# D-BAUG

Department of Civil, Environmental and Geomatic Engineering

# Annual Report 2007


Department of Civil, Environmental and Geomatic Engineering

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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# Preface

Dear readers

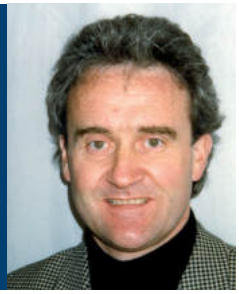
The turbulent events at ETH Zurich during 2006 were succeeded by a calmer report period. After some confusion accompanying the selection proceedings for the new President, the Swiss Federal Council appointed the Director of the Paul Scherrer Institute, Prof. Dr. Ralph Eichler, on 1 September 2007 as Head of ETH Zurich. Prof. Dr. Heidi Wunderli-Allenspach took up office as Rector at the same time, and Prof. Dr. Peter Chen took on the Vice Presidency for Research. Prof. Dr. Gerhard Schmitt remained in his capacity as Vice President Planning and Logistics.

The composition of the academic staff at our Department has for once not experienced major changes. However, search proceedings for various chairs that will become vacant in 2008 und 2009 have already begun. Prof. Dr. Michael H. Faber, Associate Professor of Risk and Safety at the Institute of Structural Engineering, was promoted to Full Professor on 1 February 2008 and Dr. Bernhard Elsener, Senior Scientist at the Institute for Building Materials, received the title of Professor on 28 March 2007.

As in previous years, this annual report aims at providing an insight into our diverse activities for both our partners within the ETH domain as well as our external partners in Switzerland and abroad. We would like to sincerely thank our partners for their trust and assistance, and we look forward to their continued support.

Zurich, February 2008

Peter Marti



**Prof. Dr. Peter Marti**
**Head of Department D-BAUG**

# Student Figures

**The Department of Civil, Environmental and Geomatic Engineering (D-BAUG) was established on October 1, 1999, by merging the former departments of civil and environmental engineering (D-BAUM) and geodetic sciences (D-GEOD) as well as the former divisions II (Civil Engineering) and VIII (Rural Engineering and Surveying).**

by Patrick Dilger

## Development of student figures

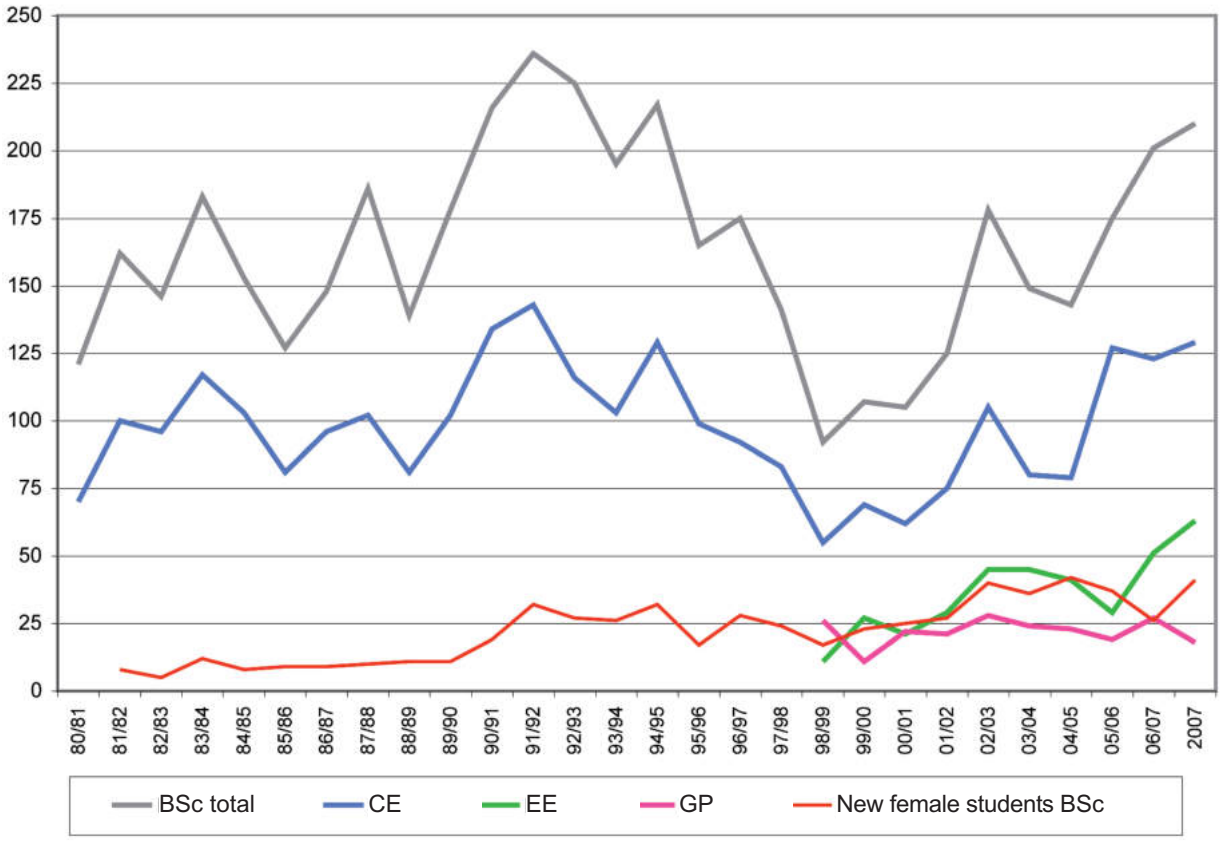
Teaching at D-BAUG concentrates on the three Bachelor and four Master curricula *Civil Engineering (CE)*, *Environmental Engieering (EE)*, *Geomatics and Planning (GP)* and *Spatial Development & Infrastructure Systems (SDIS*; only MSc). Teaching to support doctoral studies and continuing professional education also forms a key aspect of our mission.

From the year 2000 onwards, figures for new incoming students have taken a positive trend and have actually doubled since D-BAUG was established (Graph 1). Only at the beginning of the 90s was the figure even higher. The number of new female students has remained constant, reaching 20% last year.

From the outset to the end of the study programme(s), the number of degrees has increased considerably in the last 3 years, currently totalling 130. The private and public sectors are eager to recruit such well-educated engineers (Graph 2).[1]

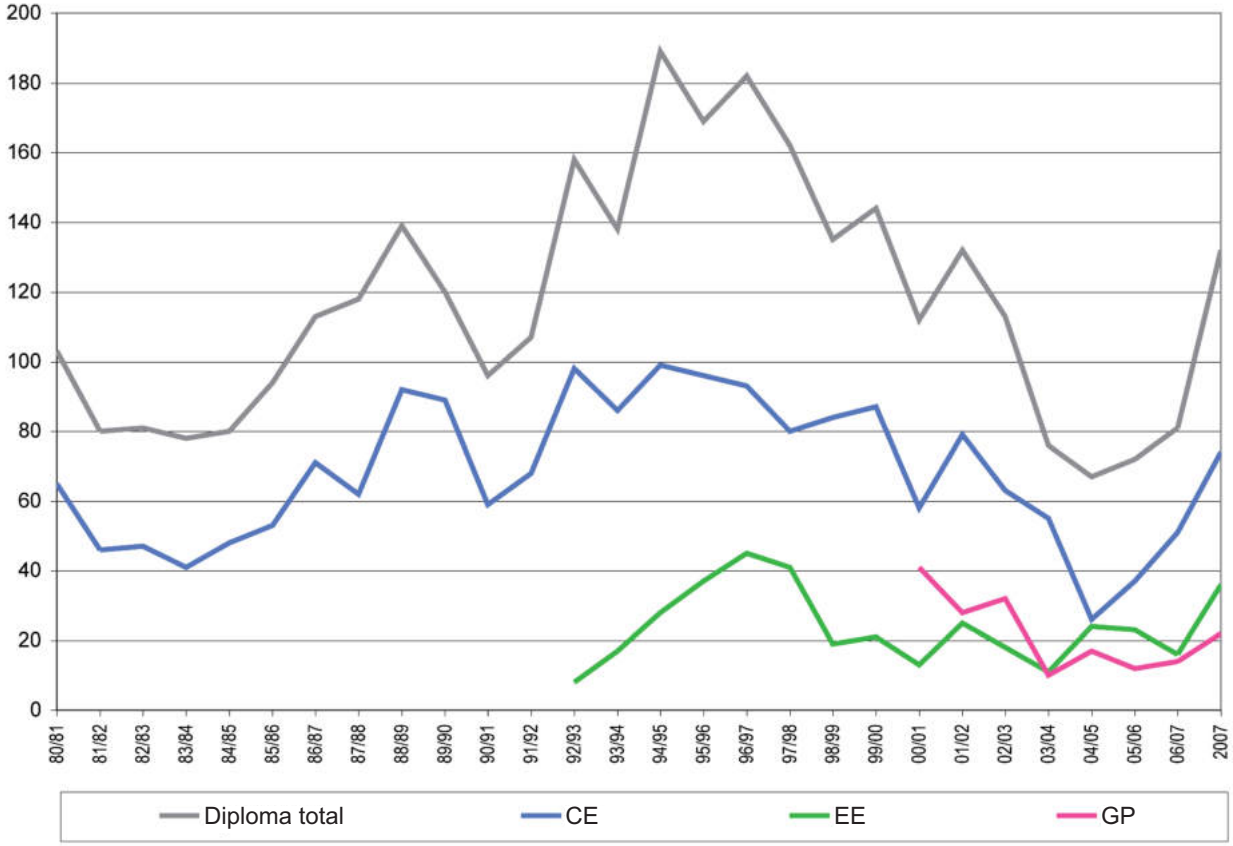
[1] Additional figures see section *Facts and Figures*.

## New incoming students at D-BAUG (BSc-level)




Graph 1

## Diploma at D-BAUG




Graph 2

# Daughter's Day at the Institute for Geotechnical Engineering (IGT)

**Sixteen students from the Progymatte Secondary School in Thun visited the Institute for Geotechnical Engineering on the 7th annual «Daughter's Day».**

by R. Herzog, J. Buchheister, A. Arnold, M. Sperl, R. Mühlethaler, S. M. Springman / IGT

This visit took place under the umbrella of the «Kidsinfo - Maidens & Technics» of the Swiss Society for Women Engineers. The goal was to give the girls hands-on insights into the excitement of geotechnical engineering, all within two hours!

Three groups of kids classified clay, tested the shear strengths of various soils and investigated groundwater phenomena. The climax was to create a dam inside a Plexiglass container out of the materials they had previously discovered and then to attempt to impound water behind it. With fascination and no horror whatsoever of dirty hands, clay, sand and gravels were placed and compacted. To the great joy of all, the dams held and then were allowed gradually to be eroded by overtopping as the water levels rose – of course this was a feature that is not permitted in reality.

All schoolgirls received a signed certificate recognising their competence as dam engineers, in memory of their day.

# Felsenau Viaduct, Berne – Load Tests

**Within the framework of the overall restoration of the tangential highway North of the city of Berne, the 33-year old Felsenau Viaduct – one of the major Swiss bridge structures – was subjected to a detailed examination. As a part of this examination comprehensive load tests were performed to obtain a reliable basis for the evaluation of the fatigue resistance of the large cantilever bridge deck slabs.**

by Barbara Ebert, Stephan Etter, Peter Marti; Institute of Structural Engineering / IBK
and Hans Martin Zogg, Hilmar Ingensand; Institute of Geodesy and Photogrammetry / IGP

## The Felsenau Viaduct

The Felsenau Viaduct of the Swiss Highway A1 is situated north of Berne between the exit Bern-Neufeld and the highway triangle Bern-Wankdorf (Fig. 1) in one of the busiest sections of the Swiss highway system. The average daily traffic on the six-lane viaduct amounts to approximately 100'000 vehicles and is characterised by a high percentage of trucks and considerable rush hour peaks due to the significant traffic generated by the City of Berne.

Commissioned in 1975, the Felsenau Viaduct is one of the most outstanding structures of the highway A1 (Fig. 2). The 1116 m long concrete structure (Fig. 3) traverses the Aare Valley in a gentle S-curve at a height of up to 60 m (Fig. 4). The approach spans, constructed with conventional scaffolding systems, lead to the large middle spans of 100 m – 156 m – 156 m – 100 m that were constructed as balanced cantilevers (Fig. 5). The viaduct's curved alignment and the variable depth of the balanced cantilever sections result in very interesting spatial intersection lines between the inclined webs and the lower slab of the hollow box girder. The elegance of the viaduct is further enhanced by the uniform, 26.2 m wide cross-section with its large cantilever slabs and the slender, only 7.46 m wide piers.

Altogether the Felsenau Viaduct provides an impressive illustration of the efficiency of structural concrete that is used most favourably in the form of plate and shell structures. All dimensions of this remarkable structure are adapted to the acting forces and moments in an optimal way, resulting in uniform stresses throughout the structural members and hence a high economy of the entire viaduct.

The Felsenau Viaduct is neither the largest nor the longest-span bridge in Switzerland but certainly one of the most remarkable of the many outstanding Swiss bridge structures. Its uniqueness is due to its convincing integration and configuration (Fig. 6) as well as its profound influence on the development of bridge design and construction. The Felsenau Viaduct deeply influenced many later bridge designs, but none of these surpassed the degree of perfection achieved with the Felsenau Viaduct.

