Report

Self-evaluation report 1999-2003: with publications

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Self-evaluation report
1999 – 2003
Self-evaluation report

Institute for Transport Planning and Systems 1999 – 2003

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Summary

This comprehensive report summarizes the work of the Institute for Transport Planning and Systems (Institut für Verkehrsplanung und Transportsysteme: IVT) from 1999 to 2004 against the background of changes in the department and inside the Institute: teaching, research, funding, publications, professional activities, and a SWOT analysis leading to a discussion of future strategy. Its analysis and detail expand on the chapters included in the official departmental evaluation report.

The institute has a thirty-year history. During this time, all transport research and teaching within the department was drawn together under its auspices. From a maximum of five chairs in the mid-1980’s the staff complement has fallen to currently two without any substantial reduction in the scope of our teaching. The third post required for a proper balance and coverage of teaching and research is currently under threat, which is particularly unfortunate as the EPFL is slow in realising its promise to replace and expand the transport staff compliment in Lausanne. For the time being the responsibilities of the third chair are shared by its two senior researchers, to whom the president of ETH has delegated this task.

Since the last review, the president of the ETH has transferred the tasks of the earlier ORL Institute to the Netzwerk Stadt und Landschaft (NSL) (Network City and Landscape), which now involves the IVT as a full member. While the organisational form is looser, the teaching responsibility is wider and includes the development of joint D-ARCH/D-BAUG MSc courses in urban design, spatial and infrastructure planning. In response to the last review, the Institute has ended its involvement in the routine testing of weighing-in-motion systems, guard rails and road surfaces and focuses its work on academically motivated experiments and measurement campaigns.

The organisational structure of the IVT has remained the same, while two of the three professors were replaced during the last years. Its three groups are:

- Transport Planning (Prof. K.W. Axhausen; 1999)
The mission of the IVT is:

- Generation of new knowledge for the planning, design, operation, and maintenance of transport systems
- Transfer of this knowledge through teaching, further education, and applied research

which it realises (1999-2003 averages) with about 40 full-time members of staff, who teach 20 hour/week and term, supported by a budget of 5.7 mio SFr, of which 40% (2.2 mio) are outside funds.

During the review period, the Department has implemented two new degree programmes, in particular from 2003 the new bachelor courses. As part of the introduction of the MSc stage and within the NSL framework, the IVT will start to offer jointly with the IRL an MSc in Spatial Development and Infrastructure Systems. This two year course will revolve around a core (about _ of the course load), which will also be compulsory for the students of the Architecture department’s course on urban and landscape design. In addition, the IVT will offer modules for courses organised in mathematics and environmental sciences. The teaching load of the IVT will therefore remain at the current high levels, to which the successful short courses have to be added. The Master course, as currently planned, can be taught with the available teaching resources, but without a third professor, problems could develop over the medium term.

The number of PhD students has been increased substantially during the review period. Eleven degrees were awarded to students supervised by IVT professors. There are currently 15 students registered with the professors of the institute, but Prof. Weidmann has only just started to recruit students.

The funding base of the institute’s research is well diversified, including the relevant Swiss sources, but also European Union, German and recently UK government funding. The Institute’s members are in turn very active in professional organisations, especially the Swiss norming body VSS, but also internationally. The publication strategy was traditionally focussed on guidelines and lecture notes, but has recently stressed successfully refereed and professional journal publication.

The focus of the road transport group is on geometric design of highways, traffic management, asset management and road safety. Its unique system of tracking vehicles unobserved has resulted in new insights into driver behaviour in curves and on gradients. The work on safety audits and on the national road safety strategy is currently being implemented. The railway operations, its simulation and freight logistics were stressed by Prof Weidmann’s predecessor at the public transport group, while he wants to turn his attention to systems engineering questions in the railway industry. Its OpenTrack railway operations simulation tool has become a market leader in its field, which is reinforced by the OpenTimetable tool for the analysis of railway performance. The transport planning group concentrates on the measurement and modelling of travel behaviour. Within this frame the work addresses the conduct of long duration surveys, the modelling of the rhythms of daily behaviour and of longer term choices, the construction of large scale network models for the analysis of accessibility change in the short and long run. Its results provide insight into the valuation of the travel experiences, which is translated into relevant professional guidance. The collection of long duration surveys built up at the institute is the largest worldwide. (The report provides relevant project summaries for each group, as well as complete project lists).

The policy environment outside ETH is both promising and difficult for transport research. It is promising because policymakers and system operators need advice, guidance, and tools for a number of pressing issues. It is difficult, because research budgets of federal agencies have not only stopped growing, but are being cut as emphasis shifts to applied and development work. The larger academic environment is favourable for transport-related research. It is a domain that interacts with many other research areas concerned with the understanding, modelling, and forecasting of everyday life and the provision of
necessary infrastructure services, and it flourishes through exchanges across disciplinary borders. Its engineering core is enriched by these processes, and it is able to address more and technically broader issues than ever before.

The Institute and its groups are well integrated into the Swiss administrative, professional, and research environment, as can be seen from the involvement in professional associations, high level advise or the funding obtained. These involvements are appropriately balanced with international ones. The groups of the IVT have been able to pursue certain topics over many years, such as driver behaviour, daily and longer term spatial behaviour and its modelling, and simulation of public transport time tables and networks. The IVT’s national and international reputation has grown accordingly.

During the review period the IVT has increased the number of PhD students, reviewed publications, and involvement in international conferences and seminars. As an engineering institute in a non-English speaking country, it has the additional responsibility and commitment to publish its results in German, thus making them available to practitioners and the public who do not read academic or English language journals.

The IVT’s priorities reflect our mission and our wish to develop the Institute as a strong research and teaching institution serving Switzerland and the wider professional community.

The implementation of the joint Master course Spatial Development and Infrastructure Systems from winter term 2006/07 is our first teaching priority. The short course and seminar activity will be maintained at current levels to ensure the on-going transfer of our work into practise.

The broad funding base of the Institute should allow us to maintain our research activities at current levels. The first priority is to increase the share of academic funding bodies, such as SNF or ETH, to support more fundamental and blue skies work required to advance the state-of-the-art of field research.

While there is no need at the moment to re-organise the IVT fundamentally, the Institute needs to find ways of integrating post-docs into its structure and to open up possibilities for long-term employment for some of the younger senior staff. The Institute also needs to find better ways of integrating into the NSL to take advantage of this challenging, but potentially very productive collaboration with the Architecture Department. Finally, the Institute will do its best to secure the appointment of the third professor, so that the successful balance of work in transport planning, as well as road and public transport system engineering can be maintained and developed.

**Keywords**

Evaluation, D-BAUG, IVT, ETH Zürich

**Preferred citation style**

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1 Structure and context

1.1 Background

The Institute for Transport Planning and Systems (Institut für Verkehrsplanung und Transportsysteme: IVT) has a thirty-year history. During this time, all transport research and teaching within the department was drawn together under the auspices of one institution. The initial impetus came from Prof. Martin Rotach in 1975, while the section ‘Highway and Railway Engineering’ was added after the election of Prof. Grob as Rektor of the ETH in 1985 and the dissolution of his Institute for Highway and Railway Engineering. At this point, there were five chairs. This number has steadily declined since, as neither Prof. Grob’s nor Prof. Rotach’s chairs (early 1990’s) were filled again. During the last decade, the work of the IVT was shared between three chairs. While Prof. Hidber’s and Prof. Brändli’s posts were filled relatively quickly,(Axhausen, 1999; Weidmann, 2004), the chair in Transport Systems – Road Traffic (Prof. Dietrich) remains unfilled and subject to discussion. The resulting organisational form is discussed below.

Further discussion about the third professorial post is handicapped by similar uncertainties at EPFL. The departments D-BAUG and ENAC agreed to co-ordinate their appointment policy (see Departmental report) in late 2002. Part of this agreement was an understanding that ENAC would quickly expand their transport staff, while D-BAUG would maintain a professorial staff complement of three posts. Unfortunately, ENAC has so far not carried out their part of this agreement. It still has not advertised the post of the recently retired Prof. Bovy and has not outlined an official plan to add posts. Our difficulties in getting permission to advertise the third post are comparable. Recent discussions in the Department even suggest the removal of the post.

Until 2002, research on highway materials and construction was administered by the IVT, but directed by Dr. Caprez of the Institute for Geotechnics (IGT). This confusing arrangement was clarified by allocating responsibility for this research to the IGT, while research on the driver/surface interaction remains with the IVT. As part of this reorganisation, the \textit{Kundlauf} testing facility for the continuous cyclical loading of road surfaces (located at the EMPA) was handed over to the IGT.

Responding to the last review, the IVT has reorganised two strands of its laboratory work since 1999. The weighing-in-motion calibration tests came to an end in 2003. The guard-rail impact tests have been transferred to TSR Engineering, Zürich, a spin-off firm founded by a former IVT employee.

While the IVT has undergone substantial internal change since the last review, it has also been repositioned within the Department and ETH overall due to the disbanding of the ORL (Institut für Orts-, Regional- und Landesplanung; Institute for Spatial Planning) in October, 2002. The ORL was an interfaculty institute sponsored by Architecture (D-ARCH) and Civil, Environmental and Geomatics Engineering (D-BAUG), with the goal of advancing research and teaching at the interface between urban design, landscape architecture, and planning. This mission was transferred to the Netzwerk Stadt und Landschaft (NSL) (Network City and Landscape), which now involves the IVT as a full member. While the organisational form is looser, the teaching responsibility is wider and includes the development of a joint D-ARCH/D-BAUG MSc course in urban design and spatial planning (See below). A first set of research projects is currently under way and more are planned in the context of the NFP 54 “Sustainable development of the built environment”.
1.2 Organisation

The IVT is organised into three groups. While each group has its own profile and mission, they all contribute to the goals and the mission of the Institute. The groups are:

- Transport Systems: Road Transport (H.-P. Lindenmann and P. Spacek)
- Transport Systems: Public Transport (Prof. U. Weidmann)
- Transport Planning (Prof. K.W. Axhausen)

These groups are led by a full professor (chair), with the exception of the group Transport System: Road Transport. Due to the vacant chair, and the discussion about its re-advertisement, the group is chaired by its senior scientists: Mr. P. Spacek and Mr. H.-P. Lindenmann. IVT’s 2002 agreement with the president of ETH gives them the same rights and responsibilities as a professor in matters of teaching, research and personnel.

The director of the Institute (Institutsvorsteher) is responsible for co-ordination of joint activities, particularly IVT teaching, common support staff, and supervision of the joint budget. He also represents the Institute in relevant departmental committees. Regular internal events consist of a research seminar in October and a staff meeting each semester. The research seminar is open to members of the NSL and invited senior colleagues from EPFL.

The common staff consists of a 50% senior co-ordinator, Dipl.-Ing. Mrs. Z. Oblozinska and three administrators sharing 190% FTE. The technicians of the Institute are part of the group Transport Systems: Road Transport.

1.3 Mission

The mission of the IVT is:

- Generation of new knowledge for the planning, design, operation, and maintenance of transport systems
- Transfer of this knowledge through teaching, further education, and applied research

which is translated by each group into specific goals:

Transport systems: Road transport:

- Research, teaching, and advice on design, construction, operations, and maintenance of road infrastructures with focus on traffic operations and traffic safety. Special attention is given to urban networks and the interfaces between the motorways/freeways and the remaining trunk road system in agglomerations.

Transport systems: Public transport:

- Generation of new knowledge for an economical public transport system and network through the advancement of methods and models for operation, infrastructure management, and design.
- Transfer of this knowledge through teaching, further education, and applied research focussed on freight and passenger transport systems and processes.
Transport planning:
- Generation of new knowledge about the structures of spatial and, in particular, travel behaviour through the advancement of methods for its observation, measurement, description, and modelling on a micro and macro scale
- Transfer of this knowledge through teaching, further education, and applied research, particularly through work on large scale networks and demand models, and on the parameters of cost-benefit analysis.

1.4 Funding and resources

The following tables provide an overview of the resources available to the Institute: persons (Table 1), full time equivalents (Table 2), funds (Table 3) and office space (Table 4).

