation of strategies leading to a 2000W city using a bottom-up model of urban metabolism	VP	Axhausen	Dobler, Jäggi	03/2009	SNF
Artemis (plug-in hybrid electric and electric vehicles)	VP	Axhausen	Waraich	11/2008	City of Zürich
City centre public transport attractiveness and influences thereon	VS	Weidmann	Nägeli, Orth, Schwertner	09/2011	Public Transports of Zurich
Continuous need-based planning for efficient agent-behaviour modelling	VP	Charypar	Märki, Charypar	10/2009	SNF
Destination choice modelling for discretionary activities: Fundamentals of choice set formation and impacts of spatial competition	VP	Horni	Horni	10/2010	SNF
EcoNav—Ecologically Aware Navigation: A viable, persuasive trip advisor for reducing CO_2-consumption	VP	Schüssler	Montini, Schüssler	10/2011	EU
Evacuating Swiss cities: An agent-based analysis	VP	Axhausen	Dobler, Kowald	01/10	BABS

Title	Group	PI	Researcher	Start	Client, Sponsor
Information technologies in the freight transport market of the future	VS	Weidmann	Bruckmann, Moll, Orth	10/2009	VSS
Intersection safety and its relation to signal plans in China	SVT	Menendez	Li, Shu	09/2011	China's National Road Traffic Research Center
Large terminals for combined transport: Evaluation of the gateway terminal projects Limmattal and Basel-Nord	VS	Bruckmann	Fumasoli	08/2011	Swiss Federal Office of Transports
Operational stability and the reliability of urban bus routes in Zürich	VS	Weidmann	Carrasco	10/2009	COST
Planning and optimising highway work zones	IV	Lindenmann	Schiffmann	06/2007	ASTRA 2006/007
Process- and effect-oriented management for operational street maintenance: An intra-municipal street maintenance model	IV	Lindenmann	Schiffmann	03/2010	ASTRA 2008/004
Requirements of freight transport logistics concerning network infrastructure and long-term network development in Switzerland	VS	Wichser	Frank, Fumasoli	10/2010	SVI 2009/008
Route choice in urban public transport systems	VP	Schüssler	Dobler, Montini, Schüssler	10/2010	COST TU0603
Segmenting road sections for pavement management	IV	Lindenmann	Schiffmann	05/2010	VSS 2009/705
Short-term prediction	SVT	Menendez	Mancera	09/2011	ERA-NET ROAD
Spatial accessibility and the dynamics of commuting in Germany and Switzerland from 1970 to 2005	VP	Axhausen	Killer	03/2008	SNF
SustainCity	VP	Axhausen	Bodenmann, Müller, Schirmer, Zöllig	01/2010	EU
The capacity and quality of public transport on streets	VS	Weidmann	Carrasco, Dorbritz, Orth, Schwertner	04/2011	VSS
The conversion of Klybeckquai and Westquai to residential zones: Ways to connect them to the public transport network and to optimise affected rail–port infrastructure	VS	Weidmann	Barth, Bruckmann, Orth	07/2011	Harbour of Basel Authority / Urban Planning Department of Basel
The correlation between road texture and the skid resistance of pavement and their influence on noise	IV	Lindenmann	Baumgartner, Schiffmann	01/2010	VSS
The development of public transport between Marly and Fribourg	VS	Weidmann	Nägeli, Schwertner, Wachter	09/2011	Public Transports of Fribourg
The impacts of market liberalisation on the sustainability of network industries: A comparative analysis of the railways and civil aviation in Switzerland	VS	Weidmann	Weidmann, Rieder	01/2008	SNF
The influence of parking on travel behaviour and energy consumption	VP	Axhausen	Montini, Schüssler, Waraich, Weis	12/2010	SVI 2008/001

Title	Group	PI	Researcher	Start	Client, Sponsor
The level of service and the performance of facilities for human-powered land transport	VS	Weidmann	Kirsch, Puffe	01/2010	VSS
The potential of carpooling	VP	Axhausen	Ciari	07/2009	ASTRA 2008/017
The realisation and implementation of road maintenance techniques in management practice	IV	Lindenmann	Schiffmann	02/2010	VSS 2009/706
THELMA: Technology-Centred Electric Mobility Assessment	VP	Axhausen	Jäggi, Waraich	01/2010	Ongoing
Traffic flow at uncontrolled urban intersections with attention to different modes of traffic	SVT	Menendez	Mancera	10/2011	VSS 2011/308
Transferable development rights for reducing land consumption and sprawl in Switzerland	VP	Axhausen	Killer	02/2011	SNF
Travel impacts of social networks and networking tools	VP	Axhausen	Hackney, Kowald	01/2008	IVT
Use of Sensitivity Analysis in the calibration of microscopic traffic models	SVT	Menendez	Ge	08/2011	COST TU0903
Verification of the stability of continuous welded rail tracks for narrow gauge railways in tight radii; Part 3: Field experiment	VS	Weidmann	Bopp	10/2011	Rhätische Bahn

Photo: Lijun Sun

8 Events and outreach

The IVT is involved in a wide range of academic and professional events to facilitate the transfer of knowledge and professional interaction. The tables below list major events for the period from 2005 to 2011, including a complete list of events for the year 2011 to give an idea of the range and number of activities of the institute.