## Structural Analysis

Within the framework of the overall restoration of the tangential highway north of Berne and in view of necessary maintenance and repair measures, the Felsenau Viaduct was subjected to a detailed examination. Since its commissioning the requirements to be met by the bridge have changed continuously. In particular, the traffic volume has tripled and the narrow emergency lanes do not meet current standards.

According to analyses based on the current structural codes SIA 260-262 (Edition 2003) the transversely prestressed cantilever slabs of the bridge deck may suffer from fatigue problems. Several cross-sections are in the decompression range under the current permanent loads. The significant scatter of both long-term effects (shrinkage, creep and

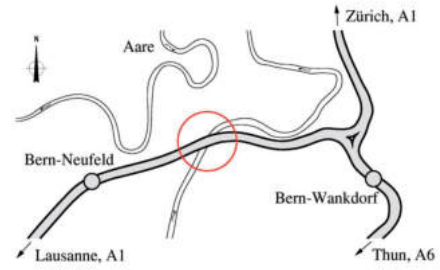



Fig. 1: Situation.

Fig. 2: Balanced cantilever spans.

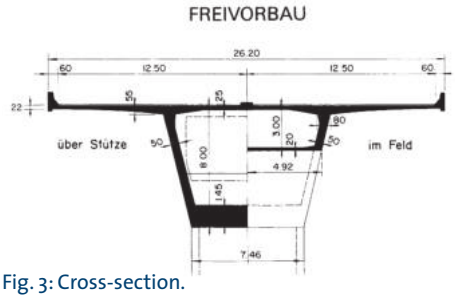



Fig. 3: Cross-section.

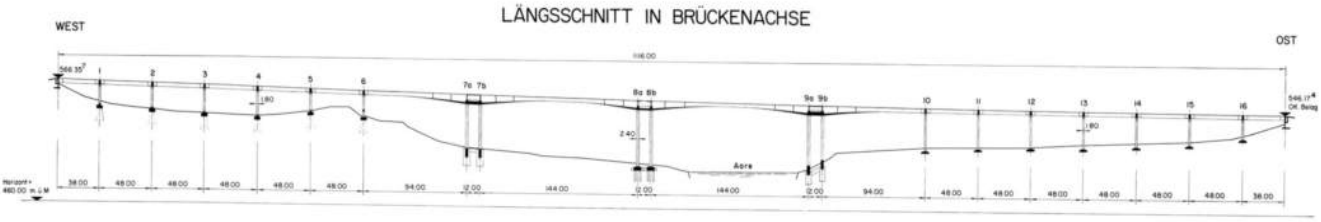



Fig. 4: Plan.

Fig. 5: Balanced cantilever construction.

Fig. 6: View from valley floor.

relaxation) and concrete tensile strength complicates the description of the cross-sectional response.

Four possible bending moment-steel stress curves (Fig. 7) illustrate this scatter and the non-linear response after concrete cracking. Therefore, no definite steel stress increments $\Delta\sigma_p$ can be determined from the traffic loads. The fatigue strength curve (Fig. 8) shows the marked non-linear relationship between $\Delta\sigma_p$ and the associated number of load cycles. Thus, the uncertainties in determining $\Delta\sigma_p$ are raised to a higher power and hence a reliable assessment of the bridge deck fatigue behaviour is impossible.

In order to obtain a reliable basis for the evaluation of the fatigue resistance and to refine the analytical models it was decided to perform additional investigations, including traffic measurements and load tests. During a representative time period all axle loads were recorded along with associated speeds, exact passing times and lane identifications; this data can be used as updated dimensioning values when applying the observational method for structural verifications. Furthermore, comprehensive load tests were performed to improve the understanding of the structural response of the cantilever slabs and to sharpen the analytical tools.

## Load Tests

The Felsenau Viaduct was closed for two nights and the traffic was detoured via the city of Berne between 10 p.m. and 5 a.m. After extensive planning, the tests were performed in spring 2007. One or two tanks, each weighing 54 tons were used to load the cantilever slabs at four selected locations.

The slab deflections were measured by precision levelling (Fig. 9) with a standard deviation of 0.15 mm. The local measurements in the loading area were connected via line measurements with fixed points beyond the bridge abutment for each loading case. Prior to the load tests measuring bolts were embedded in the median strip, the parapet and the deck slab. The bolts in the deck area were firmly connected with the concrete slab and didn't provide any obstacle to the traffic; short rods could be screwed onto each bolt allowing a short preparation time for the measurements. In a number of cross-sections tachymeter measurements from the valley floor were used to check the levelling measurements and the spatial deformation behaviour of the bridge superstructure. In addition, an independent and direct observation of the cantilever slab deformations during loading was essential. Therefore, a laser beamer positioned on the median strip and a measuring scale fixed to the parapet were used as a simple and robust deformation measuring method, providing a sound basis for necessary short-term decisions on how to proceed with the loading (Fig. 10). Finally, strain measurements on the concrete surface of one selected cross-section in vicinity of the web-cantilever slab connection permitted an independent check of the stress increments in the concrete and the reinforcement determined from the deflection measurements.

As a novelty and independent of the other measurements, terrestrial laser scanning was used to determine the bridge deformations. The deck surface in the loading area was scanned by a laser beam within a few minutes, resulting in a three-dimensional point cloud containing several million measuring points for each scan. The evaluation of the results demonstrated that the laser scanning provided reliable deformation measurements and that this new method is suitable for similar tasks (Fig. 11).

Apart from the load testing specialists a very large team was necessary to close the bridge, redirect the traffic, provide the entire infrastructure required for the testing and to maintain the communication with the public and the media. Thanks to the dedicated work of the entire team the load tests were successfully completed and will certainly be kept in fond remembrance by all those involved.

## Outlook

The test data and the improved knowledge of the structural response of the cantilever slabs are being evaluated and integrated into the structural analysis of the Felsenau Viaduct. This, along with the associated improved understanding of the fatigue resistance will provide the basis for an adequate concept of measures to maintain the serviceability of this remarkable bridge structure.

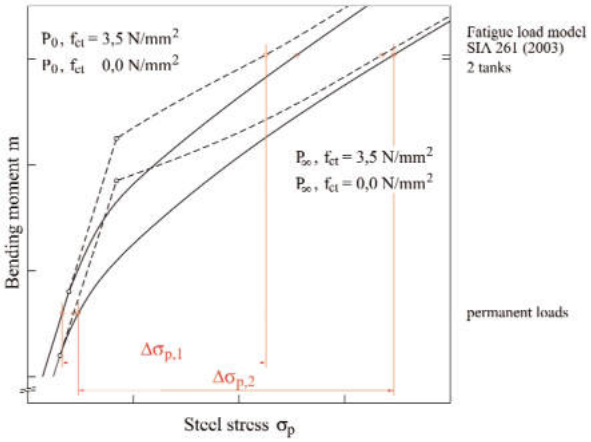



Fig. 7: Cross-sectional behaviour.

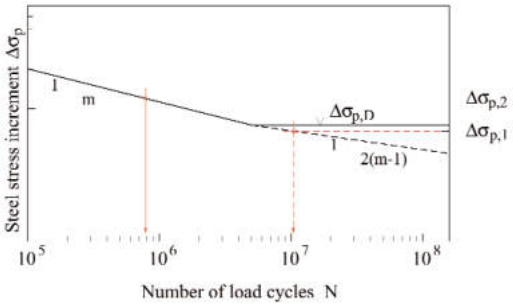



Fig. 8: Fatigue strength curve.

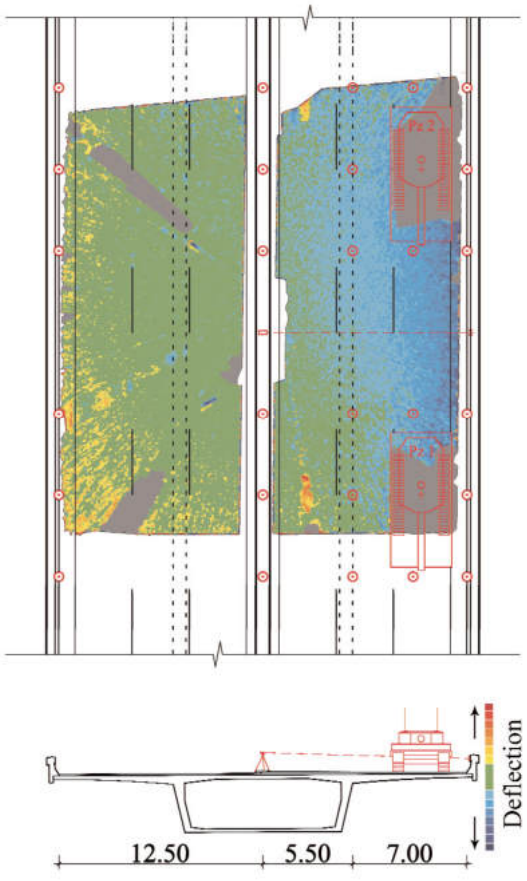



Fig. 11: Laser scanning.

Fig. 9: Levelling.

Fig. 10: Direct observation of cantilever slab deformations.

## Data Felsenau Viaduct

- *Owner:*
  Canton of Berne
- *Design:* 1971
  C. Menn, H. Rigendinger, Chur;
  Emch & Berger Bern AG, Berne
- *Construction:* 1972 - 74
  Marti AG Bern, Berne;
  Locher & Cie. AG, Zurich
- *Commissioning:* 1975
- *Dimensions:*

| | |
|---|---|
| Length | 1'116 m |
| Width | 26,2 m |
| Balanced cantilever spans | 100 m, 156 m |
| Typical approach spans | 48 m |

- Material consumption:

| | |
|---|---|
| Concrete | 31'200 $m^3$ |
| Formwork | 94'300 $m^2$ |
| Reinforcing steel | 3'060 t |
| Prestressing steel | 800 t |

# Innovation management in deregulated rail freight transport – The LEILA case study

**Freight transport remains in the shadow of passenger transport and is only taken seriously when trucks cause traffic congestion on highways or when freight trains disturb our sleep. But, while passenger transport has gradually reached saturation, freight transport has shown inexorable growth for the last forty years.**

by Prof. Dr. Ulrich Weidmann; Institut für Verkehrsplanung und Transportsysteme / IVT

## The Future of Rail Freight Transport

This growth in European freight transport has taken place on the road, the volume of which has virtually tripled. In contrast, railways have not benefited from the growth in freight traffic; their market share in the EC (now with15 countries) has dropped from over 32% in 1970 to only about 14% today. In spite of these figures, the EC hopes to reverse this trend in roadway freight transport and environmental damage. To help achieve this goal, the EC introduced the following measures in 1991:

- Common open and non-discriminatory access for all companies (meeting specified conditions) to the entire European standard gauge railway network; and
- Competition between different railway companies on the same railway lines and routes.

The EC expects that this competitive pressure will help improve service quality while reducing costs, and will motivate shippers to shift from road to rail. The example is from the USA, where freight railways were deregulated in 1980. Since then both productivity and transport volumes have doubled and the rail market share for long distance freight transport is reported to be about 47%.

Although Switzerland is not a member of the European Community, it is directly affected by European transport policy. In the bilateral land transport agreement, Switzerland committed itself to align its transport policy and principles with those of the EC. In the area of Alpine transport, Switzerland's national objective of shifting freight from road to rail can only be achieved by strengthening railways throughout Europe.

## Innovation as a key competence

Only innovative rail freight service can be successful in today's highly competitive environment. However, innovation in railway freight traffic - so critically needed to secure its future – is being held up by economics. Although logistics is a growing market, the transport process itself faces strong cost pressures and very limited profit margins. This can be observed by the fact that every Swiss inhabitant spends about 3000 CHF annually for personal travel, but only about 500 CHF on freight transport.

Only innovative rail freight service can be successful in today's highly competitive environment.