Table 1: IVT: Persons employed (as of November of each year)

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
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<th>2002</th>
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<td>-</td>
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<td>Senior scientists</td>
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<td>PhD students</td>
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<td>11</td>
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<tr>
<td>Teaching/research assistants</td>
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Table 2: IVT: FTE (as of November of each year)

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<td>2.00</td>
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Table 3  IVT: Annual budgets (in current kSFr)

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<td>6116</td>
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Table 4  IVT: Floor space (m²)

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<tr>
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<td>Laboratories</td>
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<td>1512</td>
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</tbody>
</table>

2  Teaching

2.1  Current degree and future plans

The current degree programme (Studienplan 1999) is structured around specialisations of 16 SWS (weekly hours of lecturing per term) across four semesters. The IVT offers one specialisation and an additional 16 SWS of electives. In addition, the IVT contributes to postgraduate courses in spatial planning and landscape architecture and the Diploma-programme in environmental sciences (Table 5).
Table 5  IVT: Lecturing load [h/week and term] (including non-D-BAUG programmes)

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
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<td>5.40</td>
<td>9.40</td>
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<td>17.50</td>
<td>18.50</td>
<td>19.50</td>
<td>20.90</td>
</tr>
</tbody>
</table>

Continuing their tradition, the Transport Systems groups produce detailed class notes, which serve as textbooks, both internally and externally (See the literature lists for details). The specialisation attracts around seven students each year, who usually combine it with a specialisation in structural engineering or construction management. Unfortunately, the students in the other two departmental degree programmes cannot choose transport as a specialisation, even if they wished.

The change to the BSc/MSc system has begun for the IVT, along with the rest of the department. We offered one of the topics in second semester group projects, and found that it was well received. The two required courses are now scheduled in the 4th and 5th term, but they will be presented with a slightly increased number of lecture hours. The department, the IRL, and IVT all wish to offer an MSc programme in spatial development and infrastructure systems. The internal planning for this programme is well advanced, but the co-ordination with the D-ARCH within the framework of the NSL is delaying progress at this point.

2.2  Thesis work

The IVT attracts a fair number of students for the semester (7 weeks full time work) and diploma thesis work (13 weeks full time work) (Table 6 and Table 7). The theses can be either research-oriented or problem solving. In recent semesters, the Transport Planning group supervised a minor in the Urban Design diploma thesis of the architectural degree course. These 21 students were counted as MSc thesis students, as the supervision effort was similar to that of a D-BAUG student.
Table 6  IVT: Number of theses supervised by members of the Institute by type

<table>
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<tr>
<th></th>
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Table 7  IVT: Number of theses supervised by members of the Institute by group

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<tr>
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<td>10</td>
<td>18</td>
<td>12</td>
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<tr>
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<td>3</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>17</td>
</tr>
</tbody>
</table>
2.3 Doctoral students

The previous generation of professors (Rotach, Grob, Brändli, Dietrich and Hidber in the case of the IVT) did not emphasise a PhD education for their staff members. A total of about twenty PhDs were granted between 1975 and 1998 to IVT staff members. This attitude is changing noticeably in the institute, the department, and ETH engineering departments, as evidenced by the numbers in Table 6 (Table 9 lists the topics for the degrees awarded since 1999). Prof. Axhausen and Prof. Weidmann are committed to an active group of PhD students at the IVT, as seen in Table 8.

Table 8  IVT: Doctoral theses begun

<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Area</th>
<th>Referees</th>
<th>Period</th>
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<tbody>
<tr>
<td>Michael</td>
<td>Balmer</td>
<td>Real time activity rescheduling in a parallel model of traffic flow</td>
<td>Nagel, TU Berlin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Axhausen</td>
</tr>
<tr>
<td>Sigrun</td>
<td>Beige</td>
<td>The dynamics of life style choices over the life cycle</td>
<td>Axhausen, Wegener, Universität Dortmund</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maggi, USI, Lugano</td>
</tr>
<tr>
<td>Michael</td>
<td>Bernard</td>
<td>A uniform approach to the definition of the design load for transport facilities</td>
<td>Axhausen, Brilon, Ruhruniversität Bochum</td>
</tr>
<tr>
<td>Michaela</td>
<td>Bürgle</td>
<td>Agent-based simulation of the land-use system</td>
<td>Axhausen</td>
</tr>
<tr>
<td>Saikumar</td>
<td>Chalasani</td>
<td>Data fusion for travel demand data</td>
<td>Axhausen</td>
</tr>
<tr>
<td>Martin</td>
<td>Frick</td>
<td>A dynamic simulation of daily travel demand</td>
<td>Axhausen</td>
</tr>
<tr>
<td>Philipp</td>
<td>Fröhlich</td>
<td>Growth of the specific travel demand: Switzerland 1950-2000</td>
<td>Axhausen, Bell, Imperial College, London</td>
</tr>
<tr>
<td>Jeremy</td>
<td>Hackney</td>
<td>Choice of connection/route in an agent-based simulation of travel demand</td>
<td>Axhausen</td>
</tr>
<tr>
<td>Michael</td>
<td>Löchl</td>
<td>Land use and accessibility change</td>
<td>Axhausen</td>
</tr>
<tr>
<td>Stefan</td>
<td>Schönfelder</td>
<td>Urban rhythms</td>
<td>Axhausen, Bhat, University of Texas, Austin</td>
</tr>
<tr>
<td>Martin</td>
<td>Tschopp</td>
<td>Accessibility change and economic growth</td>
<td>Axhausen, Elsasser, Universität Zürich</td>
</tr>
<tr>
<td>Urs</td>
<td>Waldner</td>
<td>Environmental assessment of land use change</td>
<td>Schmid, IRL</td>
</tr>
<tr>
<td>Siegfried</td>
<td>Weinmann</td>
<td>Impact of mental maps on route choice</td>
<td>Axhausen, Nagel, TU Berlin</td>
</tr>
</tbody>
</table>
Table 9  IVT: Doctoral theses completed since 1999

| Name       | Title                                                                 | Referees                                                                   | Period   |
|------------|-----------------------------------------------------------------------|                                                                           |          |
| Franz J.   | Gallati  Stability problems of continuous metre-gauge track in curves with small radii | Brändli, Borer FH Chur                                                    | 1997-1999 |
| Daniel     | Hürlimann Object oriented modelling of railway infrastructure and operations | Brändli, Anderheggen, ETH Zürich                                        | 1995-2001 |
| Jörg       | Jermann  GIS-based analysis of the catchment area of stations          | Giger, D-BAUG Axhausen                                                   | 2000-2004 |
| Michael    | Kohler   Track modulus of ballast track                                | Brändli, Leykauf, TU München                                             | 1993-2002 |
| Arnd       | König    Measurement and modelling of transport supply reliability    | Axhausen, Zumkeller, Universität Karlsruhe                               | 2000-2004 |
| Ulrich     | Schäffler Network design principles for public transport networks     | Brändli, Bovy, TU Delft                                                  | 2000-2004 |
| Markus     | Ullius   Use of time-table performance data for the improvement and risk analysis of rail way operations – Open Timetable | Brändli, Widmayer, ETH Zürich, Zehnder, ETH Zürich                     | 2000-2004 |
| Milenko    | Vrtic    Simultaneous route and mode choice model                      | Axhausen, Lohse, TU Dresden                                             | 2000-2004 |
2.4 Short courses, seminars and conferences

2.4.1 Post graduate studies

The IVT does not offer courses of its own, but contributes to various courses offered by others within ETH (NDS Spatial Planning (Raumplanung) and NDS Landscape Architecture (Landschaftsarchitektur)).

2.4.2 Post graduate courses

Group Transport Planning organizes an annual one-week seminar for doctoral students with Imperial College, London, Universität Karlsruhe, the Technical Universities of Berlin and München, and the Universität für Bodenkultur, Vienna.

2.4.3 Short courses

The Transport Systems – Public Transport group has offered attractive and well-attended three and four day short courses for public transport practitioners (20-30 attendees) alone and in cooperation with the Swiss Federal Railroads since 1995. It plans to continue these courses.

The Transport Planning group offered a successful 5 day course on transport planning methods to 20 engineers from Switzerland and Germany in 2003 and 2004. It is planning to supplement this base course with specialized offers in alternate years.

2.4.4 Conferences, symposia and workshops

The IVT offers a regular series of half-day (June and December) and full-day seminars (January), which attract between 40 and 125 attendees from Switzerland and Germany, involving both outside speakers and contributions from IVT members. Additional well-publicised ad-hoc seminars are offered by visitors to the Institute.

Together with the former coordinator of the NFP 41, the IVT initiated a series of national research conferences: the annual English-language Swiss Transport Research Conference (www.strc.ch), was held for the 4th time this spring. It brings together about 70-80 researchers and doctoral students from all Swiss institutions involved in transport research for a three day exchange based on written papers. The conference is co-funded by the relevant national administrations. It is now jointly organized by IVT, ENAC (EPF Lausanne), USI, Lugano, and the Universität St. Gallen.

Prof. Axhausen organized the 10th International Conference on Travel Behaviour Research in Lucerne during August 2004. It is the most important international conference in this field and was attended by 170 researchers from around the world. The next conference in this triennial series is planned for Kyoto in 2006.
3 Research

This section sets out the research context in which the Institute operates, as well as the research undertaken by each of the groups. Here we provide a discussion of main research areas, a list of projects undertaken in the last five years, and abstracts of four typical research projects to provide a better picture of the styles and strengths of each group.

The distribution of the Institute’s publications by type and group represents the diversity of its work. (see Table 10). Not mentioned here are the many Swiss norms that are directly based on our work or, in a different type of service, the datasets published in the Institute electronic data archive. As always, written results cannot fully measure the impact of an academic institution. This is particularly true in a country like Switzerland, where the IVT functions partly as a substitute for a government operated research lab, like the BAST in Germany, Volpe Institute in the USA, or INRETS in France.

<table>
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<tr>
<th>Type of publication</th>
<th>Group</th>
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<td></td>
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<td>Public transport</td>
<td>Transport planning</td>
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<td>251</td>
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</table>

3.1 Context and research sponsors

The IVT draws on a wide range of sponsors and programmes to fund its research (Table 11). ETH provides the foundation through its regular funding of teaching/research assistants, including some funding for students on an hourly basis. This funding covers the requirements of teaching, administration, and technical support and provides a base for research. This is especially important, as the ETH research fund and the SNF only provide for 60% posts for doctoral students. Our experience has shown us that this amount needs to be supplemented by 20% to 40% to recruit and retain high quality staff in a tight labour market for transport planners and engineers.

The internal ETH research fund, as well as the SNF seem to maintain informal limits on the total amount of funding available for any one group in any one period. They also cap awards by limiting the award period and total funding. While follow-on funding is possible, it increases the administrative overhead of a project. The IVT was largely absent from the last major national transport research programme (NFP 41), but initiatives like these provide good opportunities, as evidenced by the NFP 48 project awarded. The
Institute hopes to be strongly involved in the current NFP 54 “Sustainable Development for Built-up Areas”, which is in the application phase. The Institute has participated in other research programmes, such as those operated by the EU, the German Ministry of Research and Technology, and the UK Department of Transport.

However, the central outside funding source for the Transport Systems: Road Transport and Transport Planning groups is the SBT (Strassen, Brücken, Tunnel – roads, bridges, tunnels) Research Fund operated by the Federal Highways Agency (ASTRA), which draws on a share of the gasoline tax to support road transport research. While some projects are organised directly by the ASTRA, the bulk of the funding is structured, prepared, tendered, and administered by the volunteer organizations VSS and SVI. The VSS sponsored research is dedicated to developing new (or improving existing) guidelines (Swiss Norms), while the SVI research is more oriented toward basic research. However, this makes the label Programme Research for the SBT funded work problematic.

Given the mission of the IVT, we do not engage in straightforward consulting (state-of-practise), but focus instead on work that addresses state-of-the-art or state-of-the-technology issues. The small number of university level transport research groups and the relatively generous funding available has drawn a number of very well qualified consultancies into the research market; these are the IVT’s main competition for SBT grants and government projects.