Table 16 Selected major ongoing educational events and courses of the IVT (2005–2011)

Date	Title	Participants
2011–13	DAS Traffic Engineering	7 engineers and planners
2009–11	CAS Risk and Safety	25 engineers and scientists
2011–13	CAS Risk and Safety	Was not offered due to reorganisation
September 2008	Short course: Safety audits of roads (with bfu and VSS)	30 road safety experts
September 2009	Short course: Safety audits of roads (with bfu and VSS)	20 road safety experts
August 2010	Short course: Safety audits of roads (with bfu and VSS)	25 road safety experts
May 2010	Short course: RAMS/LCC for railway projects (with eduRail)	60 railway experts
May 2011	Short course: RAMS/LCC for railway projects (with eduRail)	60 railway experts
September 2006	Short course: Travel demand modelling	25 engineers and planners
October 2008	Short course: Travel demand modelling	20 engineers and planners
November 2009	Short course: Modelling decisions	20 engineers and planners
October 2010	Short course: Travel demand modelling	20 engineers and planners
October 2011	Short course: Transport planning	15 engineers and planners

Table 17 Selected international conferences, workshops and seminars (2005–2011)

Date	Title	Participants
March 2005	RailML	60 European experts
March 2006	1st IVT Alumni Day	150 former IVT students and staff
April 2007	Future of the urbanised landscape	50 German-speaking experts
June 2007	High speed conference: The future of the railway	110 German-speaking experts
November 2007	City and transport: Innovations and visions—125 years of transport engineering at the ETH Zürich	150 international experts
January 2008	IT08.Rail	300 international experts
March 2008	1st European UrbanSim users' meeting, 2008	25 international experts
March 2008	2nd IVT Alumni Day	150 former IVT students and staff
April 2008	Workshop: Peripheral traffic—Wrong periphery (with SVI)	110 Swiss experts
November 2008	New directions for Swiss road maintenance (with VSS)	70 Swiss experts
February 2009	3rd international seminar on railway operations modelling and analysis	150 international experts
April 2009	D-A-CH EMS Days (with VSS, FVS and FGSV)	60 German-speaking experts

Date	Title	Participants
June 2009	Revolution of automation: Traffic automation and society in the 20th and 21st century	110 German-speaking experts
March 2010	3rd IVT Alumni Day	150 former IVT students and staff
May 2010	2nd European UrbanSim users' meeting, 2008	25 international experts
January 2010	IVT10.rail	330 international experts
June 2011	Interdisciplinary seminar: Constantly mobile—Complex transport systems as a challenge of our societies	120 German-speaking experts
August 2011	Sustainable cities: ERSA special session	30 academic experts
March 2011	City and transport: Coexistence and competition in urban transport—The conflict about the scarce resources space and time	110 Swiss experts
May 2011	International conference on railway informatics	220 European experts

Table 18 Conferences and seminars (2011)

Event	Location	Organiser(s)
COST TU 603—Buses with a high level of service: Fundamental characteristics and recommendations for decision-making and research	ETH-Hönggerberg, 9–11 May 2011	Weidmann, Carrasco
ERSA 2011 special session: SustainCity seminar on land use and transport	University of Barcelona, 30 Aug.–3 Sept. 2011	Axhausen, Bodenmann
Interdisciplinary symposium: Stabil Mobil—Stability of public transport networks	ETH-Hönggerberg, 23 June 2011	Weidmann; University of Zürich
IVT-Kolloquium: Dezentrale Aufladeentscheidungen für das intelligente elektrische Netz	ETH-Hönggerberg, 26 July 2011	Axhausen
IVT-Kolloquium: Studentische Arbeiten HS 2010	ETH-Hönggerberg, 28 January 2011	Axhausen
6th international conference on pedestrian and evacuation dynamics—PED 2012	ETH-Hönggerberg, 6–8 June 2011	Weidmann
IVT-Seminar: A rethinking of street networks and their role in making safer and more sustainable American cities	ETH-Hönggerberg, 11 October 2011	Axhausen
IVT-Seminar: Macroscopic modelling of traffic in congested cities	ETH-Hönggerberg, 11 October 2011	Menendez
IVT-Seminar: Neue Ansätze in der Umlegung	ETH-Hönggerberg, 29 July 2011	Axhausen
IVT-Seminar: Optimale Busangebote	ETH-Hönggerberg, 26 July 2011	Axhausen
IVT-Seminar: ÖV und Flächennutzung in London	ETH-Hönggerberg, 30 June 2011	Axhausen
IVT-Seminar: Some interesting questions on parking systems	ETH-Hönggerberg, 10 November 2011	Menendez
IVT-Seminar: Strassengebühren und ÖV	ETH-Hönggerberg, 20 April 2011	Axhausen
IVT-Seminar: Web 2.0 für den ÖV?	ETH-Hönggerberg, 12 December 2011	Axhausen
IVT-Seminar: Optimal tolls based on an agent-based model of travel demand	ETH-Hönggerberg, 26 July 2011	Axhausen