Since 1999, freight railways have reduced costs, improved customer service, intensified sales efforts, optimized their organization and adopted new strategies. The visible fruits of this effort are novel, market-oriented business models, which are no longer oriented solely within national borders. Specifically:

- Large national railways have become global logistics companies;
- Smaller national railways are operating freight

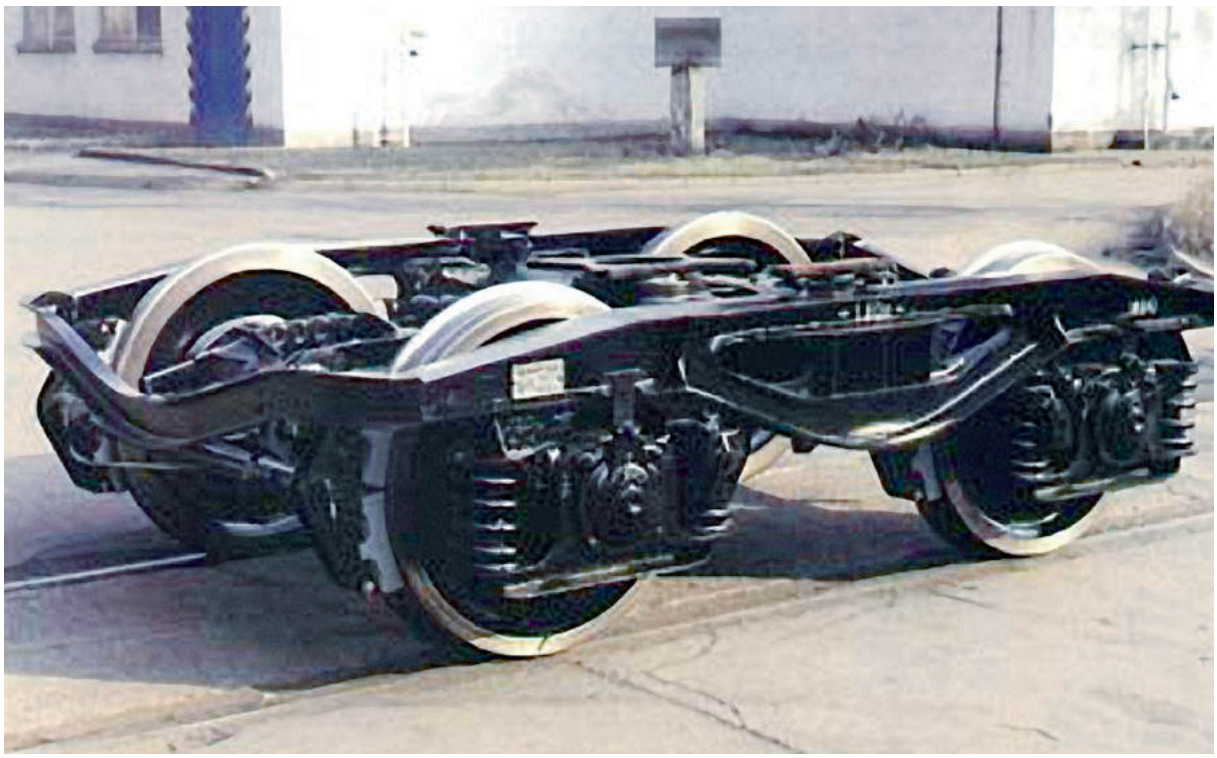


Fig. 12: Conventional rail wagon bogie Y 25, a technical level of 1948.

trains throughout Europe;
- Traditional private railways provide transport services for larger railways or serve specific customers, wherever they are located;
- Factory-based railways are increasingly involved in commercial goods transport; and,
- Companies new to railway operations are moving into the market.

Over the last several years, these changes have helped consolidate the railway market. At the same time, they have made the lack of technical innovation in freight rail service increasingly noticeable. For example:

- With their maximum speed of 80-to-100 km/h, freight trains interfere with passenger services on highly used routes;
- The freight wagon bogie, which is based on a 1950s design, creates unacceptable noise levels, vibration and track damage; and,
- Building-up freight trains takes an excessively long time, since the freight wagons have no supportive intelligence. (Fig. 12).

## The LEILA Case Study

An important way of overcoming these weaknesses is to develop an improved freight wagon bogie. This is the objective of the LEILA project being pursued by the TU Berlin and the Swiss railway car manufacturer, Josef Meyer. LEILA stands for "light and quiet, freight wagon bogie" and is characterized by the following design principles:

- Disc brakes instead of shoe brakes;
- Noise reducing bogie construction;
- Bogie coupling for radial axes alignment;
- Vibration decoupling of the car body from the bogie;
- Acoustic optimization of the complete structure; and,
- Self-powered on-board diagnostic system with sensors and telematics.

These benefits reduce wagon operating costs, but significantly increase the cost of freight wagon bogies over the standard design. Increasing bogie cost is a sensitive issue since the freight wagon bogie represents between a third to a half of the total wagon costs. Therefore, the bogie price significantly impacts the profitability of rail freight operators!

The IVT's task in this project consisted of estimating the amount of additional vehicle purchase cost for LEILA bogies that could be recouped by reducing operating costs. Due to the short time horizon and high pressure for profitability in the freight transport business, the payback period for the LEILA bogies must be within a maximum of 12 to 15 years, regardless of the actual vehicle lifespan (which is much longer) (Fig. 13, see page 15).

### LEILA bogie functional performance

IVT's first task was to analyse the functional performance of the LEILA bogie and it's impact upon railway operations and infrastructure.

The LEILA bogie reduces the degree of wheel flange striking the rail; this reduces energy consumption in curves. It also reduces wheel slipping and material fatigue damage by reducing the rolling contact forces as well as the extent of the rail surface used. This reduces rail wear and extends wheel service life.

The LEILA bogie's disc brakes reduce wheel roughening and subsequently, the degradation of wheel profiles. The integrated wheel-slip protection prevents development of flat wheels. This reduces the noise generation of freight wagons by up to 18 dB(A) at the source.

The LEILA bogie continually monitors the status of critical parts and transmits this information to the maintenance shops. The information can be integrated into a condition-specific maintenance scheduling strategy. This reduces the amount of unproductive maintenance time for rolling stock and contributes to more efficient use of workshop capacity. Finally, LEILA's intelligence systems can speed-up the train formation process, thus significantly increasing productivity.

The LEILA bogie continually monitors the status of critical parts and transmits this information to the maintenance shops.

### LEILA Innovations Stakeholder Benefits

The benefits of LEILA bogie innovations are not only evident in terms of time, but are accrued by different actors. The rail freight operator, which makes the initial investment in rolling stock and who alone bears the market risks, benefits directly from the simplification of the train, the optimisation of maintenance and the lower wheel wear. But the LEILA innovations also create significant positive benefits for other stakeholders, especially the infrastructure companies, including:

- Reduced energy consumption: reduces the need for energy supply infrastructure;
- Lower noise levels: benefits residents and infrastructure companies (they do not need to build structures to reduce noise for adjoining residents); and,
- Reduced track wear: benefits infrastructure companies.

However, while infrastructure companies accrue direct benefits from the use of LEILA bogie rolling stock, the European and Swiss principles of Open Access do not allow direct transfer payments for these benefits, even if the infrastructure and rolling stock are owned by the same company. Therefore, a suitable non-discriminatory method for allocating the benefits of the LEILA bogie rolling stock is needed. (Fig. 14).

### Using rail path price setting as an economic incentive system

Rail path prices can be used as a non-discriminatory benefit transfer mechanism between infrastructure operators and operating companies. A rail "path" is defined as a specific starting point–destination–trajectory on the railway infrastructure, which the railway infrastructure company makes available at a specific time. Today, rail path prices are used to pay for the use of rail infrastructure throughout Europe.

The current Swiss rail path pricing system was introduced in 1999. While the system is easy to use, it provides no incentives for increasing train efficiency, for a better distribution of trains throughout the day, or for increasing speeds to build up line capacity. Nor does the system include incentives to minimize track wear or distinguish between the difference in infrastructure demands between passenger and freight trains.

These shortcomings in the Swiss rail path pricing system are increasingly seen as problematic and, furthermore, the system prevents passing on the benefits of LEILA technology to the freight train operators. Therefore, the IVT developed a rail path pricing system in which each stakeholder receives incentives to optimize their part of the process, which in sum lead to optimization of the total railway system. This goal can only be achieved by focusing directly on real costs. For each cost category, a train specific factor is used to determine the cost component. The pricing system includes the following:

- Base price for operational management: Cost of train control and dispatching;
- Time period factor: Factor related to the time when the rail path is provided in terms of network demand (penalty for trains travelling at peak time periods);
- Capacity factor: Factor related to the train's deviation from the line's optimal capacity speed (penalty for faster or slower trains);
- Node fee: Fee related to the use of important railway nodes (penalty for trains that operate through heavily used rail network nodes);
- Base price maintenance: Compensation for direct track wear;
- Track quality factor: Factor related to the train's need for high track quality (penalty for trains that require a very high quality track);
- Stress factor: Factor related to the stress that the rail

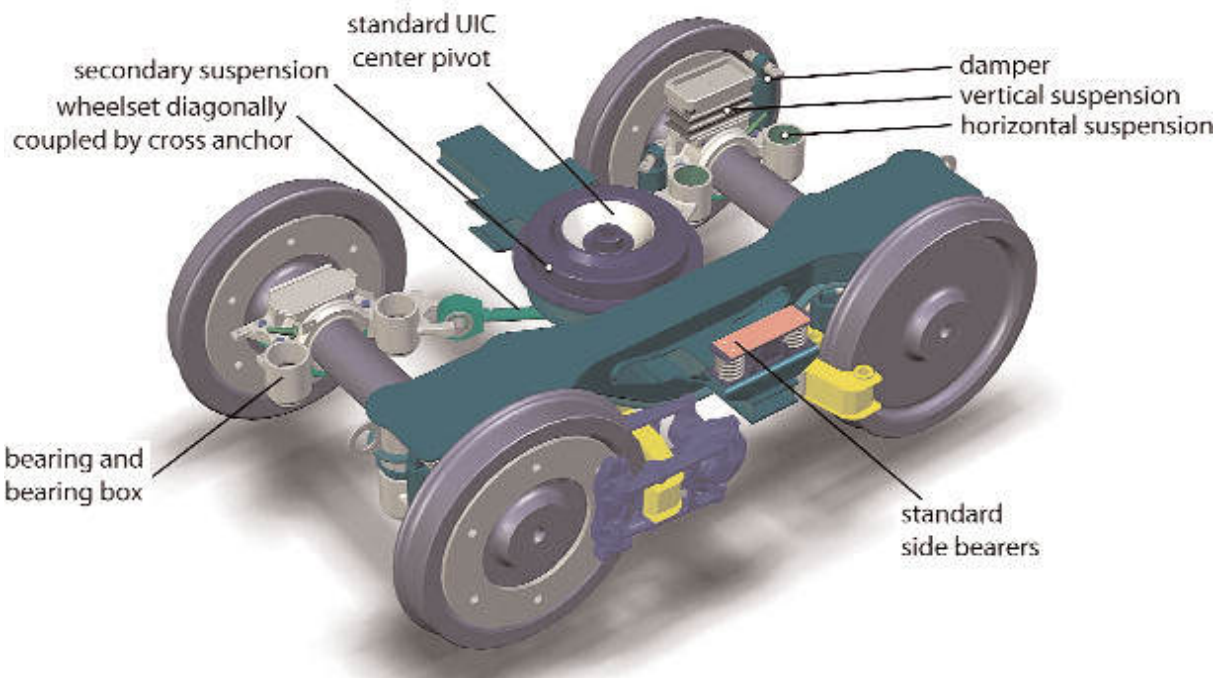



Fig. 13: New bogie type: LEILA.

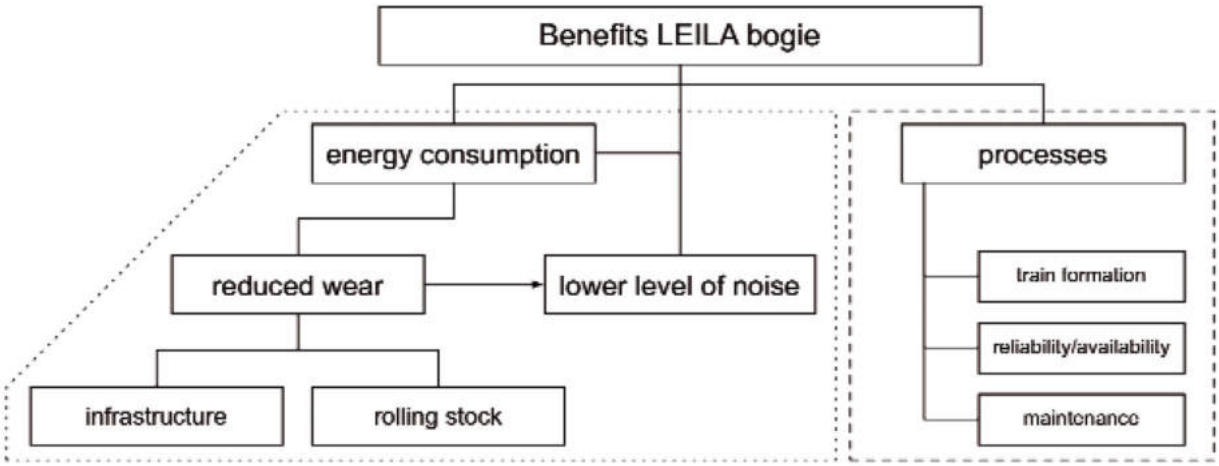



Fig. 14: Overview of the benefits from the LEILA – bogie rolling stock.

wagons place on the tracks (penalty for wagons with track damaging suspensions);
- Station fee: Costs for station maintenance;
- Travel time factor: Factor related to the quality of the planned route timetable (cost reductions for trains which cannot be allowed to use their optimal route);
- Energy consumption: Actual train energy consumption as measured by a meter in the locomotive; and,
- Noise generation: A bonus for reduced noise generation (from the existing rail path pricing system).

The exact quantitative data for these factors and costs are not yet known for all cases. Therefore, in order to develop an initial estimate of the factors, existing relationships and order of magnitude estimates were used. An additional objective was to maintain the current annual path price growth, which should not change by implementing the new system. The result was a time-based cost that provides a financial description of the different rail wagon chassis – infrastructure interaction behaviours calibrated for routes in Switzerland (Fig. 15).