The group Transport Systems: Public Transport has a different profile, as the SBT funding is normally not relevant to its work. Next to the obvious projects for public transport undertakings, it has developed a series of successful grants in the last two EU Framework Programmes.
<table>
<thead>
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<th>Abbreviation</th>
<th>Name</th>
<th>Location</th>
<th>Type</th>
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<tr>
<td>AGS</td>
<td>Alliance for Global Sustainability</td>
<td>Zürich</td>
<td>Programme Research</td>
</tr>
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<td>ARE</td>
<td>Federal Office of Spatial Development</td>
<td>Berne</td>
<td>Government</td>
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<tr>
<td>ASTRA</td>
<td>Federal Highways Agency</td>
<td>Ittigen</td>
<td>Government</td>
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<tr>
<td>BAK</td>
<td>BAK</td>
<td>Basel</td>
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<td>Federal Public Transport Office</td>
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<td>Government</td>
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<td>BBW</td>
<td>Federal Office of Education and science</td>
<td>Berne</td>
<td>Government</td>
</tr>
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<td>Programme „Understanding Mobility better”, German Ministry of Research</td>
<td>Bonn</td>
<td>Programme Research</td>
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<td></td>
<td>and Development</td>
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<tr>
<td>BUWAL</td>
<td>Federal Office of Environment, Forest and Landscape</td>
<td>Berne</td>
<td>Government</td>
</tr>
<tr>
<td>DfT</td>
<td>Department for Transport</td>
<td>London</td>
<td>Programme Research</td>
</tr>
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<td>ETH</td>
<td>ETH Research Fund</td>
<td>Zürich</td>
<td>Research Council</td>
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<td>EU 5th Framework Programme</td>
<td>Brussels</td>
<td>Programme Research</td>
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<td>Swiss Road Safety Fund</td>
<td>Berne</td>
<td>Government / Insurers</td>
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<td>Opfikon</td>
<td>Government</td>
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<td>Kanton Zürich</td>
<td>Zürich</td>
<td>Government</td>
</tr>
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<td>NCHRP</td>
<td>National Cooperative Highway Research Programme</td>
<td>Washington</td>
<td>Programme Research</td>
</tr>
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<td>National Research Programme 48</td>
<td>Berne</td>
<td>Programme Research</td>
</tr>
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<td>SBB</td>
<td>Swiss Federal Railroads</td>
<td>Berne</td>
<td>Industry</td>
</tr>
<tr>
<td>SBT</td>
<td>Research Fund Road, Bridges, Tunnels</td>
<td>Berne</td>
<td>Programme Research</td>
</tr>
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<td>Swiss National Fund</td>
<td>Berne</td>
<td>Research Council</td>
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<td>TA-Swiss</td>
<td>Swiss Technology Assessment Centre</td>
<td>Berne</td>
<td>Government</td>
</tr>
</tbody>
</table>
3.2 Transport Systems: Road Transport

3.2.1 Areas of work

The research of the Group covers highway geometric design, traffic management and engineering, maintenance, and asset management. All three research areas are strongly related to road safety, which represents the fourth research area of the group (See also Table 13 for a list of the relevant projects and Table 12 for the external funding involved).

In the field of geometric highway design the main focus is improving the dynamic driving models underlying Swiss design standards. During the past seven years, several investigations were carried out to collect and analyze driving behaviour, particularly in curves, on up- and downgrades, and in different types of intersections. This research also served to quantify the effects of several road traffic law changes on driving behaviour.

This year, for the first time, a study will begin quantifying speed-dependent elements of standard cross section profiles, such as clearances of vehicles in motion and transverse clearances between various road users with and without opposing traffic - depending on passing speed, lane width and shape, and clearance of lateral obstacles, taking vehicles’ dimensions into account.

One of the group’s specialties is basic research on driver behaviour in curves, e.g. paths or tracks of vehicles along curves on two-lane highways in rural areas and their relationship with accident occurrence. For this purpose, we have developed a special measuring system, consisting of twelve autonomous measuring posts, which are built into regular delineator poles. The delineator poles serve both as housings for instruments and as camouflage. The measuring system enables the detection of pass-through times and vehicle speeds, direction of the passing vehicles, and vehicle lengths as well as lateral distance between vehicles and measuring poles. Dedicated software was developed for the necessary analyses, allowing for reconstruction of the speed and track sequence of individual vehicles, and a graphic illustration of the sequence against the background of the actual curve situation.

In the field of traffic management, a strategy was developed for traffic control systems on freeways in agglomeration areas where the road infrastructure cannot be expanded. The strategy rests on two pillars; an operational widening of local bottlenecks (conversion of the service lane), and integrated ramp metering. For the latter, appropriate adjustments to the control algorithms had to be developed. Applications will be realized with traffic control installations in the Zurich area. A pilot installation starts operation in August 2004.

In connection with the COST 352-Action „Influence of modern in-vehicle information systems (IVIS) on road safety requirements“, investigations are planned on individual traffic- and driving behaviour and how they are influenced by supporting in-vehicle systems and other factors. For the behavioural assessment, laboratory experiments are scheduled in co-operation with the Institute of Psychology at the University of Zurich.

The work on maintenance and asset management focuses on measurement and quality assessment of road surfaces. The results were crucial to the recent nationwide assessment of Switzerland’s motorway/freeway and trunk road network. We are starting a joint research project with the IBB for the evaluation of different forms of Public – Private – Partnerships (PPP) for operational maintenance and re-
habilitation of municipal roads. We are leading an effort to set up a group of co-ordinated research projects on the scheduling of maintenance activities.

In the fields of maintenance management and road safety, great emphasis is placed on grip characteristics of road pavement, particularly the effects of skid resistance on traffic accidents. Several projects have been conducted on this topic. Thanks to our measuring instrument (Stuttgarter Reibungsmesser) we have accumulated a valuable, long-term collection of data covering a period of approximately 20 years.

Road safety research has emphasized two areas. We have developed a new approach to road safety audits, which enables the evaluation of projects. This method will be adopted as a national guideline. The second area covers the methodology for analysis of accident black spots in road networks that has been developed by our group in collaboration with the Swiss Council for Accident Prevention. This method is already standardised as a national guideline. In this field, we intend to develop a new approach to enable the early identification of dangerous sites in road networks. The aim is to suggest preventive measures before accident accumulations occur („accident prognosis“).

In the field of maintenance road-work during traffic, current investigations are focussing on improving traffic flow and traffic safety at and around highway construction sites.

Table 12 Transport Systems Road Transport: number and funding of research projects (including funds for subcontractors)

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
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<td>KTI, Government agencies</td>
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<td>FVS</td>
<td>Measuring method for Acceleration Severity Index (ASI)</td>
<td>195</td>
<td>1996</td>
<td>1999</td>
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<td>SBT</td>
<td>Speeds in curves</td>
<td>113</td>
<td>1997</td>
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<td>Evaluation and application of impact load dampers (crash cushions)</td>
<td>157</td>
<td>1996</td>
<td>2000</td>
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<td>BUWAL</td>
<td>Traffic flow on motorways; 25 years of IVT-measurements</td>
<td>30</td>
<td>1998</td>
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<td>90</td>
<td>1997</td>
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<td>FVS</td>
<td>Traffic safety databank; pilot study</td>
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<td>Accident occurrence on high volume motorways and freeways</td>
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<td>1998</td>
<td>2000</td>
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<td>SBT</td>
<td>Noise behaviour of different pavements</td>
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<td>ASTRA</td>
<td>Minimum speed limit for heavy vehicles to goods transport</td>
<td>20</td>
<td>2000</td>
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<td>Dr. Pitzinger, Zurich</td>
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<td>ASTRA</td>
<td>Maintenance and asset management of highway installations; concept 99/00</td>
<td>13</td>
<td>1998</td>
<td>2001</td>
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<td>Methods for the evaluation of traffic safety (Safety Audits)</td>
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<td>Basic parameter for federal road safety politics (VESIPO); Evaluation of operational and infrastructural policies</td>
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<td>2002</td>
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<td>SBT</td>
<td>Speed on upgrades and downgrades</td>
<td>218</td>
<td>1998</td>
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<td>SBT</td>
<td>Experiences in town centre streetscape design</td>
<td>45</td>
<td>1999</td>
<td>2003</td>
<td>M. Schwob Architekten, Bubendorf</td>
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Project titles in italics indicate that the institute was not the project co-ordinator.
Table 13  Transport Systems: Road Transport, Research projects (Continued)

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<thead>
<tr>
<th>Source</th>
<th>Title</th>
<th>Budget [kFr]</th>
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<th>Traffic management and engineering</th>
<th>Maintenance management</th>
<th>Road safety</th>
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<td>Kanton Zurich</td>
<td>Strategies for traffic control systems on motorways/freeways in agglomeration areas</td>
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<td>2000</td>
<td>2003</td>
<td>Dr. Pitzinger, Zurich</td>
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<td>ASTRA</td>
<td>Pavement management, global valuation</td>
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<td>Pavement conditions on the Swiss federal highways</td>
<td>160</td>
<td>1999</td>
<td>2003</td>
<td>Schoriering, Essen and VIAGROUP, Zürich</td>
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<td>SBT</td>
<td>Skid resistance on freeways, Comparison of measurement results SRM and SCRAM</td>
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<td>Swiss Insurance</td>
<td>Effects of passively illuminated pedestrian crossing (HMB reflectors) on traffic safety</td>
<td>185</td>
<td>2002</td>
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<td>tacag, Zurich</td>
<td></td>
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<td>30</td>
<td>2002</td>
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<td>Schoriering, Essen and VIAGROUP, Zürich</td>
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<td>SBT</td>
<td>Methods and procedures for identifying general and local measures to increase road safety</td>
<td>96</td>
<td>1998</td>
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<td>SBT</td>
<td>Capacity of high volume Roundabouts</td>
<td>149</td>
<td>1999</td>
<td>2004</td>
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<td>SBT</td>
<td>Traffic flow and road safety of road works on motorways/freeways: improvement measures</td>
<td>236</td>
<td>2000</td>
<td>2005</td>
<td>W. Schuler, Police of Kanton Zurich</td>
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Project titles in italics indicate that the institute was not the project co-ordinator
### Table 13  Transport Systems: Road Transport, Research projects (Continued)

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<th>Source</th>
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<td>186</td>
<td>2001</td>
<td>2004</td>
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<td>ASTRA</td>
<td>Evaluation of different forms on Public – Private – Partnerships (PPP) for operational maintenance and rehabilitation of municipal roads</td>
<td>140</td>
<td>2004</td>
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<td>2004</td>
<td>2006</td>
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<td>x</td>
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<td>BBW</td>
<td>COST 352: Influence of in-vehicle information systems on road requirements (IVIS)</td>
<td>394</td>
<td>2004</td>
<td>2008</td>
<td>Institute of Psychology, UNI Zurich</td>
<td>x</td>
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Project titles in italics indicate that the institute was not the project co-ordinator

#### 3.2.2 Accident occurrence on heavily used motorways

This study was supported by the Fund for Traffic Safety and had two goals. The first was to identify causes for the constant increase in accidents on heavily used stretches of motorways. A secondary aim was to use these findings to develop traffic safety measures for these stretches.

Six heavily used motorway segments, some with high volume merging areas, were chosen for the study. Based on available police accident records, it became clear that the majority of accidents occur in the merging areas, and most often at the point of entry into the motorway lanes. For this reason, analyses of traffic flow, recorded on video, were concentrated on these locations.

The study led to the following conclusions and recommendations:

- Measures to increase traffic safety on heavily used motorways must focus on the merging areas.
- The recommended approach involves improving traffic flow conditions shortly before, and during, periods of heavy traffic by ramp metering, lane allocation, and variable speed control.
- Continuous traffic management could be further enhanced by controlling distances between vehicles and their speed.
- The study also showed that an audit of acceleration ramps should be undertaken.
Figure 1  Share of gaps below 2 sec in motorway merging areas


3.2.3  Speeds in curves

This project focused on the relationship between curve radius and speed in curves on roads outside settled areas (rural roads), subject to the general speed limit of 80 km/h, while controlling for other design elements, in order to evaluate existing design standards of the VSS (Association of Swiss Road and Traffic Engineers). The project also examined changes in speed behaviour since earlier measurements in 1978, when the speed limit was 100 km/h.

Speed was measured in 23 curves with radii between 18 and 700 m. The measuring instruments also tracked individual vehicles along the curve. Only the speed of unobstructed vehicles was analysed. The most important results of this research are summarized as follows:

- Distribution of speed on circular arcs
  - Speed in curves, particularly in curves with larger radii, clearly became more homogeneous compared to 1978.
  - Speed differences V85%/V15% and standard deviations were substantially reduced compared to 1978.
  - Standard deviations increase with increasing speed as they did in 1978; however, they were lower for larger radii
• Speed profiles/speed adjustment
  • The u-shaped speed profile (deceleration on the approach to / acceleration after the circular arcs) in curves with radii > approx. 140 m was almost never observed anymore.
  • Accordingly, within the transition curves to mid sized and larger radii, almost no decelerations occur.
  • The values of the average deceleration determined for curves with smaller radii (R < approx. 115 m) correspond favourably to the value assumed for the speed model of the existing standard.
  • In 1978, decelerations were also observed within the first half of circular arc. Practically no such behaviour was observed in 1998.