Event	Location	Organiser(s)
RAMS/LCC bei Bahnprojekten: Grundlagenkurs in Kooperation mit eduRail	Congress Hotel, Olten, 19–20 May; 16–17 and 30 June 2011	Weidmann, Fink, eduRail
Stadt und Verkehr - Koexistenz und Kooperation im Stadtverkehr: Kampf um die knappen Ressourcen Raum und Zeit	Museum für Gestaltung, Zürich, 16/17 March 2011	Weidmann, Hoeppner; VBZ
UrbanSim Workshop	Athens, 4–6 July 2011	Bodenmann; NTUA/UCB
Weiterbildungsdiplom (DAS) Verkehrsingenieurwesen: Verkehr -und Verkehrsplanung	ETH-Hönggerberg, 31 October–2 November; 8–9 December 2011	Axhausen, Weis
Weiterbildungsdiplom (DAS) Verkehrsingenieurwesen: Verkehrssteuerung	ETH-Hönggerberg, 3/4 November; 5–7 December 2011	Axhausen, Weis

Photo: Michael van Eggermond

9 University and professional services

The staff of the institute is heavily involved in running the department, the school and the profession. The lists below give a complete overview of staff engagements in 2011 as well as major completed engagements from previous years.

Table 19 Ongoing service at the ETH (2011)

Organisation	Institution	Function	Name
AVETH	Board		Schüssler
D-BAUG		Deputy head of department	Weidmann
D- BAUG	Admissions committee, Master of Civil Engineering		Weidmann
D-BAUG	Admissions committee, Master of Spatial Development and Infrastructure Systems		Weidmann
D-BAUG	Advisory board, Baubetriebs-Förderpreis		Weidmann
D- BAUG	Master of Spatial Development and Infrastructure Systems	Deputy dean of studies	Weidmann
D-BAUG	Search committee, Geosensors and engineering geodesy		Weidmann
D- BAUG	Teaching committee		Scherer
ETH Zürich	CAS Risk & Safety (ETH Zürich / HSG / PSI / SLF)	Dean of studies	Weidmann
ETH Zürich	Disciplinary committee	Deputy member	Schüssler
ETH Zürich	Excellence scholarship commission		Schüssler
ETH Zürich	Future Cities laboratory	Module Coordinator	Erath
ETH Zürich	Hochschulversammlung	Vice president	Schüssler
ETH Zürich	Doctoral studies mediation board		Schüssler
ETH Zürich	Netzwerk Stadt und Landschaft	Deputy director	Axhausen
ETH Zürich	Netzwerk Stadt und Landschaft	Newsletter editor	Zöllig
ETH Zürich	Netzwerk Stadt und Landschaft	Board member	Menendez
ETH Zürich	Netzwerk Stadt und Landschaft	Board member	Weidmann
ETH Zürich	Netzwerk Stadt und Landschaft	Board member	Axhausen
ETH Zürich	Search committee Department of Management, Technology and Economics (MTEC)		Weidmann

Table 20 Completed major service engagements at ETH (2005–2011)

Organisation	Committee	Function	Name	Years
AVETH	Board	Co-chair	Schüssler	2007–09
AVETH	University senate	Vice chair	Schüssler	2007–10
AVETH	Doctoral studies mediation board		Schüssler	2009–10
D–BAUG	Departmental senate		Wichser	2004–10
D–BAUG	MSc in Spatial Development and Infrastructure Systems	Dean of studies	Axhausen	2004–08
D–BAUG	Scholarship committee	Chair	Weidmann	2007–09
ETH Zürich	Netzwerk Stadt und Landschaft	Deputy chair	Axhausen	2005–10

Table 21 Ongoing academic and professional service (2011)

Organisation	Committee	Function	Name
Alp Transit Gotthard	Mediation committee, railway technology	Mediator	Weidmann
ASTRA	MISTRA		Baumgartner
BAV	Organisational committee, railway infrastructure	Expert	Weidmann
BAV	Expert term Alp Transit	Railway technology expert	Weidmann
CEC 7th Framework Programme for Research	Transport advisory group		Weidmann
Chambre de Commerce et de l'Industrie Nord de France	Groupe logistique		Rieder
Competition and Regulation in Network Industries	Management committee		Weidmann
COST Action 804, Shanti	Management committee	Workgroup co-leader	Schüssler
COST TU 0603, Buses with a High Level of Service	Management committee		Carrasco Weidmann
COST TU 1103, Operation and Safety of Tramways in Interaction with Public Space	Management committee		Carrasco Weidmann
disP		Editor	Axhausen
DVWG, Sachsen	"Junges Forum" board		Schranil
ETR	Advisory board		Weidmann
ETR	Supplement ETR SWISS	Editor	Weidmann
GDI	Board, Regional Association of Central Switzerland, North West Switzerland, Tessin		Bruckmann
Geoinformatik 2012	Programme committee, Transportation		Weidmann
Hochschule Luzern	Examination committee, Public transport	Manager	Weidmann
HSG	"Logistikmarkt Schweiz" board	Expert	Weidmann
HSR	Civil engineering advisory board	Chair	Weidmann
IATBR	Board		Axhausen
ifmo	Advisory board		Axhausen
InnoZ	Advisory board		Weidmann
IT 13th RAIL–International Conference on Railway Informatics	Organising committee		Weidmann
JOCM	Editorial advisory board		Axhausen
JTLU	Editorial advisory board		Axhausen
LITRA	Board		Weidmann
Mathematisch-Naturwissenschaftliches Gymnasium Rämibühl	School board		Weidmann
Ministry of the Interior of Baden-Württemberg	Innovation advisory board, public transport	Expert	Weidmann
Network for Mobility	Scientific Committee		Weidmann
PED 2012, 6th International Conference on Pedestrian and Evacuation Dynamics	Co-organiser		Weidmann