### Application to LEILA

The new rail path pricing system was used to investigate whether the higher initial investment costs for LEILA type rolling stock could be refinanced through operational savings. This analysis was made by comparing the life cycle costs of LEILA rolling stock to costs for rolling stock based on the standard bogie design Type Y25. As is generally the case with innovative new products, the cost of LEILA rolling stock when mass produced was difficult to quantify. Therefore, three price scenarios were tested in which LEILA bogies were 20%, 50% and 100% more expensive than standard bogies.

The evaluation-route was the 250-km segment from Basel to Bellinzona in Switzerland, part of the North-South Transversal from the Netherlands and Germany to Italy. The evaluation consisted of measuring the wheel/rail friction in detail for three typical freight wagon types under typical loading conditions as they operated on the segment. This data and the other cost elements were used to compare the life-cycle operating costs (LCC) for the default Y25 bogie wagons to the LEILA-bogie wagons under the three different price scenarios for the different services and time application periods (Fig. 16).

To evaluate the economic viability of the LEILA bogie, a benchmark was set at the level necessary to recoup a doubled bogie investment cost over a 15-year period when the wagon is operated at least 90,000-km per year. These operating characteristics represent the highest productivity levels of current rolling stock usage. The results showed that each unit cost reduction by itself is not enough, but their sum does cover the additional costs. The decisive contributions were the new train path pricing system and the noise bonus. Without the new train path pricing system, the LEILA bogie was only viable if it costs a maximum of 50% more than the default bogie, which, from today's perspective, is not possible.

### Conclusions

Many railway system innovations are difficult to implement since they generate economic benefits for several stakeholders, but their costs are incurred by a single stakeholder. Even when the innovation's overall benefit is positive - as in the case of the LEILA bogies - these innovations are not profitable investments for the responsible stakeholder. Since railway liberalization and freight rail operators are subject to competition from trucks and other railways, this competitive environment makes it less likely that freight rail operators will pursue unprofitable investments.

Research has shown that, with a full transfer of benefits, the LEILA bogie would be a profitable investment .

Under these conditions, it is critical to transfer all the potential benefits generated by the innovation to the investor; this can be done using the rail path price as the transfer mechanism between network operators and network users. This process can make it financially rewarding for a freight railway to implement innovations that benefit the overall railway system.

The prerequisite for introducing these types of innovations is that the rail path pricing system be able to differentiate between types of benefits and determine to whom they accrue. This type of rail path pricing concept was used by the IVT to test the viability of the innovative new LEILA rail bogie. Research has shown that, with a full transfer of benefits, the LEILA bogie would be a profitable investment assuming that the additional price of the LEILA bogie is not exceeded and that the freight wagon is highly productive. In conclusion, railway market liberalization and open access are therefore not financial impediments to technological innovations.

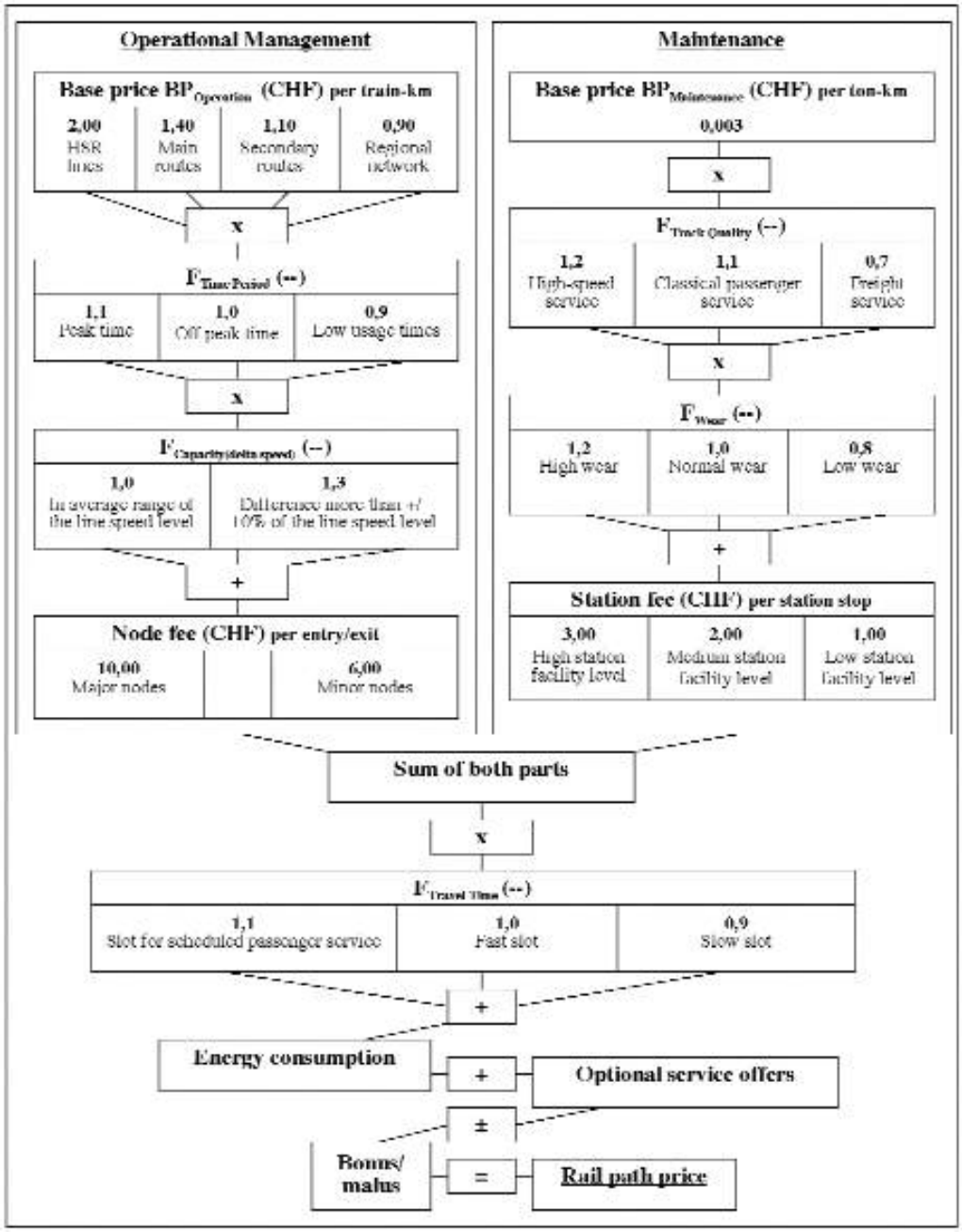



Fig. 15: Structure of the new rail path pricing model.

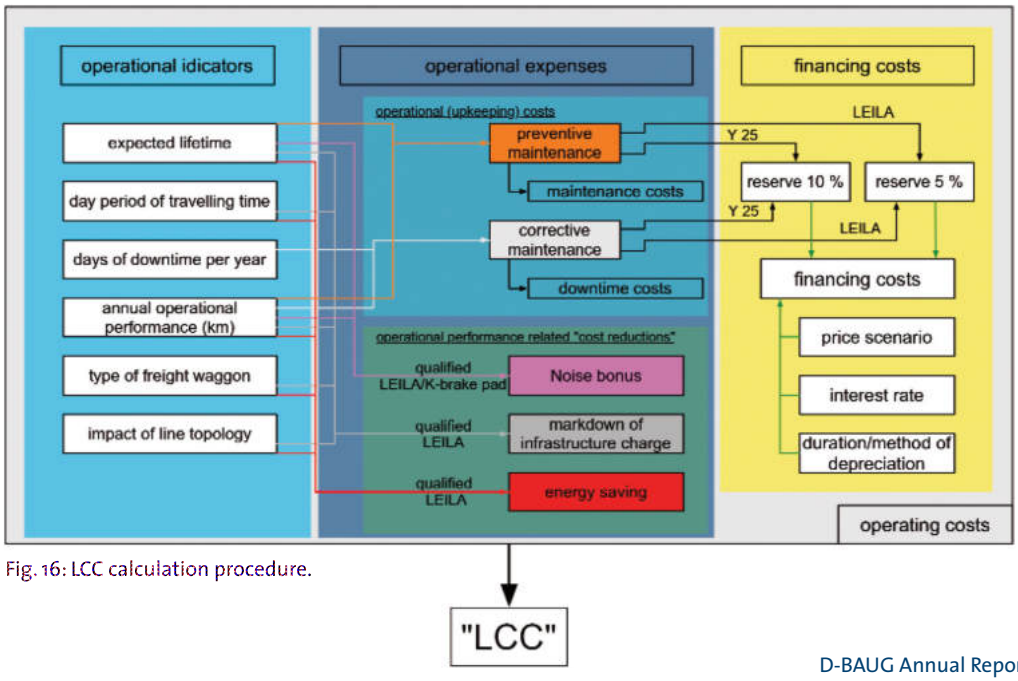



Fig. 16: LCC calculation procedure.

# Modern Interactive Multimedia Atlas Information Systems

**Interactive and multimedia atlas information systems are electronic information systems which are based on a collection of digital map data. These maps provide diverse spatially-related knowledge and serve for user-oriented information and decision-making purposes.**

by Dr. Christian Häberling, Prof. Dr. Lorenz Hurni, Dr. René Sieber, Dr. Hansruedi Bär
Institute of Cartography / IKA

Popular virtual globes, such as *Google Earth* or *NASA World Wind*, which also count as information systems, influence the daily life of computer users.

As in conventionally printed atlases, the maps in atlas information systems also visualize many diverse physio-geographic or socio-economic topics. The maps outline the most varied geographic regions and include a series of mostly standardised scales whereby generalized degrees are shown. Usually, the different map types have specific legends and symbols. Often, indexing the map content is based on thematic or geographic search criteria.

Other main components of atlas information systems are interactive functions for geographic and thematic navigation as well as querying and analysis. In addition to conventional orthogonal views of classic maps, perspective views are also possible. Unlike many Geographic Information Systems (GIS), data in atlas information systems are cartographically edited and the corresponding symbols are reproduced. Furthermore, the integrated analysis and visualisation functions are often intentionally limited to provide a user-targeted set of data. Additionally, multimedia atlases can be supplemented with additional information such as charts, diagrams, tables, texts, videos, animations, and audio documents.

Virtual globes such as *Google Earth* influence the daily life of computer users.

## Evolution of Atlas Information Systems

The leap in technology in the 1980s, which caused a rapid transition from analogue to digital cartography, created an unexpected boom in the development of Geographic Information Systems, computer-aided design (CAD) systems, and graphic programmes. Subsequently, the releases of large amounts of geometric and thematic cartographic data were important catalysts for the development of interactive atlas information systems. Initially, atlas information systems were made available on CD-ROM. Today, they are mostly distributed on DVD or via the internet.

Early digital atlases were often quite limited, e.g., name search, various zooming effects, and layer selection. Other atlases, such as the PC version of the *National Atlas of Sweden*, were based on commercial GIS software.

Only a few national atlases were drawn up at an early stage as interactive information systems, e.g., the *Atlas of Switzerland*. In addition, electronic counter pieces to conventional world or school atlases, such as *Microsoft Encarta*, were published. In the meantime, the latter has been integrated into an encyclopaedia. Modern interactive atlases predominantly make use of vector and statistical data from which maps are directly deduced (e.g., the internet-based *Tyrol Atlas)*.

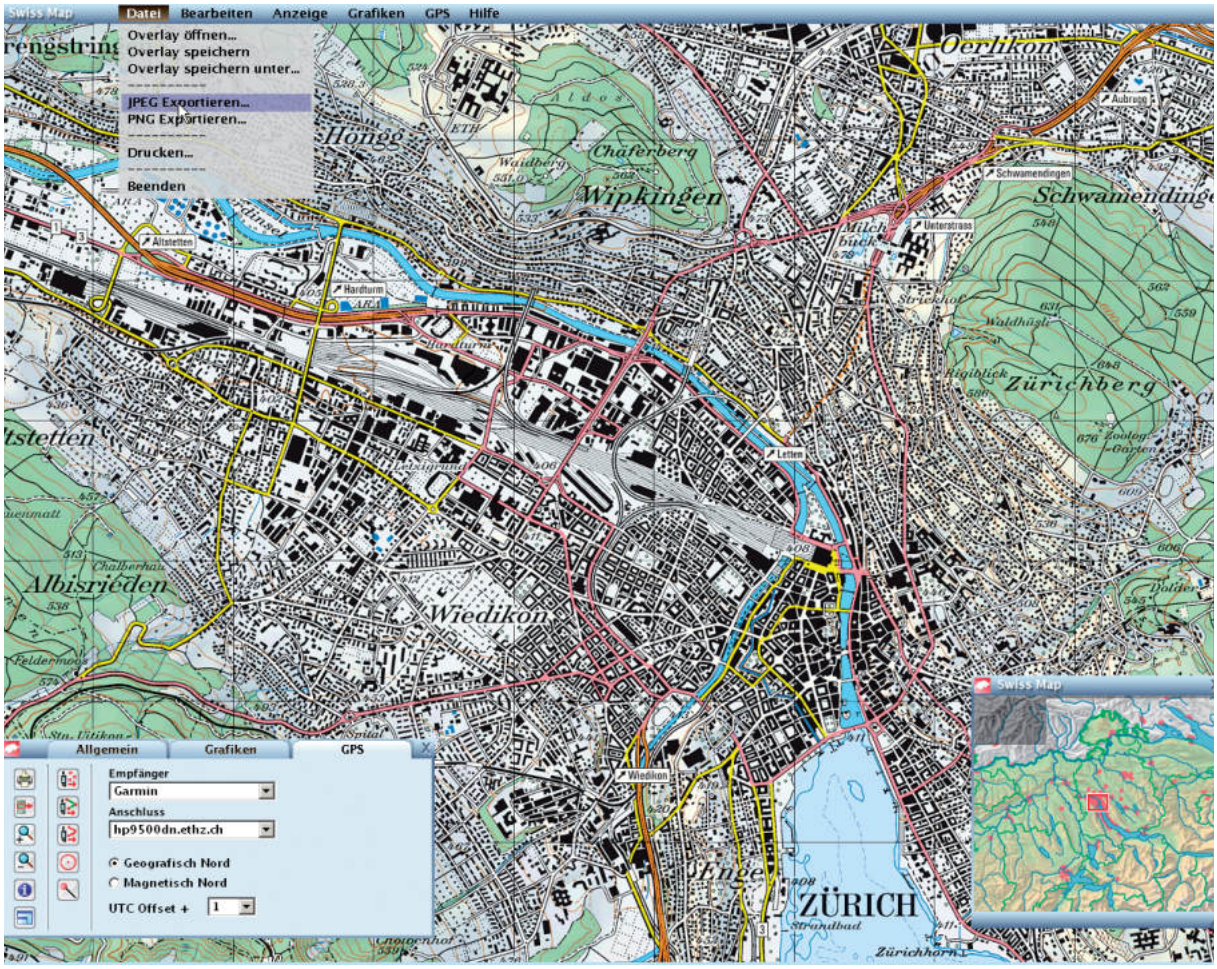



Fig. 17: *Swiss Map 50*. Raster-based topographic map without any sheet cut lines for screen use, provided by Swisstopo, Wabern.