• Speeds as a function of the curve radius
  • As in 1978 a straightforward connection between speeds and radii could not be established (Figure 2). A radius dependency of the speeds in the narrower sense does not exist. Nevertheless for design purposes this correlation is judged to be useful. The variation of the measured values became somewhat smaller compared to 1978 (Figure 3 and Figure 4).
  • Both the average- and the V85%-speeds in the circular arc were reduced compared to 1978. However, for radii larger than approx. 150 m, the V85%-values exceeded the speed limit of 80 km/h.
  • The comparison of the regression curves suggests that for R > 100 m the V85%-values for 1998 were up to 10 km/h lower than in 1978. For smaller radii the differences are lower. Only for radii < 45 m were the 1998 V85%-values up to 5 km/h higher than 1978. (Kay; please check this to make sure I understood the sentence right...thanks! K.)

• Lateral acceleration and friction demand on the circular arc
  • Similar to the changes in speeds, lateral accelerations on circular arcs with radii of more than 45 m were reduced compared to 1978.
  • The demand on radial friction (coefficient fr) in curves has decreased in line with the lateral acceleration. In curves with radii > approx. 200 m, values calculated in 1998 are lower than those in the existing standard; however in radii < approx. 150, m radial friction clearly exceeded the standard’s values.
Figure 2  V85%-speeds in the middle of the circular arc as a function of the curve radius (1998)

\[ V_{85\%} = \frac{101}{(1 + 15.191 \cdot R^{0.772})} \]

Source: Spacek and Belopitov (1999)

Figure 3  Comparison of curves for \( V_{85\%} = f(R) \) in 1963/1978 (no limit / 100 km/h limit)

Source: Spacek and Belopitov (1999)
Figure 4  Comparison of curves for $V_{85\%} = f(R)$ in 1978/1998 (100 km/h limit / 80 km/h limit).

Source: Spacek and Belopitov. (1999)

- Speeds in curves and others design elements
  - High correlations were found between speeds and the degree of curvature as well as between speeds and lengths of circular arcs. The speeds in curves also depend on road width in the circular arc and on sight distances.
  - Small degrees of curvature (between 30 gon and 50 gon) proved problematic, as they increase speeds. The same holds for curves with a short circular arc (with a driving time < 2 s)

According to existing standards, design speed in curves is based on physical characteristics and available pavement grip; it is applied to roads, which should be designed according to observed driving dynamics. Due to the 80 km/h speed limit, the difference between the observed $V_{85\%}$ (1998) and design speed of VP (according the existing standard) has decreased. From this point of view, an adjustment of the existing standard and its function $VP = f(R)$ is not considered necessary at the present time. The function VP in curves is in line with foreign guidelines, which recommend speeds based on physical models.

### 3.2.4 Speed on Upgrades and Downgrades

It has been more than 20 years since the speed behaviour of passenger cars and heavy vehicles on upgrades and downgrades was last investigated in Switzerland. At that time, rural highways were subject to a general speed limit of 100 km/h. No comprehensive surveys were undertaken after the introduction of the general 80 km/h speed limit. New surveys were also necessary for heavy vehicles anticipating the plan allowing vehicles of up to 40 metric tons in weight. The heavy vehicle quotas agreed in the bilateral negotiations with the European Union came into effect on January 1, 2001; thus one of the initial aims of this study in 1999 was to make “before” situation (28 ton weight limit) surveys. The effects of increased weight limits (and resultant reduced statutory minimal power to mass ratio for heavy motor vehicles) on speed behaviour were investigated through corresponding measurements in the “after” situation during the summer of 2002. This research project attempted to determine changes in the relationship between
vertical gradients and vehicle speed, thus enabling any desirable modifications to relevant design standards. Speed on upgrades and downgrades relates, directly or indirectly, to several geometric design elements, in particular those discussed in SN 640 138a „Auxiliary lanes on upgrades and downgrades“. Approximately 40 measurements of traffic flow on freeways and main rural highways were made.

For passenger cars, an increased homogeneity was evident in the speed distribution of 1999 compared to 1978 surveys. The speed difference between fast \( V_{50\%} \) and slow \( V_{50\%} \) cars is about 20 km/h, irrespective of vertical gradient. In 1978, it was approximately 5 to 10 km/h greater. Moreover, on upgrade stretches, in contrast to downgrade stretches, a slight dependence of speed on gradient was apparent. The increased homogeneity referred to above is due to a reduction in the speed of fast cars. It was also established that the sustained speed of passenger cars on upgrades of up to 8 % is below that of 1978 – by as much as 8 km/h on low upgrades. A slight increase in speed was recorded only in the case of very substantial upgrades.

In the case of heavy vehicles, the 1999 surveys reflected a clear tendency toward a lower speed as vertical gradient increases. The speed distribution for heavy vehicles turned out to be slightly less homogenous than that for cars. Nevertheless, the speed difference between fast \( V_{50\%} \) and slow \( V_{50\%} \) vehicles has also declined markedly between 1983 and 1999, resulting in more homogenous speed behaviour. The surveys of 2002 showed a slight increase in speed difference on upgrades compared to 1999, while a further reduction was observable on downgrades. In the case of the \( V_{50\%} \) (representative of the crawl speed of loaded heavy vehicles), some very large increases were recorded in both 1999 and 2002 vs. 1983. The measurements of \( V_{50\%} \) on upgrades were slightly lower in 2002 than in 1999, while a further increase was recorded on downgrades. The decrease of heavy vehicles’ crawl speed on upgrades in 2002 was less than feared in various quarters in advance of the authorization of trucks of up to 40 tons gross laden weight.

The crawl speed of unhindered heavy vehicles was markedly higher in 1999 than in 1983, both on upgrades (on average +13.7 km/h), and on downgrades (between +10 km/h on low downgrades and +16 km/h on steep ones). The surveys of 2002 revealed a slight reduction in crawl speed (-3.8 km/h on average) on upgrades compared to 1999, whilst a further increase in crawl speed (+4.8 km/h on average) was recorded on downgrades. Nevertheless, crawl speed of heavy vehicles on upgrades today (2002) is about 10 km/h higher than in 1983. Since the speed limit for trucks has not changed, the increased speed is due partly to technical improvements in the heavy vehicle fleet and partly to the fact that haulage firms supply vehicles with superior engines for transalpine freight traffic. This means that they greatly exceed the statutory minimal power to mass ratio of 5.0 kW/t. This hypothesis was confirmed by analysis of the weigh-in-motion (WIM) measurements on the Gotthard route.

Statistical analyses of heavy vehicle fleets in Switzerland show that, since the introduction of the distance-based heavy vehicle fee (LSVA), there have been marked increases in the numbers of both light delivery trucks (+5.4%) and particularly heavy vehicles with trailers (+11.6%). With regard to operating weights (total weight of the vehicle and its load during the journey), an increase of nearly 11% in trucks of over 26 tons was recorded following the introduction of the LSVA, but decreases were evident in lower weight categories.

The WIM analysis for north-south traffic in the summer of 2002 revealed a marked increase in the number and percentage share of commercial vehicles with operating weights above the old weight limit of 28 tons, compared to the corresponding period in 1999 (increase at the Gotthard, e.g., from 6.5% to 19%). Estimated a continuation of this trend caused the research body (IVT) to reduce crawl speed on the design standard-based upgrades by 10% compared to 2002 results.

Measurement results were supplemented by microscopic simulations of deceleration processes and start-up accelerations for trucks, using various power to mass ratios and rear-axle ratios on various
grades. Comparing empirical and simulated values a new typical heavy vehicle was defined with a specific power to mass ratio of 11.1 hp/t and recommendations were drawn up for the design standard. In addition, new speed profile recommendations were developed for heavy vehicle crawl speed on upgrades and downgrades (Figure 5).

Figure 5 Acceleration and deceleration curves of the design heavy vehicle on different grades

Source: Koy and Spacek (2003)

3.2.5 Methods for evaluation of traffic safety (Safety Audit)

Changes on road infrastructure are bound to have safety consequences. In Switzerland, no procedure to conduct a coherent, objective project examination of these effects had ever been established. Ongoing research has now developed a safety audit procedure concentrating on road and traffic safety evaluation. Similar to an environmental impact statement, it provides all road infrastructure projects with a risk and danger evaluation. Negative effects on traffic safety should be identified in advance of any system change (preferably by a neutral third party) through a standardized audit process, which will also help to spread best practice. Such an audit has to be simple, practical, and relevant, and it should be able to test planned projects to determine all aspects and levels of road and traffic safety. It should fit into the existing planning and assessment procedures.

The process was designed based on a thorough review of international experience and national research, shown in Figure 6. In addition to the audit function, the process should identify improvements in the scheme under review.

This audit procedure, unlike those currently used, is divided into a preliminary and a main examination summarized in a written report. The main task of the preliminary examination is to determine the general safety level of the existing road infrastructure. The safety level of a road infrastructure (or parts of it) indicates possible risks, compared to similar roads, highlighting accidents or potentially dangerous situations. It enables the auditor to determine the locations of accident-black spots or those with a low safety level.

After the determination of the safety level of the existing infrastructure, the main examination follows with actual traffic safety evaluation. This is divided into two comparative examinations.
The first comparison examines the relevant safety indicators of the existing road infrastructure and those of the current project, with the latter ideally showing an improvement. Expected negative effects on traffic safety should be identified at this point. The assessment is based on proposed changes in infrastructure as well as expected changes in traffic flow.

The second comparison correlates the project itself and the standards. It goes without saying that a complete conformation to guideline design is most probably unachievable because of cost compromises or legal objections. Never the less, the comparison is helpful in recognizing trade-offs with the help of standards, guidelines and professional experience. What effect the differences between the actual project and standards would have on traffic safety shall be recorded by the auditor and are also part of the concluding report.

The research report provides a first collection of checklists and of quantification proposals. This new procedure has been tested by external project managers for two different road schemes. Their experiences will be integrated into the final proposal.
3.3 Transport Systems: Public Transport

3.3.1 Areas of work

The following sections describe the research focus of the group, however, there are also ongoing projects for public administration, transport companies, and public transport industry in areas such as administrative and financial management of public transport, or infrastructure and rolling stock investment decisions.

Freight Transport and Logistic: Since 1990, the IVT has pursued research projects in the field of freight transport, which is a crucial competence and important business of Swiss railway companies due to their geographical position in Europe. Furthermore, freight railways are affected directly by the EU’s open access-policy; they must respond with new, specifically, international business models. The Freight transport research projects and consulting for SBB are focussed on the intermodal transport chain covering road, air, water, and rail as well as special rail operation questions. Rail Operation: A traditional focus is the optimisation of rail operations in conjunction with the design of rolling stock and infrastructure. The aim here is minimisation of infrastructure and rolling stock investment for new transport services and optimisation of transport services on existing infrastructure. Matching the EC-direction 91/440, Switzerland required its railways to provide separate accounts for their networks and their operations. This separation changed traditional rail operation processes. The group supports railway infrastructure companies in finding and defining new processes for the optimised utilisation of their limited capacity.

Track Construction: Most research on track structures is standard gauge oriented. But in many countries, notably Switzerland, there are large metre gauge railway networks. The group works to adapt research results to meter-gauge structures, and to complement and extend the findings with its own research projects. For example, the IVT adapted design methods to the needs of meter-gauge railways and investigated the problematic nature of continuously welded track in tight curves (60 – zoom).

Rail simulation: The group views rail simulation primarily as a tool for supporting rail operation planning, online management, and infrastructure planning. It is based on traditional rail operation research. The simulation tools, Open Track and Open Timetable, which were developed in-house in recent years, have been adopted by many European railway infrastructure companies and specialised consultants.

Professor Weidmann, in post since June, 2004, sees the following areas within public passenger and freight transport systems (railway, bus, aviation, shipping) research as the focuses of the group: (i) development of networks and services, (ii) planning and realisation of infrastructures and (iii) network management and maintenance. Complementary subjects are traveller behaviour, transport policy, and sustainability. His research aims are the optimisation of system designs, investment strategies for network operators, and cost-effective maintenance methods.