Organisation	Committee	Function	Name
SATW	Programme committee, Transportation		Weidmann
Savannah Simulations	SimWalk, scientific advisory board		Weidmann
SBB	Advisory board, "Traffic Management" research fund		Weidmann
SBB	Infrastructure division	Expert	Weidmann
SBF	FP 7 support group, Transport	Expert	Weidmann
SCONRAIL	Board	Chair	Weidmann
SLG	"Tunnels and Underpasses" committee		Baumgartner
SLG	FLUX prize jury		Weidmann
SNF	Division IV	Research councillor	Axhausen
SVI	Advisory committee, SVI 2004/014 "Data mining"	Chair	Axhausen
Symposium, "Verkehrslandschaft Gotthard"	Advisory board		Weidmann
SYSTRANSIS	Board		Weidmann
TR-A	Editorial advisory board		Axhausen
Transportation		Editor	Axhausen
TRB	Committee ABJ40 "Survey methods"		Axhausen
TRB	Committee ADB10 "Traveller Behaviour and Values"		Axhausen
TRB	Committee AHB45 "Traffic Flow Theory and Characteristics"		Menendez
University of Stuttgart	Advisory board, Institute of Transportation Research		Weidmann
VBG	Advisory board		Weidmann
VKB	Zürich chapter	Chair	Weidmann
VÖV	Steering committee, Standards of Swiss Railway Technology		Weidmann
VÖVZH	Board		Weidmann
VSS	EK 1.02 Transport planning		Axhausen
VSS	EK 1.04 Supply planning		Axhausen
VSS	EK 2.06 Intersections		Baumgartner
VSS	EK 5.04 Roadway maintenance		Schiffmann
VSS	EK 7.01 Goals and strategy of road maintenance	Chair	Schiffmann
VSS	EK 7.05 Roadways		Baumgartner
VSS	EK 8.04 Freight facilities		Bruckmann
VSS	EK 8.04 Intermodality		Moll
VSS	EK1.01 Transport planning data and parking		Axhausen
VSS	FK 7 Management of road maintenance		Schiffmann
ZHAW	Advisory committee, BSc in Transportation		Weidmann
ZHAW	Advisory committee, Transport Systems Research		Weidmann

Table 22 Completed major academic and professional service (2005–2011)

Organisation	Committee	Function	Name	Years
AIPCR	National Committee Switzerland		Doerfel	2005–08
ASTRA	Platform Intelligent Transport Systems		Spacek	2004–11
ASTRA	Project management board MISTRA		Lindenmann	2004–10
CEC	7th Framework Programme for Research, Transport Advisory Group		Weidmann	2009
FERRMED	Advisory Council		Wichser	2008–09
FGSV	AA 1.11 Measurement and forecasting of travel demand		Axhausen	2004–07
FVS	Advisory board		Lindenmann	2004–11
IATBR	Board	Chair	Axhausen	2004
its–ch	National Programme Committee for its–Europe (Geneva)		Spacek	2006–08
ÖAMTC Akademie	Advisory board		Axhausen	2004–07
SVI	Board		Weidmann	2004–09
SVI	Peer review committee SVI 2002/002 Measurement and valuation of transport reliability	Chair	Weidmann	2004–07
SVI	Peer review committee SVI 2004/004 Political decision-making in transport planning	Chair	Weidmann	2006–07
SVI	Peer review committee SVI 2004/014 "Data mining"	Chair	Axhausen	2009–10
SVI	Working group "Mobility in the Periphery"	Chair	Weidmann	2005–06
SVWG	Board		Axhausen	2004–08
TRB	A1C02 Passenger travel demand forecasting		Axhausen	2004–05
DfT	Peer review committee "National Transport Research Centre"		Axhausen	2007–08
VöV	Working group "Construction"		Wichser	2004–10
VöV	Working group "Light railways"		Wichser	2004–10
VSS	Co-ordination committee		Lindenmann	2004–07
VSS	EK 1.02 Transport planning	Chair	Axhausen	2004–09
VSS	EK 2.05 Road alignment		Spacek	2004–9
VSS	EK 2.06 Intersections		Spacek	2004–09
VSS	EK 3.04 Traffic safety		Doerfel	2004–09
VSS	EK 3.04 Traffic safety		Leemann	2007–09
VSS	EK 3.04 Traffic safety		Lindenmann	2004–09
VSS	EK 3.06 Road safety		Laube	2004–07
VSS	EK 3.08 Capacity	Chair	Koy	2004–05
VSS	EK 3.08 Capacity		Spacek	2004–09
VSS	EK 8.02 Foundations		Wichser	2004–10
VSS	FK 7 Infrastructure management	Chair	Lindenmann	2004–07
VSS	FK 8 Public transport	Chair	Wichser	2008–10
VSS	Research quality assurance	Chair	Lindenmann	2007–10
WCTR	Scientific advisory board		Axhausen	2004–09