Many national mapping authorities now publish their topographic map series in raster format, often supplemented with additional place names and vector-based data for transport networks and hiking trails. These systems provide interfaces for importing data from self-recorded GPS tracks or with simple drawing and marking functions. Examples of such atlas information systems are the TOPO! interactive Maps from the US Geological Survey or the DVD-based Swiss Map series with the time-tested Swiss National Map series published by swisstopo, Wabern (Fig. 17).

## The Institute of Cartography, ETH Zurich – the Swiss Competence Centre for Atlas Information Systems

Since its foundation in 1925, the Institute of Cartography, the oldest academic institution for cartography world-wide, has constantly been involved in designing and editing atlas projects. The illustrated map topics and forms of visualisation were always manifold and adapted to the atlas type in question. In particular, the institute's map authors were always committed to fulfilling the users' needs and to implementing a high-quality graphic design of the map content.

The Swiss national atlas, the *Atlas of Switzerland*, was first established in the 1960s at the Institute of Cartography by the former institute heads, E. Imhof and E. Spiess, and was edited over decades. The printed version presented a wide variety of topics on Switzerland on large-size maps. Since 1995, it was developed as a digital edition. From its first publishing, this multimedia atlas information system set high-quality standards in terms of both its graphic quality and interactive functions (see special chapter).

Digital school atlases also underwent similar developments. This type of atlas mainly consists of physical-geographic and thematic maps of various scales on many different areas, from towns to regions, from countries to continents and outlines of the world. It can be browsed by simultaneously using name indexes and topic lists to find places, rivers, mountains, territories or specific topics.

The Institute of Cartography was in charge of editing the *Swiss World Atlas* (*Schweizer Weltatlas*) for several decades. This printed school atlas in book format is the most frequently used atlas at secondary

school level in Switzerland. Currently, the Institute of Cartography is developing a prototype for a supplementary, interactive edition (see special chapter). *The Swiss World Atlas – interactive* should be available to both teachers and pupils as an internet-supported atlas information system for direct use on the screen as well as using maps for class material, e.g., master copies.

Besides national and school atlases, other topical atlas information systems cover the users' specific needs. New modes of digital mapping and modern technologies are used nowadays for areas such as geology, hydrology, climate, planning or history. The Institute of Cartography is also involved in the development of such specialised atlases. Hence, three years ago, in collaboration with European partners, *STATLAS* was developed as a distributed system to visualise statistic census and economic data (Fig. 18). The most recent development from this type of atlas is the internet-based *Literary Atlas of Europe* which outlines new presentation modes for geographical settings from novels and novellas. The atlas should allow scientists to develop new comparative analysis and research methods (Fig. 19).

### *Atlas of Switzerland* – a Highly Sophisticated National Multimedia Atlas

The *Atlas of Switzerland (AoS)* has become a well-established national cartographic product. The second edition of the interactive *Atlas of Switzerland (AoS2)* plays a prominent role in diffusing national spatial data and knowledge. The atlas is based on concepts implementing adaptive maps and interactive tools in a multimedia environment. The concept also integrates 2-D and 3-D maps as well as a highly developed graphic user interface.

The basic idea of the *Atlas of Switzerland* is best communicated by the metaphor of the atlas as a 'story book'. Users should feel just as comfortable as with a book. Whether for lay people or experts, the atlas should provide a framework for users to immerse themselves in maps, data and history. While 'travelling' through the data, the map is always the starting point for investigative rambles and acts as an anchor. But the interactive map provides even more: in the classical sense, it represents the perfectly designed product, always showing cartographically the results of the user queries in an easily accessible form. With its sophisticated maps and easy-to-use tools, the *AoS2* not only satisfies the users' curiosity, but also meets their demands.

The *AoS2* is also a common tool at secondary schools and universities where it is frequently used to teach geography, cartography and even architecture. Private individuals use the *AoS2* as a source of information, to plan their recreational activities and for illustrations. More technical applications of the *AoS2* can be found in communication, transportation and water management. With its 2-D maps and 3-D views, the *AoS2* is also used for illustrations in numerous magazines and newspapers. Even 3-D visualizations are used in posters for political advertising. Since the first prototypes in the late nineties, the *AoS* has often been an integral part of public exhibitions, e.g., 'Maps of Paradise' (at the Swiss Embassy in London in 2004), 'Mapping Switzerland' (at Seedamm-Cultural Center, 2005), '150 Years ETH Zurich' (2005), 'In the Alps' (at the Museum of Modern Arts Zurich, 2006), and 'Constructing Mountains' (at the Swiss Alpine Museum Berne, 2007).

The *Atlas of Switzerland* unites many visualization and analysis functions in an advanced form. The conceptual framework and modular technical design allow for sophisticated interactive map authoring and for future development of its functions.

The *Atlas of Switzerland* has already established itself as a leading contemporary atlas product.

The current 10-year planning period ensures that the *Atlas of Switzerland* covers the main subject areas. Each edition of the *Atlas of Switzerland* focuses on a main theme for identification purposes. The *Atlas of Switzerland 2* mainly provides maps on 'Nature and Environment', the third edition will deal with 'Traffic, Energy and Transportation', and a further fourth edition will focus on 'Culture and History'.

Future functions development of the *Atlas of Switzerland 3* will also include visualisations of multivariate point symbols and diagrams as well as network maps. Currently, extended 3-D visualisation methods (clouds, moon, starry skies), integrating linear vector elements (river and traffic networks) into the 3-D module, and statistic 3-D surfaces are also being developed. This atlas will offer new tools, e.g., user-defined map labelling and advanced colour mixing, integrating external statistical data and GPS tracks. With the "smart legend" approach, legends can be upgraded from a purely statistical information tool to being dynamic and analytic.

Concerning future delivery platforms and product lines, national atlases will increasingly change to be internet-based, being used in schools, and using extracts for regional areas (special versions with spatial emphasis). Along with the *Atlas of the USA*, *the Atlas of Canada*, the *Atlas of Sweden* and *the National Atlas of Germany,* the *Atlas of Switzerland* has already established itself as a leading contemporary atlas product.

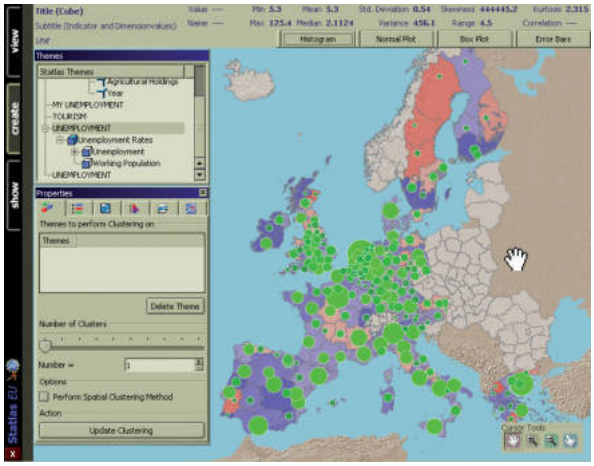


Fig. 18: Screenshot from the web-based *STATLAS* prototype showing the interface for user navigation.

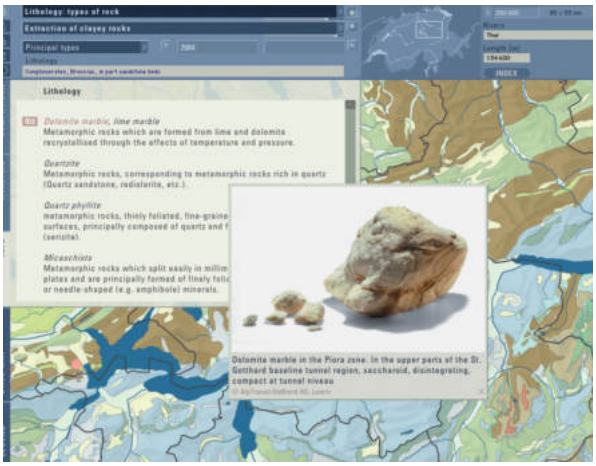


Fig. 20: *Atlas of Switzerland 2*. Interactive map showing the lithology with displayed multimedia information.

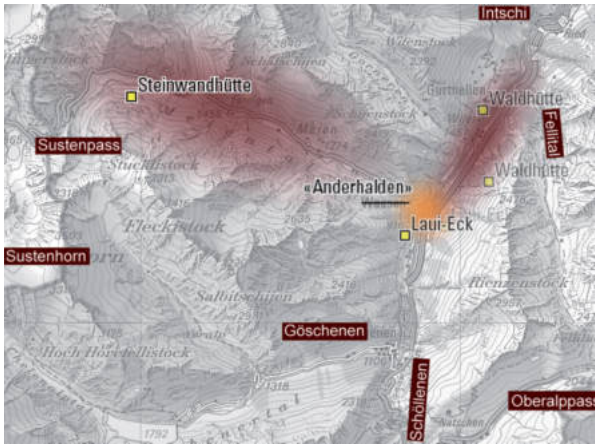



Fig. 19: Map draft for the *Literary Atlas of Europe*. The map section shows the setting of Ernst Zahn's historical novel, "Albin Indergand" (1901). The following three characteristics are visualized in an animated map: imprecisely located zones of action (brown), a transformed setting (the village of Wassen named as "Anderhalden", orange), and a few imprecisely located settings (smoothly animated point symbols, yellow). Base map: © 2007 swisstopo.

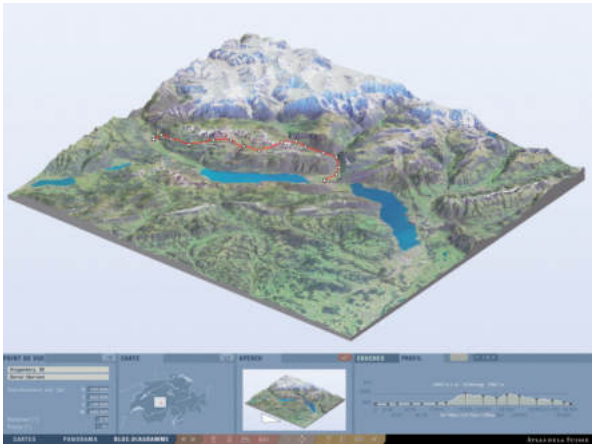


Fig. 21: *Atlas of Switzerland 2*. 3-D block diagram overlaid with a satellite image and a profile track.

## Features of the interactive edition *Atlas of Switzerland 2*

- CD-ROM and DVD edition in four languages (German, French, Italian, English) for Mac and PC;
- Licence free runtime edition with plug & play;
- More than 1000 map topics from the fields of 'Nature and Environment', 'Society', 'Economy', 'State & Politics', and 'Switzerland & Europe';
- 2-D maps with different map types (vector, raster and symbol maps), advanced analytical tools (to compare values, temporal analysis), rich base map and geographic information (Fig. 20);
- 3-D section with panoramic views and block diagrams, smart navigation tools (e.g., for climbers), multilayer overlay, advanced visualisation modules (analytic, cartographic, photorealistic) (Fig. 21);
- Multimedia elements with over 600 text panels, hundreds of pictures, sounds and videos;
- Exporting the visualisation attributes of the map for later use;
- Image export and printing.