Table 14 summarizes the flow of research projects and funds, while Table 15 details them individually.
Table 14  Transport Systems Public Transport: Number and funding of research projects (excluding consulting work)

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
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<td>NSF, SPP, SBT</td>
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<td>-50</td>
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<td>KTI, Government agencies</td>
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<td>71</td>
<td>8</td>
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<td>Industry</td>
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<td>Services</td>
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Table 15  Transport systems – Public transport: Research projects

<table>
<thead>
<tr>
<th>Source</th>
<th>Title</th>
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<th>End</th>
<th>Partner</th>
<th>Area</th>
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<th>Freight Transport</th>
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<th>Rail Operation</th>
<th>Track construction</th>
<th>Rail Simulation</th>
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<tr>
<td>EU</td>
<td>IMPULSE</td>
<td>212</td>
<td>1996</td>
<td>1999</td>
<td>10 partners</td>
<td>SBB</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>SBB</td>
<td>Open track and Open TimeTable</td>
<td>100</td>
<td>1998</td>
<td>2004</td>
<td></td>
<td>SBB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>BBW</td>
<td>COST 339 Small Containers</td>
<td>200</td>
<td>1998</td>
<td>2001</td>
<td>Guha AG (CH) and 10 countries</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>ETH, SBB</td>
<td>Bonus/Malus System</td>
<td>60</td>
<td>1998</td>
<td>1999</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EU</td>
<td>IDIOMA</td>
<td>80</td>
<td>1998</td>
<td>2000</td>
<td>Rapp AG und Guha, Zürich, Neuweiler AG Kreuzlingen, ACTS AG, Bern</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>ETH, VgV</td>
<td>Track modulus of ballast track</td>
<td>110</td>
<td>1999</td>
<td>2002</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EU</td>
<td>INHOTRA</td>
<td>300</td>
<td>2000</td>
<td>2003</td>
<td>9 partners</td>
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<td>x</td>
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<tr>
<td>EU</td>
<td>PORTAL</td>
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<td>2003</td>
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<td>2004</td>
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<td>x</td>
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<td>2004</td>
<td></td>
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<td>x</td>
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</tr>
</tbody>
</table>

Project titles in italics indicate that the institute was not the project co-ordinator
3.3.2 Open Track and Open Timetable

OpenTrack is a planning and simulation tool for railway operations, which the group is continuously developing and refining. OpenTrack supports the analysis of all essential design problems of a railway operator: railway operations (line and node capacity, bottlenecks, headways, timetables, propagation of delays), infrastructure design (evaluation of variants, evaluation and design of signalling systems), and rolling stock planning (scheduling, requirements). An animation mode shows running trains, prepared routes, and current signal aspects. The simulation also generates numerous types of evaluation summaries and diagrams. The interface of the simulation allows user actions (e.g. simulation of disturbances) while the process is running. Special functions support user analysis of the extensive output data, especially the progress of the simulation.

The OpenTimeTable software shows how trains deviated from their timetable in the recent past, and when and where delays tend to arise. OpenTimeTable enables users to study systematic delays and to fine-tune timetables, creating more attractive services and increasing capacity utilisation. In the near future, OpenTimeTable will offer features that automatically analyze train operations over time and notify users of any systematic trend in timetable adherence.

Figure 7 Overview of Open Track
3.3.3 European RTD projects in intermodal freight transport

Intermodal transport combines the best features of different transport modes. The group’s extensive knowledge fosters independent consulting on many current questions surrounding intermodal transport. Much of our research and consulting work has taken place within the framework of European research and technological development (RTD) projects. The group has provided scientific and expert support in the following projects.

In.Ho.Tra stands for Interoperable Intermodal Horizontal Transshipment, and it helps develop and test horizontal transshipment technologies for smaller terminals. In contrast to traditional transloaders, In.Ho.Tra devices are small, inexpensive to buy and run, energy-efficient, easy to automate, and can operate under the railway catenaries. Deploying such devices in smaller terminals allows for dense terminal network with the desirable short initial and final road stages of shipment.

IDIOMA stands for both initial and final stages in intermodal freight transport and of urban pickup and delivery services.

In the Zurich test region, three subprojects were carried out for IDIOMA:

- The FURMIA horizontal transshipment device was developed and field-tested in terminals with small and medium volumes. It is inexpensive to buy and should help lower operating costs of such locations.
- The CombiBox system worked on integrating smaller shipment sizes within the intermodal logistics chain and easing loading and unloading. Its field test involved commercial freight movements of boxes, particularly a city freight van offering services between Rothenburg and Zurich.
- ACTS is the German acronym for Rolling Container Transport System. The project helped pinpoint the needs of the consumer-goods market for ACTS, estimated its potential, and investigated compatibility problems with conventional intermodal transport.

COST actions 315 and 339 analyzed the consequences of introducing containers under 20 and over 40 feet long in European transport systems.

The IMPULSE program aimed to improve transshipment technology and thus make intermodal transport more competitive. It focused on future scenarios/methodologies for railway operations and their consequences on elements of the transport chain (transshipment terminals, rolling stock, and road distribution).
3.3.4 Bonus/Malus System for Train Delays

In the context of EU directive 91/440, most European railways have separated infrastructure management and train operations into two separate companies. The goal of this separation is to achieve more transparency in the performance of railway services and to reduce production costs through competition. However, this separation could mean that the various entities might no longer work together smoothly. To avoid this danger, and to guarantee the quality of transport services, the Swiss Federal Railways (SBB) asked the group to develop a quality-assurance instrument. A research grant from the Swiss Federal Institute of Technology Zurich also supported this work.

In 1998 and 1999, the IVT developed a bonus/malus system. This system, when implemented, will serve as an incentive for all participants to cooperate in maintaining a smooth and punctual system operation. Specifically, in the future, any member entity causing a disturbance will pay a penalty, and those affected by the disturbance will receive compensation. The study devised both complex and a simple bonus/malus systems, and under each system, the costs of a disturbance form the basis for the calculation of a penalty payment.

The complex bonus/malus system records the precise effects of a disturbance. This recordkeeping requires an elaborate IT program that renders short-term implementation of this system unlikely.

To implement a system short term (within a few months), the project proposed a simple bonus/malus system. For the calculation of the malus amount, which a party must pay if it causes a disturbance, the effects of the disturbance are merely estimated. Calculation of the amounts of bonuses to be paid to parties affected by the disturbance is based on the simple assumption that, during a given period, the disturbance affects all partners in proportion to the volume of transport services they provide.

In the simple bonus/malus system, the central dispatcher must merely note the location and the initial delay in minutes in a table that also contains trains’ running characteristics. The time reserves in the timetable help estimate both the location where the train will have recovered from the delay, and the previous delay on each track section and node. A delay on a given track section and node translate into penalty points and then into Swiss francs. The penalty payments go into a fund that is periodically distributed to infrastructure managers and train operating companies affected by third-party delays.
**3.4 Transport Planning**

**3.4.1 Areas of work**

The group Transport Planning changed directions with the appointment of Prof. Axhausen in March, 1999. Building on his earlier work, the group has since pursued six mutually reinforcing topics:

- Long-duration travel diaries and observations
- Rhythms of daily behaviour
- Longer term life style choices
- Accessibility and spatial change
- Large network and travel demand models
- Valuation of generalized cost elements
There is no one-to-one match between research areas and projects, which in many cases contribute to more than one area. The projects, partners involved, and funding details are listed in Table 16, together with their contribution to various areas of research. Table 17 summarizes the number of projects and the funding by source.

The following paragraphs summarize the work undertaken in these areas, while the following four subsections highlight four individual projects.

**Long-duration travel diaries and observations:** The IVT currently has the world’s most extensive collection of recent long-duration travel diary data: Six-week travel diaries in Karlsruhe (1999), Halle (1999), Thurgau (2003); 12-week leisure activity diary (Kanton Zürich, 2002), plus the five-week Uppsala diary (1971). The underlying surveys were designed, and their implementation supervised, by the institute. The ideas developed from these surveys have begun to influence general practice in the field; e.g. the next Swiss national travel survey.

For the GPS-data set from Borlänge, the institute developed automated approaches to the imputation of trip purpose and trip identification. This work is supplemented by the development of metadata standards for travel behaviour data.

**Rhythms of daily behaviour:** The long-duration surveys available at the institute make it possible, for the first time, to describe the home range of travellers, as well as their individual activity spaces. We have developed relevant measures for these, and have been able to show that their link with the usual socio-demographic variables is weak. On the other hand, we have also been able to show for the first time how important behavioural innovation is for travel behaviour using completely new combinations of place and trip purpose.

The transfer of these new measures to other datasets providing origin-destination information is possible and has been successfully demonstrated for commuting behaviour. Again, we are now able to characterize changes in the commuting sheds of all Swiss municipalities in new and comprehensive ways.

**Longer term life style choices:** The approach of the group emphasises longer term choices of persons and households (home and work locations; mobility tool ownership: licence, car, public transport, season tickets, bicycles) as the frame for daily behaviour. We are exploring interactions between these choices using new data sets, but are also widening the frame of reference. We have introduced the term mobility biography to describe these dynamics and are starting to develop suitable surveys to test our hypotheses formally. We have highlighted the embedded nature of travel behaviour within the social network of the traveller and demonstrated this impact using some initial small-scale surveys.

**Accessibility and spatial change:** The existing econometric literature about interaction between transport infrastructure, economic growth, and spatial change is handicapped by two factors: overly large spatial unit or very short time series. The simulation models currently available in Switzerland to evaluate the land use transport interaction are too simplistic and omit long-term life style choices.

The first shortcoming has been addressed by the development of a unique data set, which describes the available regional-level transport infrastructures and public transport services in Switzerland since 1850, covering the period after 1950 in great detail. This is matched by a socio-economic database describing all – about 3000 – Swiss municipalities for this time period. While the mapping of the accessibility change over this time period and at this level of detail is already important, it is clear that these initial descriptive analyses must lead to appropriate econometric data modelling to link investment to economic or spatial
change (See the Figure enclosed at the end of the report). This work has begun with the doctoral work of Tschopp and Fröhlich.

In the context of the NSL (Network City and Landscape), which is a joint initiative of the D-BAUG and D-ARCH, the group has started to develop an agent-based model of land-use transport interaction. This work will integrate existing work on longer-term life style choices, and will interact with new, dynamic daily travel behaviour models.

**Large scale network and travel demand models:** The commercial or in-house modelling capabilities for cost-benefit analysis available for Swiss local, regional and national authorities are severely limited, as this area of work has not received sufficient funding over the last two decades. The group has provided an important stimulus by implementing new regional, national, and European-level state-of-the-art network and travel demand models.

The route and mode choice models estimated here are increasingly used in general practice and the origin-destination matrices provide important starting points for other applications. The study of the impacts of Swiss tilting trains demonstrated in a methodologically convincing way that choice parameters derived from stated preference surveys produced in this case forecasts of a quality equal or superior to those derived from revealed preference data. This is an important contribution to the on-going discussion about the suitability of these data sources.

**Valuation of generalized cost elements:** For the first time, Switzerland is developing a formal cost-benefit guideline within the framework of a wider assessment of project sustainability. Prof Axhausen chairs the professional committee (VSS) in charge of the development of the CBA-guidelines.