Photo: Michael van Eggermond

10 Personnel and finances

10.1 Staff development of the groups (2005–2011)

The three groups had different trajectories in the reporting period. While the two established chairs increased their staff numbers, the new third group began from scratch and the fourth group was wound up. The support staff remained roughly constant.

Table 23 Staff numbers: IVT (2005–2011)

Staff *(in capita)*	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Full / Associate professorships	2	2	2	2	2	2	2
Assistant professorships							
Senior scientists (FS ffl11)	3	3	3	3	3	4	1
Senior research fellows	12	11	6	4	2	3	5
Postdoctoral research fellows					1	2	2
Doctoral (PhD) students	21	25	25	33	38	37	38
T&R assistants	3	5	6	5	2	2	2
Technical and ICT staff	3	3	3	3	3	4	3
Administrative staff	3	3	4	4	4	4	4
Total *(in capita)*	47	52	49	54	55	58	57
Total *(in FTE)*	40.1	46.9	44.2	49.6	50.1	51.8	51.9

Table 24 Staff numbers: Transport Systems—Motorised Transport (2005–2011)

Staff *(in capita)*	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Senior Scientists, Titular Prof. (FS>10)	2	2	2	2	2	2	
Senior Research Fellows (FS 9-10)	5	5	3	3			
Postdoctoral Research Fellows							
Doctoral (PhD) Students	2	2	3	4	5	5	3
T&R Assistants	1	1	3	2	2	2	
Technical + ICT Staff	2	2	2	2	2	2	
Administrative Staff							
Total *(in capita)*	12	12	13	13	11	11	3
Total *(in FTE)*	10.4	10.2	11.8	11.8	11.0	11.0	2.5

Table 25 Staff numbers: Traffic Engineering (2005–2011)

Staff *(in capita)*	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Senior scientists, Titular professors (FS>10)						1	
Senior research fellows (FS 9–10)							1
Postdoctoral research fellows							
Doctoral (PhD) students							4
T&R assistants							
Technical + ICT staff							
Administrative staff							
Total (*in capita*)						1	5
Total (*in FTE*)						1.0	4.0

Table 26 Staff numbers: Transport Systems (2005–2011)

Staff *(in capita)*	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Senior scientists, Titular professors (FS>10)	1	1	1	1	1	1	
Senior research fellows (FS 9–10)	4	3	1	1	1	1	2
Postdoctoral research fellows					1	1	
Doctoral (PhD) students	4	6	7	11	14	13	13
T&R assistants	2	4	3	3			2
Technical + ICT staff							2
Administrative staff							
Total *(in capita)*	11	14	12	16	17	16	19
Total *(in FTE)*	10.0	13.0	11.5	15.0	16.0	14.5	18.5

Table 27 Staff numbers: Transport Planning (2005–2011)

Staff *(in capita)*	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Senior scientists, Titular professors (FS>10)							
Senior research fellows (FS 9–10)	1	1	2	1	2	3	4
Postdoctoral research fellows	1						
Doctoral (PhD) students	17	17	17	15	17	17	18
T&R assistants							
Technical + ICT staff							
Administrative staff							
Total (*in capita*)	19	18	19	16	19	01	22
Total (*in FTE*)	15.8	17.1	15.4	13.6	15.2	15.0	21.1

10.2 Staff changes in 2011

The following members of staff went into retirement: Prof. H.P. Lindenmann, Prof. P. Spacek and J. Wichser. A sad event for us, but hopefully a happy one for them, which the IVT and lots of their colleagues and guests celebrated with them last summer.

New challenges were found by Dr. S. Bepperling, D. Jacobs, N. Grau-Leemann, M. Scherer, B. Garcia de Soto Lastra, Dr. N. Latuske, G. Santel, Ph. Schmidt and A. Zaugg.

New arrivals to our institute included J. Cao, L. Montini, S. Wiedersheim, Dr. D. Bruckmann, Th. Dubernet, T. Fumasoli, B. Garcia de Soto Lastra, Q. Ge, A. Mancera, L. Nägeli and J. Ortigoso.

At the beginning of the year 2011, the institute had 56 employees, which indicates the strength of our research programme and of our level of activity.