### *The Swiss World Atlas – Interactive*: A Future-oriented Teaching Tool for Modern Geography Lessons

The most widely used printed school atlas in Switzerland is the *Swiss World Atlas* (*Schweizer Weltatlas, Atlas mondial suisse, Atlante mondiale svizzero*). With an average of 30,000 copies sold per year, this atlas can be considered as a highly successful teaching aid. Since its first edition nearly a hundred years ago, the *Swiss World Atlas* has undergone many phases of changes. To mention just the last major phase, the transition from manual to digital production that slowly started in the early seventies, has finally been accomplished with the beginning of this century. Within the next few years, the printed atlas will be supplemented with an interactive version. The planned web atlas *Swiss World Atlas – interactive* is not intended to replace the existing printed atlas, but rather to adequately highlight the special features of a modern atlas information system in the classroom and to support individual learning at the monitor (Fig. 22). Such an atlas, for instance, enables the teacher to introduce structural features of different countries and world regions in stages. Pupils can discuss amongst themselves the impact of socio-cultural changes worldwide or physical-geographic processes within their local environment.

The printed *Swiss World Atlas* will be supplemented with an interactive version.

But what else can an interactive atlas offer apart from replacing outdated maps on classroom walls and additional maps on current topics? Similar to the printed version, the newly developing interactive atlas will, with respect to its content and didactic features, follow an exemplary approach. Spatial phenomena will mainly be taught by topographic and thematic maps and additional graphical representations (Fig. 23). At a later stage, a more holistic and systematic approach is aimed for. Topographic overviews and also various thematic maps will be expanded to cover the majority of the globe at different map scales. It is also important to prepare the atlas content according to the needs of the particular level of education. While pupils in their first years of secondary education mainly use an atlas for discovering and recognizing spatial distributions and patterns, pupils in higher classes (upper secondary school and grammar school level) will focus more on spatial analysis, comparison and modelling.

### An Overview of some Innovations and Special Features of the Planned Interactive Atlas:

- *Map comparison*: Map comparison is a familiar cartographic technique to visually detect patterns of changes. For this purpose, two or more maps are shown side by side. This technique of overlaying requires that the maps involved completely match with respect to scale, map projection, orientation, and degree of generalisation.
- *Synchronised maps*: Since computer screens are being made even larger, comparisons between different related maps is again of interest. The term "synchronised maps" describe a technique that supports interactions between a set of maps. Synchronised map are coupled in such a way that their centres always point to the same location in space. Whenever a map is moved, all dependent maps are instantaneously adjusted. This requires that all maps need to be geo-referenced, that is, their map projection and geometric transformation must be known.
- *Virtual globes*: A virtual globe is a type of planet viewer software that shows the surface of the earth, or any other planet, in a perspective view. The user is given the impression of sitting right in front of a real globe (Fig. 24). The virtual globe has the advantage of showing the earth as a virtually unbounded surface. Thus, the virtual globe does not favour a particular region; it avoids the typical Europe-centric maps and makes any sheet line systems unnecessary. The technique of texture mapping used for the globe can also be used for other map projections. However, it would not be appropriate to base an atlas exclusively on a virtual globe. Due to the type of projection, the virtual globe cannot provide a worldwide overview, and it shows the user no more than a hemisphere at a time. Furthermore, it shows heavy distortions towards the peripheral regions.
- *3-D maps*: So-called 3-D maps, perspective and usually oblique views of maps are rarely found in printed atlases. In an interactive atlas for educational purposes, 3-D maps are of a particular interest, since they can assist in understanding and interpreting contour lines and the analysis of real terrain forms. Well suited for this purpose are small parts of large-scale maps that show pronounced differences in elevation. As such, 3-D maps always show a very specific view. However, this is different with an interactive atlas, since the view can be changed at any time.

Following the successful completion of the two-year prototype stage, the first release of the *Swiss World Atlas - interactive* is expected in 2009 when it will be used in Swiss secondary and grammar schools. By involving teachers, ongoing discussions about the content of the atlas and how it is implemented in the modern geography lesson, a user-oriented development of the atlas will be guaranteed.

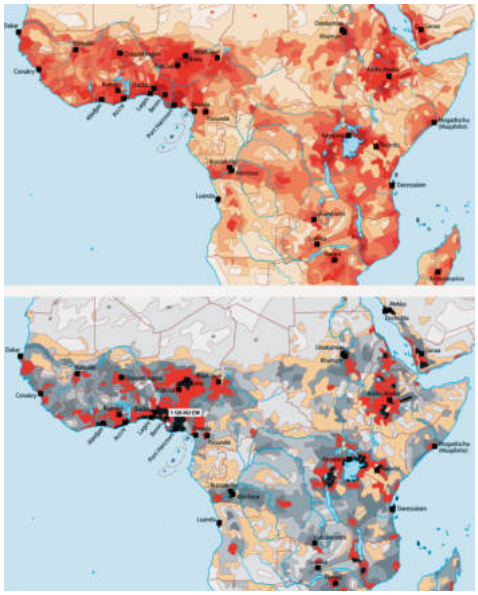


Fig. 22: *Swiss World Atlas – interactive*. Interactive map of population density in Africa. Top: traditional choropleth map with graduated colour shades for the corresponding population density. Bottom: When using the computer mouse, the population density of the desired areas is shown in colour while the remaining areas are interactively assigned a corresponding grey shade.

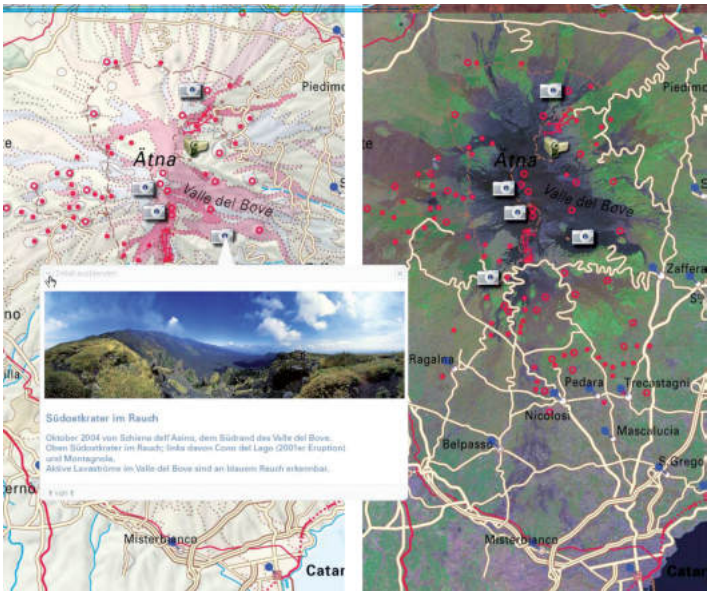



Fig. 23: *Swiss World Atlas – interactive*. Multimedia map of Mount Etna. Left side: By clicking on objects on the activated metadata layer, additional information, photos and movies can be called up. Upon activating the "detail" link, the photo or video are enlarged or accompanying texts are shown. Right side: User-controlled map with additional satellite image.

Fig. 24: *Swiss World Atlas – interactive*. Screenshot from the virtual globe. After reprojection, existing world maps are used to construct a virtual globe.

## Future Developments of the Atlas Cartography

In future, atlas information systems will be designed in an even more diversified way to classical atlases. Implementating basic data and generating illustrations will no longer exclusively follow the traditional graphical approaches. Thematic data will increasingly be stored in standardised, geo-referenced databases from where they will be retrieved and visualised for interactive maps with defined cartographic principles and symbol libraries. Atlas information systems will be queried by search engines with additional geographical search functions. Further, web-based spatial data sets will be integrated in such systems. This also allows the import of user-generated geodata. With such holistic approaches, atlas information systems will be expanded and updated by a broad public. In this way, they will become collaborative geo-information platforms.

## Fragmentation processes in impact fracture

**Engineering materials are often particle compound materials or agglomerates of finer aggregates. To break up the agglomerates for re-use or to produce for example finer powders, various milling technologies are in use.**

by H.A. Carmona, F.K. Wittel, H.J. Herrmann / IfB

One basic principle of comminution that can be found in many applications, is shooting the agglomerate against a target. We study the impact breakage of spherical particles using a three-dimensional Discrete Element Model. Large scale computer simulations are performed with a model that consists of agglomerates of many elementary particles, interconnected by beam-truss elements in three dimensions.

With our model we focus on the simulation of the fracture and fragmentation processes that take place simultaneously during a very small time interval. By this, different fragmentation mechanisms, their origin and their interaction during the fragmentation process, can be studied in detail. The Fig. 25 shows the temporal and spatial evolution of damage inside an impacting agglomerate sphere. It was found, that damage initiates in the inside with quasi-periodic angular distribution and grows to the outside of the specimen. The final shape of the experimentally observed large wedge-shaped fragments could be reproduced and explained.

By predicting the fragmentation, we create means for optimizing comminution processes and tools to achieve certain size distributions for example with minimal powder production and minimal energy input for various material systems.

## Model experiments for studying the contact zone between cement paste and aggregate

**Despite continuous modifications in mixing methods and recipes, concrete durability remains an important issue.**

by S. Ruffing, P. Minder, J.G.M. van Mier / IfB

Notably, this behaviour appears to depend on the strength and stability of the bond between cement stone and aggregate. To improve the poor understanding of the complex mechanisms within the contact zone, fundamental model experiments are required.

Calcite, the main mineral compound of limestone, was used as model material for aggregates. The reaction kinetics of calcite was investigated with ordinary Portland Cement (CemI42.5N). The presence of calcite has an accelerating effect on the hydration of cement CemI42.5N (Fig. 26). The microstructure of the interfacial transition zone was investigated with an Environmental Scanning Electron Microscope (ESEM). The ESEM-images in Fig. 27 show a single calcite crystal embedded in a 7-days old cement matrix. Interaction with the cement paste (here: filigree Calcium-Silicate-Hydrate (CSH)) is obvious and motivates the experimental investigation of on-going solution and crystallisation processes.

A pore solution based on CemI42.5 N was used for modelling the dynamic processes of cement hydration. A droplet of this model solution was injected in-situ on a calcite crystal with a syringe in the ESEM chamber (Fig. 28). In this experiment an optimal set of measurement parameters (pressure and temperature) was determined. It will be applied in future attempts to improve the bond between cement stone and aggregate and with that the durability of concrete.

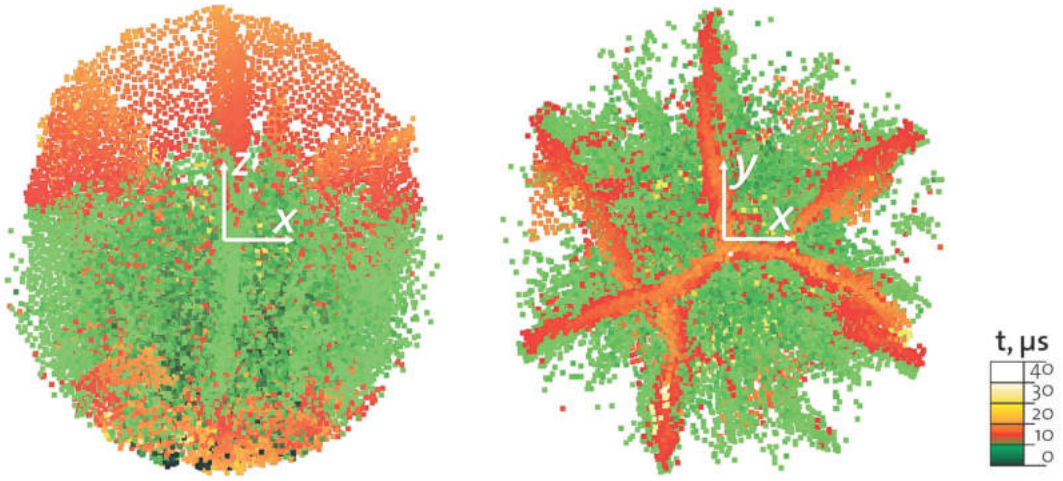



Fig. 25: Visualization of the fragmentation process. Colored dots display the positions of the broken bonds according to their time of breaking.

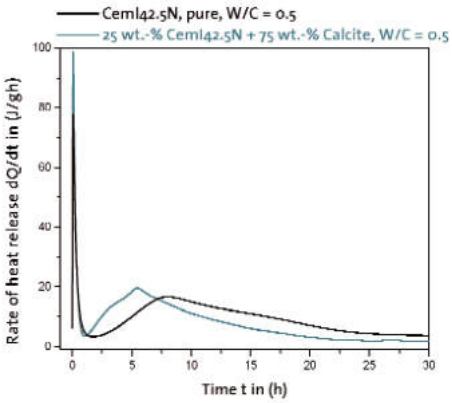



Fig. 26: Rate of heat release of pure Cem142.5N and Cem142.5N with calcite.

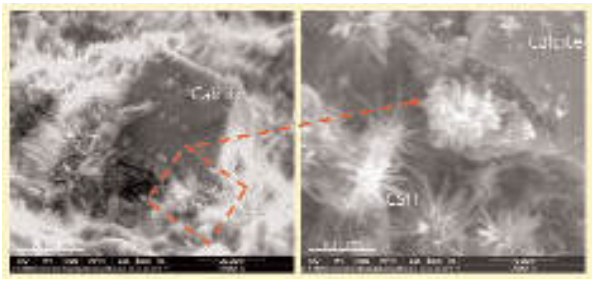


Fig. 27: Calcite embedded in a cement matrix consisting on Cem142.5N (right photo is the magnification of the left one).