In this context, the institute has undertaken the first Swiss study of the value of travel time savings and, notably, the first study to estimate the value of travel time reliability. The state-of-the-art estimates provide trip-purpose specific values and clearly show mode, income, and distance dependence of the valuations. The distance dependence has never previously been demonstrated in such clear terms. Reliability values are as important as those for the travel time savings, highlighting the need to reconsider investment decisions which stress speed at the expense of reliability.
### Table 16  Transport planning: research projects

<table>
<thead>
<tr>
<th>Source</th>
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<th>Partner</th>
<th>Area</th>
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<td>2000</td>
<td>2003</td>
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<td>2001</td>
<td>Prognos, Basel</td>
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<td>2001</td>
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<td>SBT</td>
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<td>2000</td>
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<td>SNF</td>
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<td>283</td>
<td>2001</td>
<td>2003</td>
<td>Universität Bern, Universität Neuenburg</td>
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</table>

Project titles in italics indicate that the institute was not the project co-ordinator.
Table 16  Transport planning: research projects (Continued)

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<th>Rhythms...</th>
<th>Life-style choices</th>
<th>Accessibility</th>
<th>Large scale models</th>
<th>Valuation</th>
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<td>2001</td>
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<td>TA-Swiss</td>
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<td>2001</td>
<td>2002</td>
<td>ASIT, Bern; econcept, Zürich</td>
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<td>SBT</td>
<td>Meta-data standards for trip generation surveys</td>
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<td>2002</td>
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<td>2005</td>
<td>EPF Lausanne</td>
<td>X</td>
<td></td>
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<td>Large Scale Multi-Agent of Travel...</td>
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<td>2002</td>
<td>2005</td>
<td>D-INF, ETH Zurich</td>
<td>X</td>
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<td>SBT</td>
<td>Estimation of static and dynamic origin-destination matrices from traffic counts</td>
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<td>2002</td>
<td>2004</td>
<td>Imperial College, London; PTV Swiss, Berne</td>
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<td>2005</td>
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<td>2004</td>
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<td>NFP 48</td>
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<td>2002</td>
<td>2005</td>
<td>x</td>
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</table>

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### Table 16: Transport planning: research projects (Continued)

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<th>Source</th>
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<th>Rhythms...</th>
<th>Life style choices</th>
<th>Accessibility</th>
<th>Large scale models</th>
<th>Valuation</th>
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<td>117</td>
<td>2003</td>
<td>2004</td>
<td>Universität Bern, Universität Neuenburg</td>
<td>x</td>
<td>x</td>
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<td>SBT</td>
<td>An uniform system of design loads for transport infrastructures</td>
<td>205</td>
<td>2003</td>
<td>2005</td>
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<td><em>Regional accessibility among European areas</em></td>
<td>86</td>
<td>2003</td>
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<td>BAK, Basel</td>
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<td>glow</td>
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<td>5</td>
<td>2003</td>
<td>2003</td>
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<td>51</td>
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<td><em>OPUS</em></td>
<td>308</td>
<td>2003</td>
<td></td>
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<td>Stability of travel patterns</td>
<td>153</td>
<td>2003</td>
<td>2005</td>
<td>Widmer, Frauenfeld</td>
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<td><em>ETIS Base</em></td>
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<td>2003</td>
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<td>NEA, Rotterdam</td>
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<td>SBT</td>
<td>Estimation of national origin-destination matrices by mode</td>
<td>200</td>
<td>2004</td>
<td>2006</td>
<td>Emsch + Berger, Zürich</td>
<td>x</td>
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<td>130</td>
<td>2004</td>
<td>2006</td>
<td>EB+P, Zürich; PTV, Karlsruhe</td>
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Project titles in italics indicate that the institute was not the project co-ordinator.
Table 17  Transport planning: number and funding of research projects (including funds for subcontractors)

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<tr>
<th></th>
<th>1999</th>
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<th>2002</th>
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<td>850</td>
<td>536</td>
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<td>-</td>
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<td>KTI, government agencies</td>
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<td>Industry</td>
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<td>100</td>
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<td>13</td>
<td>-</td>
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<td>454</td>
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<td>Services</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>-</td>
<td>91</td>
</tr>
</tbody>
</table>

Funds are credited in the year of the project start

3.4.2  Thurgau 2003 six-week diary

The observation of travel (and activity) patterns over long time periods is rare in transport planning due to the complexity of diary instruments for the respondents. The scarcity of data is in striking contrast to the modelling needs at the forefront of state-of-the-art, highly advanced activity scheduling models. While passive observation tools, such as GPS or GSM, have the advantage of low respondent burdens and precise measurement of time-space paths of travellers, they cannot obtain the qualitative aspects of the behaviour; the best possible alternative are imputations for activity type, number of persons participating, etc.

Against this background, the group continued the work started with the 1999 Mobidrive survey and the 2001 Zürich twelve-week leisure survey. In fall/winter 2003, together with the Ingenieurbüro Widmer, Frauenfeld, they conducted a new six diary survey in the rural and small town environment of Thurgau. The survey protocol and diary forms followed the Mobidrive example, but reflected the insights gained from the earlier surveys. The forms added questions about the social networks of the respondents, asked for planning horizons of the activities, whether the visited location was new, (See Figure 10) and also requested the group size of both the trip and the joint activity.

260 persons in 99 households participated, as planned. While recruitment was difficult, the respondents rarely abandoned the survey once they started. The trip rates are above the Swiss national averages and fatigue was not a problem.

The analysis of the data has just begun. It will focus on behavioural stability in activity involvement in respect to both timing and location of activities. The availability of the matching Mobidrive survey invites comparison between the urban context of the German respondents and the rural and small town context of Thurgau. The data will also be important to our on-going development of simulation models of activity scheduling and execution, as they allow the calibration of household interaction and scheduling models over time.
3.4.3 Human activity spaces

The activity space idea – which was developed in parallel with a range of related approaches to describe individual perception, knowledge, and actual use of space in the 1960s and 1970s (see Golledge and Stimson, 1997 for a discussion) – attempts to represent the space containing places frequented by an individual over a period of time. Activity spaces are (geometric) indicators of the observed or realised daily travel patterns (see also Axhausen, 2002). This is emphasised here, because related concepts such as the action space (e.g. Horton and Reynolds, 1971), the awareness space (e.g. Brown and Moore, 1970), the perceptual space (e.g. Dürr, 1979), mental maps (e.g. Lynch, 1984) or space-time prisms (e.g. Lenntorp, 1976) describe the individual potentials of travel – based on spatial knowledge, mobility resources, the objective supply of opportunities etc.

Very few studies have concentrated on detailed measurement of individual activity spaces (Dijst and Vidakovic, 1997; Dijst, 1999) so far. The recent availability of the multi-week Mobidrive travel data now makes it feasible to measure the extent of individual activity spaces and to test hypotheses about the usage of urban space and the multi-centred structure of our daily mobility (see Axhausen, Zimmermann,

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1 It should be noted that there is a range of studies of spatial behaviour and activity spaces on the aggregate level of sociodemographic groups or zones (see e.g. Kutter, 1973; Zahavi, 1979; Beckmann, Golob and Zahavi, 1983a, b; Holzapfel, 1980; Scheiner, 2001). Those studies use cross-sectional travel or time-use data.
3.4.4 Evaluating the quality of SP and RP forecasts with a national transport model

For the last two decades, Switzerland has not maintained national level transport demand models. The new skills available at the IVT since 1999 have allowed federal agencies and the Federal Railroads to build up this capability with our help. In addition, there was little local experience with either random utility models or stated preference data. Most forecasts were based on aggregate own-elasticities.

The introduction of a new train service provided an opportunity to advance the state of the national models, and to test the quality of stated preference (SP) versus reveal preference (RP) versus elasticity based forecasts. This methodological question had never been addressed at this level of spatial scale or complexity in the literature before. The train service changes are based on new tilting rolling stock, which allows for the reduction of travel times between Zürich, Neuchâtel, Lausanne, and Geneva. The project had to forecast the effect of those changes, using all three parameter sets, while simultaneously controlling for any change in the motorway system. The quality of the forecasts was assessed against the 2001 traffic counts, which was the target year of the forecasts.

The first part of the project was the calibration of the previous year’s (1999) model system, based on earlier work of the group (Vrtic, Axhausen, Koblo and Vödisch, 2000). The parameters of the timetable-based public transport assignment model were estimated from a new SP route choice experiment. The survey, with a 70% response rate and 1500 respondents, also involved mode choice SP experiments. The variable sets of the mode and route choice experiment overlapped. The parameter estimates of the two experiments were very similar, which increased confidence in the results.
***Figure 11***  Measuring activity spaces: overview of basic concepts

**a) Confidence ellipses**

Basic approach: probability; smallest possible area in which a defined share of all visited locations is situated

Measure: size of area (plus direction of main axis)

Special feature/quality: shows dispersion of visited locations

Precedent in studies of the home ranges of animals (Jennrich, 19xx)

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**b) Kernel densities**

Basic approach: density surface; based on the proximity of activity locations

Measures: a) area covered exceeding a certain threshold value, b) “volume”

Special feature/quality: represents local clusters / sub-centres within individual activity space

Adaptation of an idea well established in many areas of spatial analysis.

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**c) Minimum spanning trees (networks)**

Basic approach: smallest possible geometry based on all observed origin-destination relations

Measure: a) height of tree, b) size of buffered area around tree

Special feature/quality: indicator for the perception of urban space

New approach consistent with the ideas of mental mapping.

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Source: Schönfelder and Axhausen, 2003
The 'before' calibration, in which both existing car and public transport matrices were adjusted to fit the available counts, was of high quality. After expanding these 1999 matrices with a growth factor to 2001, the new route shares and mode choices were calculated three times using a pivot-approach (see Figure 12 for an example), once for each parameter set. The scale of the SP error distribution was not constrained against the RP distribution. The results were compared against individual counts, against corridor cross sections, as well as against the best estimate of total matrix volume, again estimated against all available 2001 counts. The SP based forecasts performed consistently best in each type of comparison. While the differences from other methods were not large in relative terms, the other forecasts showed some systematic errors, which obviously make application problematic.

Figure 12 Absolute differences in link volume: SP-based forecast and traffic counts [Railway network]

Source: Vrtic and Axhausen, 2004

In conclusion, the study provided the Federal Offices and the SBB with a well calibrated demand forecasting system, which has since been adopted in a number of sponsors’ internal studies. It also provided further evidence of SP – based parameters’ suitability for forecasting. However, the study raises the question whether the accepted practise of rescaling error distributions is appropriate. Could it be that the RP error distribution is actually less relevant for forecasting then the SP error distribution?
3.4.5 2003 Swiss value of travel time savings

For the first time, the VSS is preparing an official cost-benefit guideline for road investments and policies. As part of this effort, the ASTRA supported (via the SVI) a study of Swiss travel time savings values, also for the first time. In collaboration with Rapp Trans, John Bates, and Michel Bierlaire, the IVT organised, conducted, and analysed a specialised set of SP experiments. After two careful pre-tests, 1150 persons replied to route and mode choice experiments customised to the characteristics of a trip they described in an earlier RP interview.

A very careful and comprehensive step-by-step modelling strategy was adopted, which increased the complexity by adding different groups of variables, and later by estimating joint models for the different SP data sets. All calculations were performed with Biogeme (see http://roso.epfl.ch/biogeme). Thus, the final utility function incorporates those blocks of variables that had improved model fit, tested individually with the basic model including only the stated choice experimental variables:

- Inertia variables (car and PT-season ticket ownership, mode of the reported trip)
- A random parameter formulation of the travel cost variable
- Elasticity of the cost parameters with respect to income and trip distance
- Interactions between travel time and trip purpose

The combination of these elements provided new insights into the structure of the travel time valuations. The effects of distance and income elasticities were particularly striking (see Figure 13 for the example of Swiss commuters). Against this background, discussions about short travel time savings are less relevant, because the impact of mean trip distance at a particular location is more decisive. In addition, the composition of the travellers with respect to their incomes needs to be given more weight. The tests performed of that hypothesis, (that short time saving should be given smaller weights), were negative.

The study also documents fully how markedly its sample had drifted away from a nationally representative sample due to various stages of self-selection: participation in the original interview, acceptance to participate in a second survey, and finally response to a complex SP exercise. The derivation of nationally representative VTTS therefore required a reweighing to the population mean with regards to trip length and income. The resulting mean VTTS values by trip purpose are equivalent to 30% to 50% of the average hourly wage.
4   Professional activities

Members of the Institute are very involved in professional, generally unpaid, work in Switzerland and elsewhere. The two professional organisations SVI and VSS (especially the latter, due to its role as developer of national norms and guidelines and as a central funding body) play central roles, Mr Lindenmann is especially active here. Prof. Axhausen’s role as the Associate editor of Transport Research A and earlier of multiple editorial boards is noteworthy on the international side.

Table 18 lists the most relevant activities of the Institute. The remaining activities are listed in Table 20 (5 pages) in Appendix B.
<table>
<thead>
<tr>
<th>Organisation</th>
<th>Committee</th>
<th>Special function</th>
<th>Member</th>
<th>Period</th>
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<td>Spacek</td>
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Table 18  List of Important professional activities (Continued)

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<td>VSS</td>
<td>FK 7 Maintenance management</td>
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<td>2002</td>
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5  Outlook and future plans

5.1  Starting point

Generation change in the Institute’s leadership has dominated the review period. The uncertainties surrounding the appointment processes (e.g. succession within Transport systems: Public transport), the difficulties of new beginnings (Transport Planning, as well as Transport Systems: Road Transport), and the implementation of two new curricula (Diplom 1999 and BSc 2003) have influenced our work. The wider changes in the department, particularly the closing down of the ORL and the setting up the NSL, required close attention to position the IVT for a successful future. The on-going uncertainties about the appointment of a third professor in the next planning period (2008-2011) dampen activities in the affected group (Transport Systems: Road Transport), as they cloud the longer term perspectives. Still, the ETH funding base is sound overall and allows us to respond to the challenges ahead.