Table 28 List of student assistants (2011)

Name	Appointment	Name	Appointment
Ackle, Lukas	Autumn 11	Jochum, Johanna	Spring and Autumn 11
Ahmad, Sumaira	Spring 11	Kleinbrod, Ulrike	Spring and Autumn 11
Ambühl, Lukas	Autumn 11	Länzlinger, Daniel	Autumn 11
Baeriswyl, Vincent	Spring and Autumn 11	Leemann, Michèle	Spring and Autumn 11
Beutler, Eveline	Spring 11	Mächler, Jonas	Spring and Autumn 11
Eckstein, Daniel	Spring and Autumn 11	Mächler, Evelyn	Spring and Autumn 11
Fahrni, Reto	Autumn 11	Merz, Erika	Spring 11
Fjodorova, Vera Nika	Spring 11	Neubrand,Stefanie	Spring 11
Flütsch, Franziska	Spring and Autumn 11	Otter, Nina	Spring and Autumn 11
Frei ,Patrice	Autumn 11	Podransky, Pascal	Spring 11
Galimova, Raisa	Spring and Autumn 11	Roeck, Martin Vincenzo	Spring and Autumn 11
Häfliger, Stefan	Spring 11	Santani, Darshan	Spring 11
Hartung-Hoffmann, Fritzi	Spring and Autumn 11	Schenk, Nathalie	Spring and Autumn 11
Hug, Rolf	Spring 11	Scherler, Fabian	Spring 11
Hüssler, Michael	Autumn 11	Schlatter, Christian	Spring and Autumn 11
Imoberdorf, Ilona	Autumn 11		

Table 29 List of visitors (2011)

Title	Name	Home university	Period of stay
Trainee	de Vries, Nicolaas	TU Delft, the Netherlands	06/09/10–31/01/11
Dr.	Drábek, Michal	TU Prag, Czech Republic	01/10/10–30/09/11
Trainee	Dubernet, Thibaut	UT Compiègne, France	01/02/11–15/07/11
Trainee	Karan, Virani	IIT Guwahati, India	11/05/11–21/07/11
Trainee	Wang, Jia Mei	Tongji University, Shanghai	01/06/11–31/05/12
Trainee	Wachter, Markus	ETH Zürich	01/09/11–31/08/12
Dr.	Li, Pingfang	TMRI, Jiangsu Province, China	02/09/11–20/11/11
Trainee	Shu, Aibing	TMRI, Jiangsu Province, China	07/09/11–20/11/11
Ass/ Prof.	Garrik, Norman	University of Connecticut, USA	07/09/11–30/4/2012

10.3 Special equipment

The **Railway Operations Laboratory** of the Transport Systems chair is a unique educational facility. It was built in the 1970s and was modernised from 2009 to 2011 with the help of our partners Siemens and SBB to meet state-of-the-art standards. It is one of the most sophisticated educational facilities of its kind in Europe. Seven stations replete with all generations of interlockings and a distance control system allow users to simulate the main production processes accurately. The acceleration, deceleration and speed profiles of the trains are scaled close to reality. The railway laboratory is heavily used by the SBB and the IVT, and it receives 2–3 visitor groups per month.

Figure 17 Railway Operations Laboratory

Source: Jahresbericht 2009

Laser Measurement System

This system that was developed and used by the Traffic Engineering group detects moving vehicles. It both localises vehicles and identifies their dimensions. A detected vehicle can be tracked in the sensor range, whereby speeds and trajectories can be registered. Moreover, the laser measurement system distinguishes several traffic directions and is able to measure the distance between vehicles traveling in parallel lanes.

Figure 18 Laser measurement system

Source: Jahresbericht 2009

Measuring posts

Twelve measuring posts are used by the Traffic Engineering Group to track the trajectories of vehicles along a road segment. Each post is equipped with an ultrasonic sensor that detects the vehicles that cross the section and registers their dimensions, speeds and distance from the post. With this system, it is possible to register longitudinal and transversal vehicle trajectories.

Figure 19 Measuring posts

Source: Jahresbericht 2009

10.4 Funding

The institute finances its operations both with funding provided by the ETH as well as through support from a wide range of outside sources.

The annual budget is about 5,500 kCHF, about half of which comes from outside sources. The funding profiles of the groups differ according to their style of operation: Some draw more on competitive academic sources, while others draw on equally competitive and selective commercial and administrative funds. The mix of sources gives the IVT its independence. The high share of third-party funds enables us to offer an educational breadth that would otherwise have to be sacrificed. The main sources are (in alphabetic order):

- CTI: Commission for Technology and Innovation, the Swiss technology transfer funding source
- The EU: European Union Framework programmes promote academic and policy research
- Foundations such as the Volkswagen Foundation support academic research
- Industry
- SBT (Road, Bridge, Tunnel) funds administered by the Federal Roads Office (ASTRA), partly through VSS and SVI, to advance practice-relevant research, state-of-the-art standards and guidelines
- SNF: Swiss National Funds for academic research and some programme funding
- The Swiss Government

Table 30 Funds by source: IVT (2004–2011)