Fig. 28: Injection of Cem142.5N pore solution on calcite.

## Shrinkage cracking in concrete

**Concrete is sensitive to the relative humidity of its environment: it shrinks upon drying, and swells upon (re-)wetting.**

by J. Bisschop, A. Casanova, J.G.M. van Mier / IfB

Due to drying shrinkage the surface layer of concrete usually contains many microcracks. These may ultimately grow to larger cracks under continuous drying or, in concrete floors and pavements, due to the forces exerted by traffic. Thus, drying shrinkage cracking reduces the long-term durability of concrete surfaces.

Drying shrinkage deformations and microcracks in concrete are too small to be seen by the naked eye. At high magnification under the microscope, however, the dynamic response of concrete to drying is directly evident. The surface deformations can be measured in-situ using an optical microscope or environmental scanning electron microscope (ESEM) in combination with a technique called *digital image correlation*. Digital images taken at various steps during drying are mathematically compared to the initial image taken of the undeformed concrete. The displacement of small clusters of pixels is followed from image to image, and based on this principle a 2-dimensional strain field on the drying surface can be calculated.

Cellular-like strain patterns are observed in hardened cement paste undergoing drying under a microscope (Fig. 29). The red areas are under the highest tensile strain and these areas correspond to microcracks. Purple and blue regions are under compression. Understanding the micromechanisms of drying shrinkage cracking will help to design concrete mixtures with a high surface durability.

## 3-dimensional elasticity of wood

**Wood is a high-performance material brought to perfection by nature, with excellent mechanical properties in spite of low density.**

by D. Keunecke, S. Hering, P. Niemz / IfB

In the course of evolution, wood anatomy was ideally adapted to external loads. Fibrous cells, aligned parallel to the stem axis, represent the main component of the wood tissue.

Consequently, wood shows strongly anisotropic material behaviour in contrast to many other materials (e.g. metal, synthetics, glass, cement). This also applies for the elasto-mechanical behaviour of wood that is commonly described by elastic engineering parameters (Young's moduli, shear moduli, Poisson's ratios) related to the three principle anatomical directions (L=longitudinal, R=radial, T=tangential) (Fig. 30).

Within the scope of a dissertation carried out at the Institute for Building Materials (Wood Physics) the elastic engineering parameters were determined for the conifers Common yew and Norway spruce by combining different experimental approaches (ultrasound measurements, tensile tests, digital image correlation). The results allowed a 3-dimensional illustration of the deformation behaviour of both species with the aid of so-called deformation bodies (Fig. 31). They have to be interpreted as follows: To any arbitrary chosen axis in the 3-dimensional coordinate system representing the L, R and T directions of a wood species, an identical tensile load is applied. The bodies illustrate the degree of deformation depending on the load direction. As became apparent, both species varied largely in their degree of anisotropic elasticity. When used for construction purposes, such results might help choosing the best-suited wood species under the given mechanical demands.

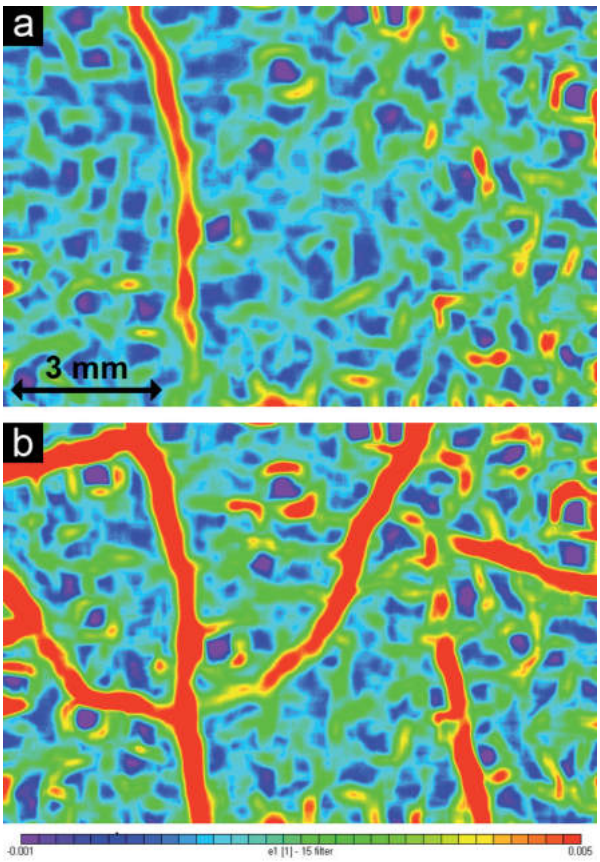



Fig. 29: Strain-patterns in hardened cement paste after (a) 15 min, and (b) 30 min drying at 50% relative humidity.

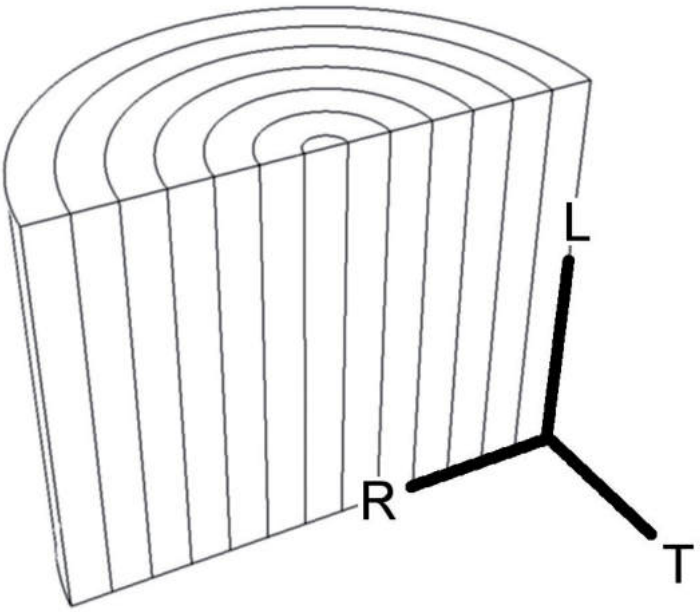



Fig. 30: Definition of the three main anatomical directions of wood.

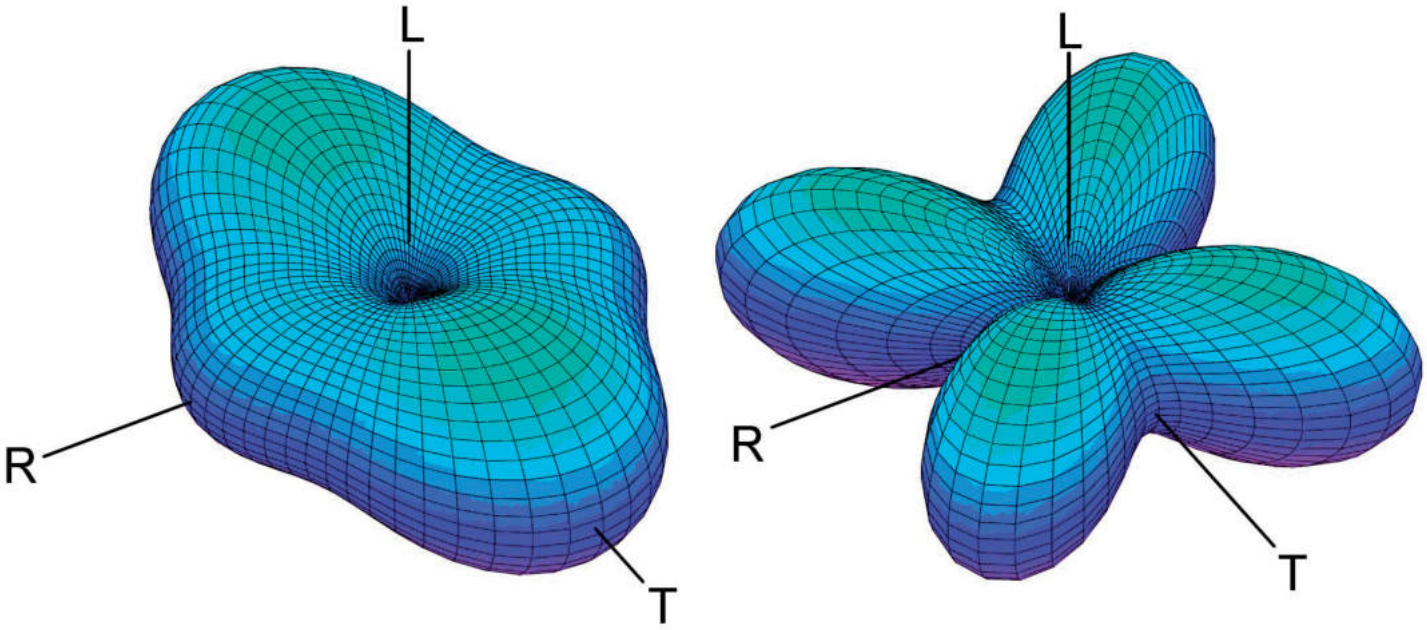



Fig. 31: Deformation bodies for yew (left) and spruce (right) under uniaxial tensile load.

## New non-destructive testing methods for wood and wood-based materials

**For wood as natural, organic building material, whose properties are largely influenced by its environment, non-destructive testing methods represent important research instruments.**

by D. Mannes, P. Niemz / IfB; E. Lehmann / PSI

For wood as natural, organic building material, whose properties are largely influenced by its environment, non-destructive testing methods represent important research instruments. Apart from conventional methods like X-ray and ultra-sound, several new, innovative methods have come into operation in recent years. Within the scope of a dissertation at the Wood Physics group of the Institute for Building Materials, investigations on wood using neutron radiation and synchrotronlight have been conducted at the Paul Scherrer Institut (PSI), Villigen. The dissertation is a joint research project of the ETH and the PSI, financed in equal shares by both institutions. At the Swiss Light Source (SLS), the synchrotron radiation source of the PSI, microtomographic investigations were carried out aiming at the penetration behaviour of different adhesives into wood on a microscopic level (Fig. 32 und 33).

Other experiments performed at the spallation neutron source (SINQ) of the PSI focus on the qualitative and quantitative evaluation of the sorption behaviour (absorption of gaseous water from the ambient air) of different wood based materials and building components. These findings provide new information on the penetration behaviour of fluids in wood, which will be used for the modelling and optimisation of wood bonding using different adhesives. Investigations based on neutron imaging allow the qualitative and quantitative determination of moisture beneath coatings or adhesive joints with a high spatial and temporal resolution.

## Rock fall impact tests on protection galleries

**In April 2007 and together with the Federal Institute for Forest, Snow and Landscape Research (WSL), rock fall impact tests on reinforced concrete slabs have been carried out in WSL's outdoor testing area near Walenstadt.**

by K. Schellenberg, T. Vogel / IBK

The slabs had dimensions of 4.50 m x 3.50 m and a thickness of 0.25 and 0.35 m, respectively. They were covered by a 0.4 m thick cushion layer out of gravel and represent a section of an average rock fall protection gallery in scale 1:2. Masses of 800 and 4000 kg were dropped on to the slabs from increasing height until failure was reached (Fig. 34).

With six slabs and 38 tests in total information was produced to study the influence of the slab stiffness and of uniformly distributed shear reinforcement on the protection capacity of galleries. In addition, an innovative cushion layer out of cellular glass that has a low density was tested together with Geobrugg Protection Systems. This material can be used to improve existing structures by placing thicker cushion layers, which allow for better load distribution.

The collaboration with WSL led to a measuring concept to record the dynamic processes during the impact. Accelerations in the falling weight and the reaction forces at the supports describe the global impact behavior. Strains in the bending reinforcement and on the concrete slab surface give indications on the structural response. Additional acceleration measurements in the slab and a digital interpretation of the high speed videos give supplementary data to understand the impact behavior of the slabs.

The test results are used to calibrate analytical models, which will allow drafting of feasible recommendations for the design of rock fall galleries.

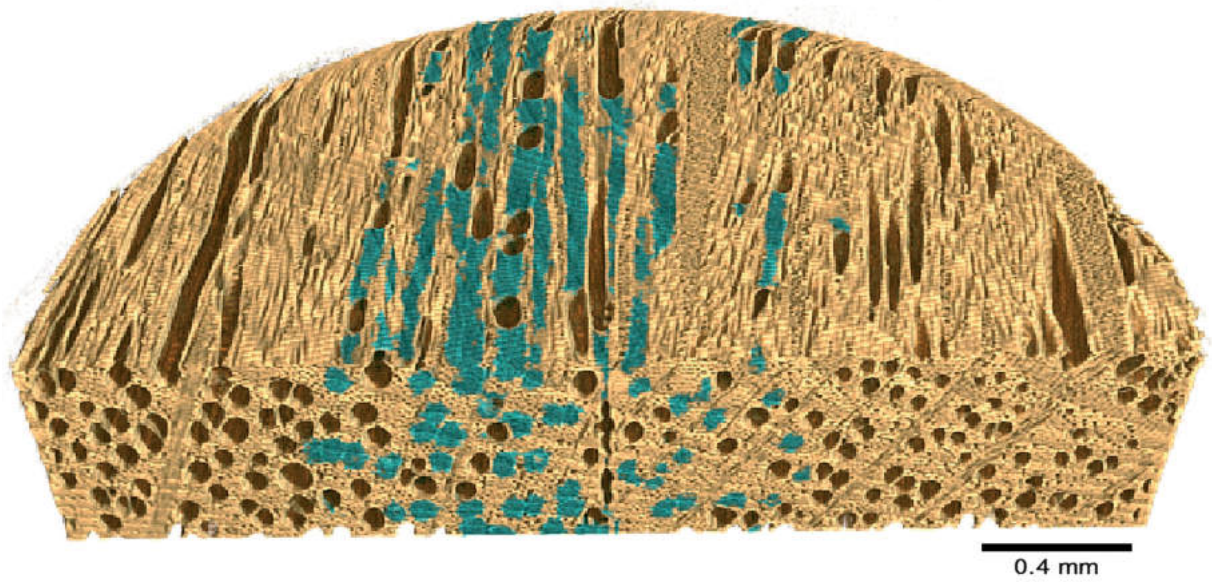



Fig. 32: Visualised synchrotron micro-tomography of a beech wood sample glued with polyurethane resin.