The policy environment outside ETH is, paradoxically, both promising and difficult for transport research. It is promising because policymakers and system operators need advice, guidance, and tools for a number of pressing issues: management and maintenance of transport systems at the capacity point, regulatory and ensuing organisational change, realisation of the transport safety objectives (VESIPO), forecasting of the land-use transport interaction in an environment guided by on-line information and real-time pricing signals¹, and project evaluation under budgetary and environmental justice constraints. It is diffic-

¹ The Swiss discussion on road pricing and tolling has been officially started by the relevant federal agency in May of this year.
cult, because research budgets of federal agencies have not only stopped growing, but are being cut as emphasis shifts to applied and development work.

The larger academic environment is favourable for transport-related research. It is a domain that interacts with many other research areas concerned with the understanding, modelling, and forecasting of everyday life. (e.g. urban design, land use planning, economics, sociology, computing, and operations research), and it flourishes through exchanges across disciplinary borders. Its engineering core is enriched by these processes, and it is able to address more and technically broader issues than ever before. Funding is as easy or difficult as ever and often depends on the availability of dedicated programme research, which can seldom be forecast. Thus, longer-term research agendas rely on funding sources that change at random intervals.

5.2 Strengths, weaknesses, opportunities, and threats (SWOT-analysis)

To avoid the repetitiveness inherent in a SWOT analysis, the following discussion brings together pertinent strengths, weaknesses, opportunities, and threats. We have omitted typical headings.

The Institute and its groups are well integrated into the Swiss administrative, professional, and research environment, as our numerous involvements in professional societies and the success of our short courses and seminars show. This strength is also a weakness, as these time consuming involvements preclude engagement on the international scene. Still, the recent experiences of the groups Public Transport and Transport Planning have shown that a better balance is possible.

The groups of the IVT have been able to pursue certain topics over many years, such as driver behaviour, daily and longer term spatial behaviour and its modelling, and simulation of public transport time tables and networks. The IVT’s national and international reputation has grown accordingly. The direction of these efforts is, on the other hand, too strongly focussed on a small number of senior staff, which creates imbalances and bottlenecks. It also creates threats, as the Institute cannot offer the non-professorial staff long term perspectives due to ETH personnel policy, which restricts the number of permanent senior staff per chair to one. The Institute has no tradition of incorporating post-doctoral students into its structure, which could alleviate this stress.

The planned arrival of a Master course in Spatial Development and Infrastructure Systems is a big opportunity for the Institute to improve the balance of its recruiting. Too often, the Institute has had to limit itself to recruitment among civil engineering students with transport specialisations, whose research skill set needed substantial supplements in statistics, operation research, computing, or GIS. The new Master course should allow us to provide students from diverse disciplinary backgrounds with good domain knowledge and understanding. This should help us, and the wider transport community, to satisfy the various skills requirements more easily. The Master course, as currently planned, can be taught with the available teaching resources, but without a third professor, problems could develop over the medium term. The additional teaching requirements will have to be fulfilled, whenever possible, by using elements from the Master course to avoid overloading the teaching staff. The Institute considers this additional teaching as an opportunity to build bridges to Mathematics, Environmental Sciences, Landscape Architectures, Computer Science, and other departments within ETH.

In the past, academic aspects of IVT research were somewhat neglected, as visible in the small number of PhDs granted and the low share of peer-reviewed publications before 1999. While this reflected the prevailing ethos of ETH engineering departments, the IVT has started to address this weakness in recent
years through sustained increases in the number of PhD students, publications, and involvement in international conferences and seminars. As an engineering institute in a non-English speaking country, it has the additional responsibility and commitment to publish its results in its native language (German), thus making them available to practitioners and the public who do not read academic or English language journals. ETH policy on the admission of PhD students is overly rigid in its acceptance of non-ETH graduates, in particular with accepting course work undertaken elsewhere. This often creates problems, as the Institute’s PhD students sometimes have non-standard or non-engineering backgrounds. The Institute hopes that this issue, and the issue of the missing doctoral level courses, will be addressed in the near future, as our own MSc course can only partially solve this problem.

5.3 Future priorities and plans

The IVT’s priorities reflect our mission and our wish to maintain the Institute as a strong research and teaching institution serving Switzerland and the wider professional community.

The implementation of the joint Master course Spatial Development and Infrastructure Systems from winter term 2006/07 is our first teaching priority. While the organisational form has not been finalised, nor the involvement of our colleagues from Architecture clarified at this point, we are optimistic that these issues can be resolved during the winter term. Our additional teaching involvements inside ETH will be structured and prepared afterwards. The short course and seminar activity will be maintained at current levels to ensure the on-going transfer of our work into practise.

The broad funding base of the Institute should allow us to maintain our research activities at current levels. The first priority is to increase the share of academic funding bodies, such as SNF or ETH, to support more fundamental and blue skies work required to advance the state-of-the-art of field. It would also provide more opportunities for academic publication. The issues to be addressed are (in alphabetical order):

- Extension of the on-going work on driver behaviour,
- Impact of transport telematics, and traffic control systems
- Integrating learning, personal biographies and social networks into travel forecasting models
- Integration of the work on the short term and long term dynamics through development-appropriate simulation models
- Investment strategies and cost-benefit analysis for infrastructure and rolling stock, and their implementation processes
- Maintenance management
- Methodologies for safety audits and safety forecasting
- New strategies for services and production in passenger and freight transport (inter-modality)
- Regulatory policy and policy strategies and their organisational implementation

While there is no need at the moment to re-organise the IVT fundamentally, the Institute needs to find ways of integrating post-docs into its structure and to open up possibilities for long-term employment for some of the younger senior staff. The Institute needs also needs to find better ways of integrating into the NSL to take advantage of this challenging, but potentially very productive collaboration with the IRL and the Architecture Department. Finally, the Institute will do its best to secure the appointment of the third professor, so that the successful balance of work in transport planning, as well as road and public transport system engineering can be maintained and developed.
## Appendix A  List of organisations

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## Appendix B  List of further professional activities

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<td>VAB</td>
<td>Schiedsgericht Einstellungenverträge SBB</td>
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<td>VÖV</td>
<td>Regelwerk Technik der schweizerischen Eisenbahnen (POL RTE)</td>
<td>Leitung</td>
<td>Weidmann</td>
<td>2004-</td>
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<td>VÖV</td>
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<td>Wichser</td>
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<td>VSS</td>
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<td></td>
<td>Axhausen</td>
<td>2002-2004</td>
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<td>VSS</td>
<td>FK 2 Planung und Projektierung</td>
<td></td>
<td>Axhausen</td>
<td>1999-2004</td>
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<td></td>
<td>Belopitov</td>
<td>2001-</td>
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<td>VSS</td>
<td>EK 3.05 Gestaltung und Betrieb</td>
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<td>EK 3.04 Verkehrssicherheit</td>
<td></td>
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<td>VSS</td>
<td>EK 5.03 Dimensionierung und Abnahme</td>
<td></td>
<td>Horat</td>
<td>2001</td>
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<td>VSS</td>
<td>EK 3.08 Leistungsfähigkeit</td>
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<td>Koy</td>
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<td>VSS</td>
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<td>Laube</td>
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<td>VSS</td>
<td>EK 9.01 Grundlagen und Begriffe</td>
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<td>2003-</td>
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<td>2001-</td>
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<td>Schiöffmann</td>
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<td>VSS</td>
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<td>Seiler</td>
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<td>VSS</td>
<td>EK 2.10 Passiver Schutz</td>
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Table 20  Further professional activities (Continued)

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<th>Member</th>
<th>Period</th>
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<td>Spacek</td>
<td>1991-</td>
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<td>2002-</td>
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<td>EK 9.07 Fahrzeugführers-Unterstützung</td>
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<td>Weber</td>
<td>2004-</td>
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<td>VSS</td>
<td>EK 8.02 Grundlagen</td>
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<td>Wichser</td>
<td>2003</td>
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<td>VSS</td>
<td>EK 8.04 Kombinierter Güterverkehr</td>
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<td>Wichser</td>
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<td>VSS</td>
<td>Koordinationskommission</td>
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<td>Lindenmann</td>
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<td>Lindenmann</td>
<td>2001-</td>
</tr>
<tr>
<td>VSS</td>
<td>EK 7.09 Gesamtbewertung im MSE</td>
<td>Präsident</td>
<td>Lindenmann</td>
<td>2001-</td>
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<td>VWI</td>
<td>Kuratorium</td>
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<td>Weidmann</td>
<td>2004-</td>
</tr>
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<td>Switzerland</td>
<td>Jury (Preisgericht)</td>
<td></td>
<td>Lindenmann</td>
<td>2001-2003</td>
</tr>
</tbody>
</table>
Appendix C  CVs of the senior staff in alphabetical order

Kay W. Axhausen (from March 1999)
Born 8. 10. 1958 in Heidelberg, German and Austrian citizen

Education
1984-1989  Universit"at Karlsruhe, Dr.-Ing (PhD) in Transport Planning
1982-1984  University of Wisconsin-Madison, M.S. in Civil Engineering
1978-1982  Universit"at Karlsruhe, B.Eng-equivalent in Civil Engineering

Professional experience
1999-      ETH Z"urich, Full Professor for Transport Planning
1995-1999  Leopolds-Franzens-Universit"at, Innsbruck, Full Professor of Road Transport
1991-1995  Imperial College, London, Lecturer and Senior Lecturer
1989-1990  Transport Studies Unit, University of Oxford, Research and Senior Research Officer
1984-1989  Institut f"ur Verkehrswesen, Universit"at Karlsruhe, Research Officer

Current major professional activities
2004      VSNU evaluation panel for architecture (TU Delft and Eindhoven), member, 2004
2003-     Transportation Research, Associate Editor
2003-     International Association for Travel Behaviour Research, chair
2002-     World Conference of Transportation Research, member, Scientific Steering Committee
2002-     Institut f"ur Mobilit"atsforschung, Berlin, Kuratorium, member, 2002-
2000-     VSS, chair, EK 2.02 Transport Planning
2000-     VSS, member, FK 2 Planning and Design
1996-     TRB, member, ADB40 Passenger Travel Demand Forecasting; ADC10 Urban Transportation Data

Peter Giger
Born 1945 in Z"urich, Swiss citizen

Education
1981-1984  ETH Zurich, Dr. sc. techn. ETH
1965-1970  ETH Zurich, dipl. Bauing. ETH

Professional experience
1985-      ETH Zurich, IVT, (leading scientist and lecturer)
1979-1985  ETH Zurich, Institute for Road, Railway and Rock Construction (chef of the section Railway Construction)
1972-1979  Swiss Federal Railways (Project Manager for the Construction of new railway lines)
1970-1971  ETH Zurich, Institute for Statics and Construction (Assistant)
**Peter Keller (until April 2004)**

Born 6.11.1944 in Basel, Swiss citizen

**Education**
- 1975–1977 ETH Zürich, NDS Raumplanung (MSc Spatial Planning)
- 1964-1970 ETH Zürich, dipl.-ing. Architecture

**Professional experience**
- 1983- ETH Zürich, IVT, Wissenschaftlicher Adjunkt (Senior Lecturer) for Spatial Planning
- 1977-1983 ETH Zürich, ORL, Oberassistent (Lecturer) for Planning Methods
- 1970-1975 Planungsbüro Ueli Roth, Architect and Planner
- 1970-1971 ETH Zürich, ORL, Assistant

**Major recent professional activities**
- 1998- HSR Rapperswil, Department of Planning, member of the advisory council
- 1982-1983 City of Zürich, Jury member, urban design competition Rigiplatz

**Hans-Peter Lindenmann**

Born 6.7.1946 in Gelterkinden, Kanton Basel-Landschaft, Swiss citizen

**Education**
- 1966 – 1971 ETH Zurich, dipl. Bauing. ETH

**Professional experience**
- 2002 - ETH Zürich, Senior scientist and lecturer; chair of Transport Systems – Road Transport
- 1990 – 2002 ETH Zürich, Lecturer and senior scientist
- 1998 Visiting Lecturer at the Nanjing University of VR China, Transportation College (Prof. W. Huang)
- 1978 - 1990 ETH Zürich, Senior research officer
- 1975 - 1978 ETH Zürich, Research officer
- 1971 - 1975 Tiefbauamt Basel-Landschaft, Chief of the Section Road Design