	2004	2005	2006	2007	2008	2009	2010	2011	2005–2011
ETH funds									
Staff	76%	73%	60%	46%	62%	62%	52%	56%	59%
Operating	4%	4%	3%	3%	4%	4%	3%	3%	3%
IT	2%	2%	1%	1%	2%	2%	2%	1%	2%
Third party funds	18%	22%	35%	50%	32%	33%	43%	40%	37%
Total [kCHF]	3,436	4,330	5,331	6,501	4,972	5,215	6,560	5,476	5,484

Figure 20 Third-party funds raised by type: IVT (2005–2011)

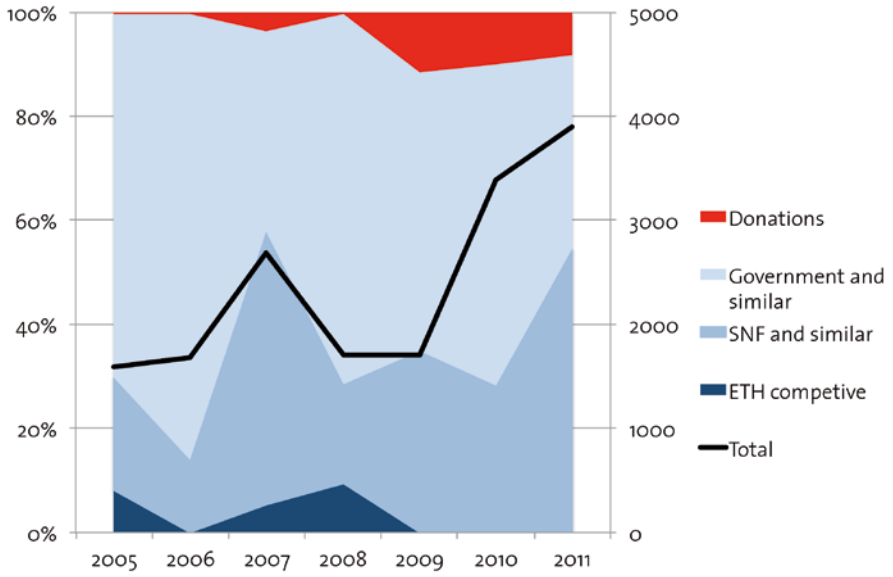


Figure 21 Third-party funds raised by group: IVT (2005–2011)

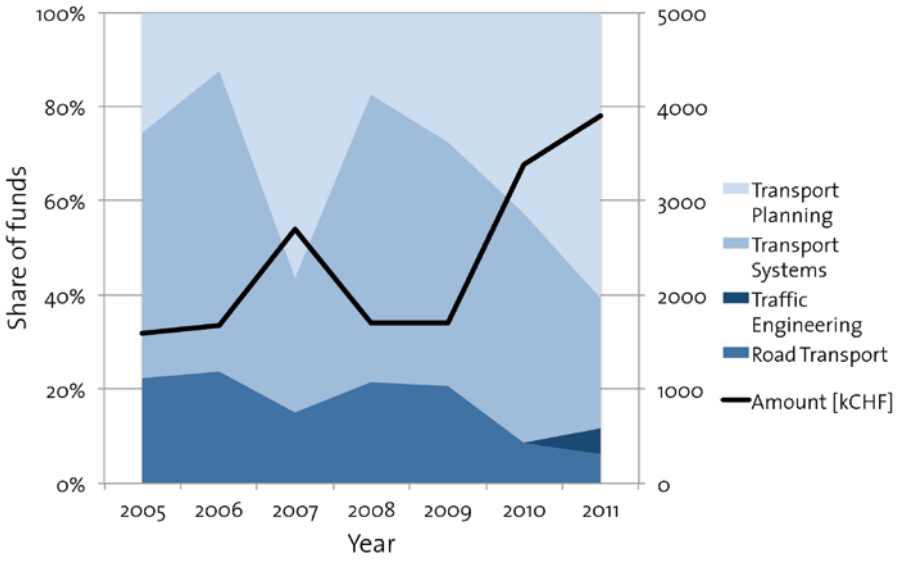


Table 31 Funds raised by type: Traffic Engineering (2005–2011)

Type	Funds raised (kCHF)						
	2005	2006	2007	2008	2009	2010	2011
ETH competitive research grants							
SNF, KTI, EU funding							22
Government, industry, private							190
Donations (estimated value)							
Total [1)]							212

Table 32 Funds raised by type: Transport Systems (2005–2011)

Type	Funds raised (kCHF)						
	2005	2006	2007	2008	2009	2010	2011
ETH competitive research grants							
SNF, KTI, EU funding	90	140	104	212	170	145	
Government, industry, private	731	928	566	822	517	1,167	752
Donations (estimated value)	7	7	97	7	198	341	325
Total	828	1,075	767	1,041	885	1,653	1,077

Table 33 Funds raised by type: Transport Planning (2005–2011)

Type	Funds raised (kCHF)						
	2005	2006	2007	2008	2009	2010	2011
ETH competitive research grants	130		142	160			
SNF, KTI, EU funding	135	80	1,148	70	340	812	2,099
Government, industry, private	144	127	229	70	128	628	269
Donations (estimated value)							
Total	409	207	1,519	300	468	1,440	2,368

Appendix A: Abbreviations

Table 34 List of organisations

Abbreviation	Original name	English name	Location
AIPCR	Association Mondiale de la Route	World Road Congress	Paris
Alp Transit Gotthard			Luzern
ASTRA	Bundesamt für Strassen	Federal Roads Office	Bern
AVETH	Akademische Vereinigung des Mittelbaus der ETH	Academic Association of Scientific Staff	
BAV	Bundesamt für Verkehr	Federal Office of Transport	Bern
CEC		Commission of the European Communities	Brussels
COST		European Cooperation in Science and Technology	Strasbourg
D-BAUG	Departement Bau, Umwelt und Geomatik	Department of Civil, Environmental and Geomatic Engineering	Zürich
DfT		Department for Transport	London
disP	disP – The Planning Review		Zürich
DVWG, Sachsen	Deutsche Verkehrswissenschaftliche Gesellschaft	German Association of Transport Sciences	Berlin
ETH Zürich	Eidgenössische Technische Hochschule	Swiss Federal Institute of Technology	Zürich
ETR	Eisenbahntechnische Rundschau		Hamburg
Fachpreis FLUX		FLUX Prize	Bern
FERRMED	Promotion du Axe Ferroviaire de Marchandises		Brussels
FGSV	Forschungsgesellschaft für Strassen- und Verkehrswesen	German Association for Road and Transport Research	Berlin
Fonds für Verkehrssicherheit	Fonds für Verkehrssicherheit	Funds for Road Safety	Bern
GDI	Gesellschaft der Ingenieure des öffentlichen Verkehrs	Association of Public Transport Engineers	Bern
Hochschule Luzern		University of Applied Sciences	Luzern
HSG	Universität St. Gallen	University of St. Gallen	St. Gallen
HSR	Hochschule für Technik	University of Applied Sciences	Rapperswil
IATBR		International Association for Travel Behaviour Research	
ifmo	Institut für Mobilitätsforschung	Institute for Mobility Research	Munich
Innenministerium Baden-Württemberg	Innenministerium Baden-Württemberg	Ministry of the Interior of Baden-Württemberg	Stuttgart
InnoZ	Innovationszentrum für Mobilität und gesellschaftlichen Wandel	Innovation Centre for Mobility and Social Change	Berlin
its-ch		its Switzerland	Bern
IVT	Institut für Verkehrsplanung und Transportsysteme	The Institute for Transport Planning and Systems	Zürich

Abbreviation	Original name	English name	Location
JOCM		Journal of Choice Modelling	Leeds
JTLU		Journal of Transportation and Land Use	Minneapolis
LITRA	Informationsdienst für den öffentlichen Verkehr	Information Service for Public Transport	Bern
ÖAMTC Akademie	Österreichische Automobil-, Motorrad- und Touring Club Akademie	Austrian Car, Motorcycle and Touring Club Academy	Wien
SATW	Schweizerische Akademie der Technischen Wissenschaften	Swiss Academy of Technical Sciences	Bern
SBB	Schweizerische Bundesbahnen	Swiss Federal Railways	Bern
SBF	Staatssekretariat Bildung und Forschung	State Secretariat for Education and Research	Bern
SCONRAIL	Schweizerische Konformitätsbewertungsstelle	Swiss Office of Conformity and Accreditation	Winterthur
SLG	Schweizer Licht Gesellschaft	Swiss Light Association	Bern
SLG	Schweizer Licht Gesellschaft		Bern
SNF	Schweizer Nationalfonds	Swiss National Science Foundation	Bern
SVI	Schweizerische Vereinigung der Verkehrsingenieure und Verkehrsexperten	Swiss Association of Transportation Engineers and Experts	St. Gallen
SVWG	Schweizerische Verkehrswissenschaftliche Gesellschaft	Swiss Association for Transportation Science	Bern
TR-A	Transportation Research A		Amsterdam
Transportation			Heidelberg
TRB		Transportation Research Board	Washington, D.C.
Universität Stuttgart		University of Stuttgart	Stuttgart
VBG	Verkehrsbetriebe Glattal	Transport Executive of Glattal	Glattbrug
VKB	Vereinigung der Kader des Bundes	Association of Swiss Federal Management Employees	Bern
VÖV	Verband öffentlicher Verkehr	Public Transport Association	Bern
VÖVZH	Vereinigung zur Förderung des öffentlichen Verkehrs Zürich	Association for the Advancement of Public Transport, Zürich	Zürich
VSS	Schweizerische Verband der Strassen- und Verkehrsfachleute	Swiss Association of Road and Transport Experts	Zürich
WCTR		World Conference of Transportation Research	Lyon
ZHAW	Zürcher Hochschule für Angewandte Wissenschaften Winterthur	University of Applied Sciences, Winterthur	Winterthur

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10 Dissertations

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13.3 Transport Planning

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