**Current teaching**
- ETH See list below

**Current major professional activities**
- 1996- VSS, President of FK7, Road Maintenance, Chair of several EK's
- 2004 - COST 352, In-vehicle Information Systems, member of the Swiss Group
- 1998 – 2002 COST 345, Assessing Highway Structures, MC-Member
- 1982 – 1996 VSS, Vice – President of the FK3, Traffic and Transportation
- 1998 - VSS, member FK9, Transportation and Telematics
- 1996 - Road Safety expert in UVEK - Committee
- 1994 - Traffic and Transportation Safety expert in UVEK Committee VESIPO
- 1992 - Road Maintenance expert in ASTRA Committee MSE
Peter Spacek
Born 8.6.1946 in Brünn (Czech republic), Swiss citizen

Education
1972-1973 ETH Zürich, dipl. Bauing. ETH
1965-1969 Technical University Brünn, Civil and geomatics engineering

Professional experience
2002- ETH Zurich, Senior scientist and lecturer;
chair of Transport Systems – Road Transport
1998- ETH Zürich, IVT, Lecturer
1987-1998 ETH Zürich, IVT, Senior scientist
1978-1987 ETH Zürich, IVT, Senior research officer
1975-1978 ETH Zürich, IVT, Research officer
1969-1972 Stadt Winterthur, Urban Planning Department, Traffic engineer

Current teaching: See list below

Major recent professional activities
2004- Third International Symposium on Highway Geometric Design, member of the scientific committee and corresponding author of TRB committee A3A08 Operational Effects of Geometrics
1999-2003 Co-ordinator of the ASTRA research on the impacts of the 40t-weight limits on road performance
2000- Scientific advisor for the implementation of the new traffic control system for the trunk road and motorway system of the Kanton Zürich
1990-1996 Chair of VSS EKs „Alignment“ and „Intersections“

Ulrich Weidmann (from June 2004)
Born 1963 in Chur, Swiss citizen

Education
1988-1994 ETH Zurich, Dr. sc. ETH
1983-1988 ETH Zurich, dipl. Bauing. ETH

Professional experience
2004- ETH Zurich, Professor for Transport Systems
2001-2002 Head of department Engineering Railway Systems, Swiss Federal Railways, business unit Facility Management
1999-2000 Deputy head of business unit Regional Transportation, Swiss Federal Railways; head of department Strategies and Development respectively Planning
1998 Head of department Regional Transportation, Swiss Federal Railways/Passenger Transport division
1995-1998 Planification Engineer at Swiss Federal Railways, Passenger Transport division; from 1997 on deputy head of Planification department
1994-1995 Planification Engineer at Swiss Federal Railways, Operating division
1988-1994 Scientific collaborator at ETH Zürich, IVT
Jost Wichser, dipl. Bauing. ETH

Born 1947 in Glarus, Swiss citizen

Education

1967-1973 ETH Zurich, dipl. Bauing. ETH

Professional experience

1989- ETH Zurich, IVT (leading scientist and lecturer)
1984-1989 Rhetian Railways Chur (chief of planning and project and track management)
1978-1983 Rhetian Railways Chur (track maintenance manager)
1974-1978 Rhetian Railways Chur (project engineer for infrastructure)
1973-1974 Stadtplanungsamt Zurich (traffic engineer in planning departement)

Major recent professional activities

1990- VöV Arbeitsgruppe Bau, guest member
1990- VöV Arbeitsgruppe Trambahnen, member
1997-2003 Braunwaldbahnen AG, board chairman
1998-2001 COST 335 Small Container, chairman
2001- VSS EK 8.02 Special Questions Public Transport, member
2001- VSS EK 8.04 Freight Transport, member

Milenko Vrtic (from July 2004)

Born October 13, 1965, Banja Luka, Bosnian citizen

Education

2004 PhD in transport planning, TU Dresden
1994-1990 University of Sarajevo, MA Traffic Engineering

Professional experience

1999- ETH Zürich, IVT, Research officer
1993-1999 Prognos AG, Basel; Transport planner
1991-1992 Municipal public transport operator, Banja Luka; Traffic engineer and group manager

Major recent professional activities

2002 SVI Committee „Computer science in the traffic planning“, member
## Appendix D  
2003/04 lecturing responsibilities by group

### Table 21: Transport systems - Road transport: Courses thought in 2003/04

<table>
<thead>
<tr>
<th>Course</th>
<th>Sem</th>
<th>Class</th>
<th>hours/week</th>
<th>Title</th>
<th>Lecturer</th>
<th>No. of Students</th>
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</thead>
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<tr>
<td>CE, G+P</td>
<td>2</td>
<td>A/S</td>
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<td>1.5</td>
<td>Transport systems II</td>
<td>Spacek; Lindenmann</td>
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<tr>
<td>CE</td>
<td>5</td>
<td>L</td>
<td>1.0</td>
<td>Network models and simulation</td>
<td>Lindenmann</td>
<td>8</td>
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<tr>
<td>CE</td>
<td>5</td>
<td>L</td>
<td>1.0</td>
<td>Traffic engineering</td>
<td>Spacek</td>
<td>9</td>
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<tr>
<td>CE</td>
<td>6</td>
<td>L</td>
<td>1.0</td>
<td>Design of transport infrastructures</td>
<td>Spacek</td>
<td>13</td>
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<td>CE</td>
<td>6</td>
<td>L</td>
<td>2.0</td>
<td>Traffic control systems</td>
<td>Spacek; Lindenmann</td>
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<td>L</td>
<td>1.3</td>
<td>Construction and maintenance of transport infrastructure</td>
<td>Lindenmann</td>
<td>12</td>
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<tr>
<td>CE</td>
<td>8</td>
<td>L</td>
<td>2.0</td>
<td>Environmental impact</td>
<td>Lindenmann; Spacek</td>
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<td>8</td>
<td>L</td>
<td>1.3</td>
<td>Maintenance management</td>
<td>Lindenmann</td>
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Table 22  Transport systems – Public transport: Courses thought in 2003/04

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<th>Sem</th>
<th>Class</th>
<th>hours /week</th>
<th>Title</th>
<th>Lecturer</th>
<th>No. of Students</th>
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<td>5</td>
<td>L</td>
<td>1.0</td>
<td>Traffic Engineering</td>
<td>Giger</td>
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<td>L</td>
<td>2.0</td>
<td>Operations Research</td>
<td>Giger</td>
<td>9</td>
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<tr>
<td>CE</td>
<td>6</td>
<td>L</td>
<td>1.0</td>
<td>Design of transport infrastructures</td>
<td>Giger</td>
<td>12</td>
</tr>
<tr>
<td>CE</td>
<td>7</td>
<td>L</td>
<td>1.0</td>
<td>Construction and maintenance of transport infrastructure</td>
<td>Wichser</td>
<td>13</td>
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<tr>
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<td>7</td>
<td>L</td>
<td>2.0</td>
<td>Operations- and infrastructure management</td>
<td>Wichser</td>
<td>10</td>
</tr>
<tr>
<td>CE</td>
<td>8</td>
<td>L</td>
<td>0.7</td>
<td>Maintenance management</td>
<td>Wichser</td>
<td>12</td>
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<td>CE</td>
<td>8</td>
<td>L</td>
<td>1.0</td>
<td>Transport logistics</td>
<td>Wichser</td>
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Table 23  Transport planning: Courses thought in 2003/04

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<th>Sem</th>
<th>Class</th>
<th>hours /week</th>
<th>Title</th>
<th>Lecturer</th>
<th>No. of Students</th>
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<tr>
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<td>0.7</td>
<td>Module Transport Planning</td>
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<td>NDS Landschaftsarchitektur</td>
<td>1</td>
<td>L</td>
<td>0.7</td>
<td>Module Transport</td>
<td>Axhausen</td>
<td>15</td>
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<td>L</td>
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<td>6</td>
<td>Lab</td>
<td>2.0</td>
<td>Measurement and Modelling Laboratory</td>
<td>Axhausen</td>
<td>3</td>
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<td>6</td>
<td>L</td>
<td>2.0</td>
<td>Transport Concepts</td>
<td>Axhausen</td>
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<td>7</td>
<td>L</td>
<td>0.7</td>
<td>Technology and the Environment</td>
<td>Axhausen</td>
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<td>L</td>
<td>2.0</td>
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<td>Axhausen</td>
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<td>CE</td>
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<td>L</td>
<td>1.0</td>
<td>Network models and simulation</td>
<td>Axhausen</td>
<td>8</td>
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<td>CE</td>
<td>5</td>
<td>L</td>
<td>2.0</td>
<td>Settlement, Environment, Transport</td>
<td>Keller</td>
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</table>
Appendix E List of key publications by group

E.1 Transport systems – Road transport (by author)


Spacek, P. (Forthcoming) The basis of the Swiss design standard for roundabouts, Transportation Research Record.

Spacek, P. (Forthcoming) The influence of speeds on the design standards in Switzerland, Transportation Research Record.

E.2 Transport systems (by author)


E.3 Transport planning – Public transport (by author)


Appendix F  Additional References

Publications and presentations
January 1999 – June 2004
Publications and presentations: January 1999 to June 2004

October 2004

Abstract

This list includes all publications and presentations of IVT members of staff.

Keywords

Literature list, presentations, IVT, ETH Zürich
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1 Swiss norms based on IVT research

1.1 Transport Systems: Road Transport


2 Lecture notes

2.1 Transport Systems: Road Transport


Lindenmann, H.P. (2003) Bau und Erhaltung von Verkehrsanlagen (Construction and maintenance of traffic facilities), Lecture notes, IVT, ETH Zürich, Zürich.


2.2 Transport Systems: Public Transport

The Group maintains a system of lecture notes for individual lectures or groups of lectures which are distributed as appropriate.

2.3 Transport planning

The Group maintains a website to distribute the overheads for the required course on transport planning (see http://www.ivt.ethz.ch/education/verkehrsplanung), where the students also find associated notes and papers.
3 Refereed journal papers

3.1 Transport Systems: Road Transport


3.2 Transport Planning


4 Refereed papers in books and proceedings

4.1 Transport Systems: Road Transport


4.2 Transport Planning


5 Papers in professional magazines

5.1 Transport Systems: Road Transport


5.2 Transport Systems: Public Transport

5.3 Transport Planning


6 Published books and reports

6.1 Transport Systems: Road Transport


Lindenmann, H.P. and M. Doerfel (2002) Verkehrssicherheitsbeurteilung (VSB) (Safety Audit), FA 304.97.01, final report to the Swiss Road Safety Fund, Bern.


6.2 Transport Systems: Public Transport


Wichser, J. et al. (2001) COST 339 Small Container, final report to DG TREN and COST, IVT, ETH Zürich, Zürich.

6.3 Transport Planning


7 Invited contributions

7.1 Transport Systems: Road Transport

7.2 Transport Systems: Public Transport

7.3 Transport Planning


8 Unpublished reports

8.1 Transport Systems: Road Transport


8.2 Transport Systems: Public Transport


8.3 Transport Planning


9 Working and unpublished conference papers

9.1 Transport Systems: Public Transport


9.2 Transport Planning


10 Incidental pieces

10.1 Transport Systems: Road Transport

10.2 Transport Systems: Public Transport

10.3 Transport Planning
11 Metadata series


Vrtic, M. (2004) Forecast based on different data types: A before and after study (Stated Preference - Route choice), Travel Survey Metadata Series, 5, Institut für Verkehrsplanung und Transportsysteme (IVT), ETH Zürich, Zürich.


Vrtic, M. (2004) Traffic counts - Raod passenger traffic (cars / average working day), Travel Survey Metadata Series, 9, Institut für Verkehrsplanung und Transportsysteme (IVT), ETH Zürich, Zürich.
12 Invited conference presentations

12.1 Transport Systems: Road Transport

12.2 Transport Systems: Public Transport
12.3 Transport Planning


13 Seminar presentations

13.1 Transport Systems: Road Transport


13.2 Transport Systems: Public Transport


13.3 Transport Planning


14 IVT seminar and other internal presentations

14.1 Transport Systems: Road Transport


14.2 Transport Systems: Public Transport


14.3 Transport Planning