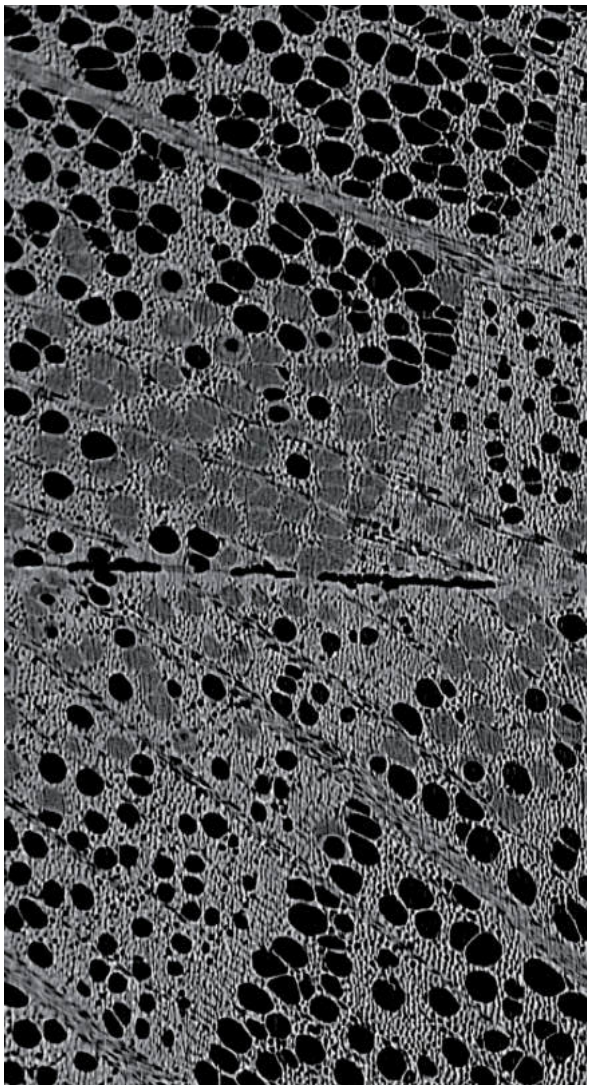


Fig. 33: Synchrotron micro-tomography image of a beech wood sample glued with polyurethane resin; the adhesive joint is visible as horizontal line in the centre with adjacent areas where the adhesive has filled the wood vessels.

Fig. 34: A bolder of 800 kg is dropped on a reinforced concrete slab from 15 m of height.

## Ground improvement with stone columns

**Soft, fine-grained soils are common in the Swiss «Mittelland». They are highly compressible, have low shear strength and low permeability, all of which cause strongly time-dependent load-settlement response.**

by T.M. Weber, J. Laue, S.M. Springman / IGT;
G. Peschke / IfB

The Serviceability and Ultimate Limit States can often be achieved only through ground improvement, typically with stone columns that also accelerate drainage. The load transfer between soil, column and superstructure is complex. Extensive model tests have been carried out in the geotechnical centrifuge under enhanced gravity at 50g, permitting investigations (under equivalent stress conditions) of the installation and load response during embankment construction. Fig. 35 shows a cross-section through the stone column group, post-centrifuge test, with an enlarged ESEM picture of the contact zone.

The results show that stress redistribution and micro-structural changes take place around the columns, leading to compaction of the surrounding soil as well as an increase in the stiffness and strength. The analyses with the Environmental Electron Microscope (ESEM) identified a localised zone with reduced permeability through reorientation of the clay particles (smear). This research has delivered greater understanding about the effect of installation method on the load bearing capacity of sand columns, leading to improved design methods based on physical evidence and a fundamental approach.

## An efficient way of electrochemical chloride extraction

**Chloride ions from de-icing salts can penetrate the concrete cover and severely corrode the reinforcement. The resulting loss in cross section can lead to structural and safety problems.**

by B. Elsener, U. Angst / IfB

The traditional way of rehabilitating these damaged reinforced concrete structures is to remove chloride contaminated concrete, eventually replace the reinforcement and put new concrete or shot-crete in place. In this way frequently good concrete with high compressive strength has to be removed (with high costs, noise and dust) only because it is chloride contaminated.

An alternative, nearly non-destructive way of rehabilitation is to use electrochemical chloride extraction (ECE). Applying an electric field between an anode placed on the concrete surface and the reinforcement, the resulting current will transport the negatively charged chloride ions towards the anode, thus essentially extract chloride ions from concret (Fig. 36). The normal way of operation today is to apply a continuous DC current for about 6 – 8 weeks.

Chloride ions in concrete show a complex chemical equilibrium between bound and free chlorides. From the mechanism of ECE it is clear that only free chloride ions present in the pore solution of concrete can be extracted. Also the efficiency of the treatment decreases with decreasing chloride content.

In our research work we were able to continuously measure the free chloride content in concrete with chloride sensors placed at different depth of the concrete cover. A first surprising result showed that the extraction of the free chlorides was completed within about 3 - 4 days of treatment (Fig. 37). In a current-off period of some days the equilibrium was re-established and chemically bound chloride dissolved. But only after switching on the electric field, free chloride ions in the pore solution could be detected and were extracted rapidly again.

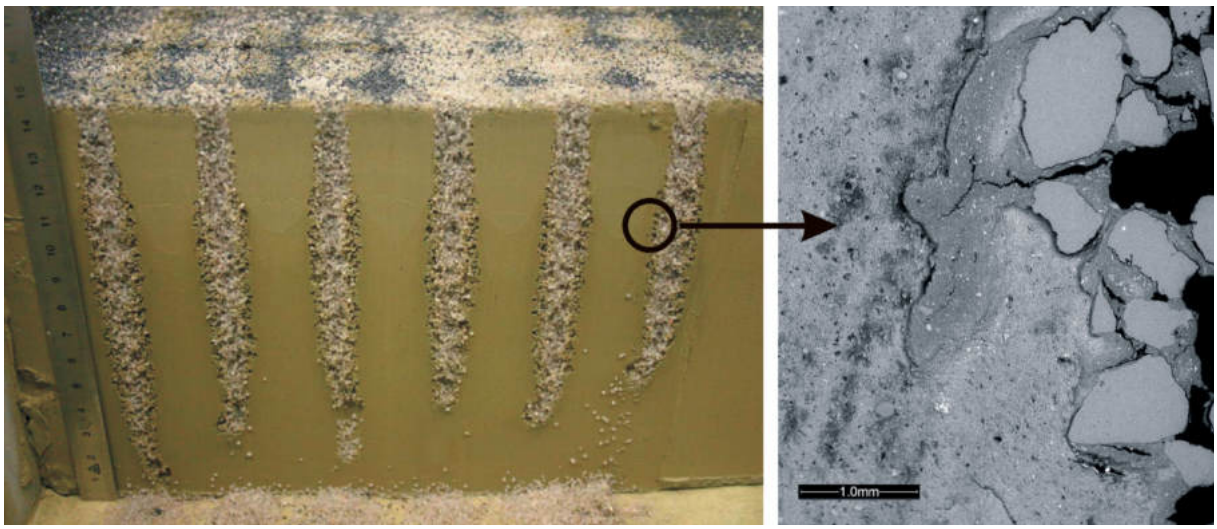



Fig. 35: Cross-section through stone column group and ESEM picture of the contact zone.

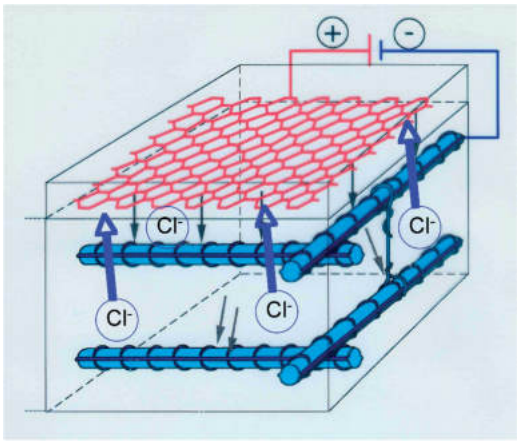



Fig. 36: Principle of electrochemical chloride removal from concrete. A DC voltage of ca. 30 V is applied between the external anode (plus) and the rebars (cathode, minus). Negatively charged chloride ions are transported to the anode at the concrete surface.

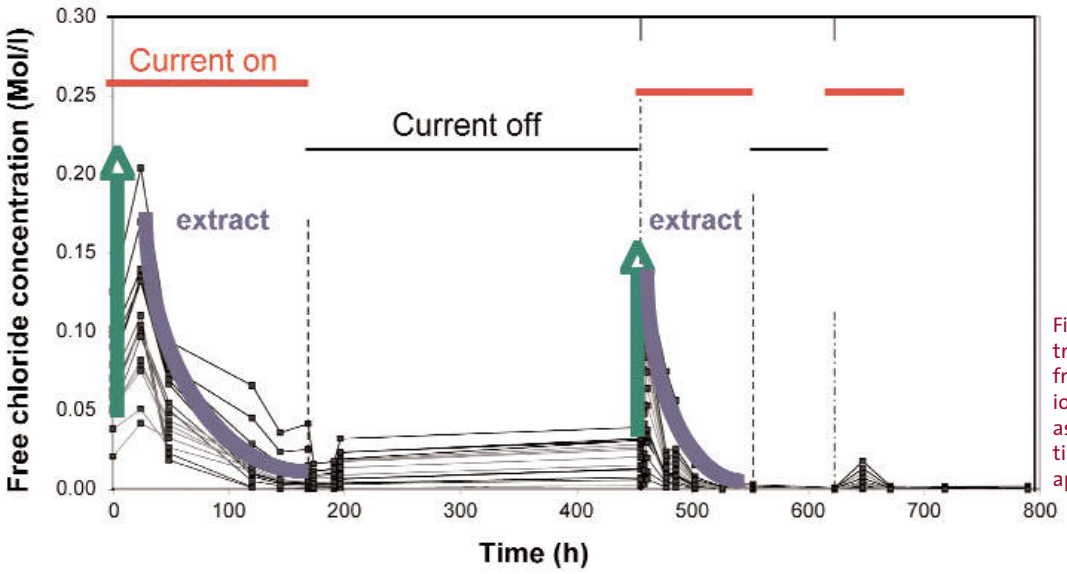



Fig. 37: Concentration of the free chloride ions in concrete as a function of time and current applied.

The main conclusion from the point of view of research is that in addition to free chloride ions in the pore solution and chemically bound chloride a third state, chloride physically adsorbed on the pore walls of the concrete, has to be considered in order to explain the results.

For practical application it can be concluded that an intermittent electrochemical chloride extraction (current on – off periods of some days) will result in a much more efficient and rapid treatment.

## MATSim: Development Status

**Agent-based modeling is pursued at ETH and IVT through the development of the MATSim toolkit (see annual report 2006).**

by A. Horni, M. Balmer, K.W. Axhausen / IVT

Currently, the dynamics of 7.2 million agent days can be optimized for a traffic network with 60'000 edges and 1.7 million activity locations on a computer with 8 processor cores in less than 24 hours. The excellent performance is achieved by simulating the dynamics of the network edges with an event-oriented queue simulation as opposed to a time step driven simulation. Additional computing speed is gained by implementing accelerated routing methods instead of traditional Dijkstra-routing algorithms.

Comparing the simulation results with Swiss traffic count data for an average working day shows a good match of the dynamics. As the difference between the simulated and the counted values corresponds to the not yet modeled share of transit and commercial traffic, a good fit of the absolute values for remaining traffic can be assumed. Astonishingly this holds true already prior to the outstanding detailed calibration of our simulation.

Substantial progress has been made in visualizing the simulation results. A comparison of the simulated and counted values and their visualization with Google Earth has become an easy task (Fig. 38). MATVis-Replay (Fig. 39 and 40), which was presented at a "Science City" day, enables the visual tracking of the daily path of single agents or arbitrarily composed groups of agents.

Further improvement of the simulation is expected for next year in the field of secondary location choice (shopping, leisure, etc.) and public transport modeling, and finally mode choice.

## Modelling of residential rent prices

**The most advanced land-use and transport models at IVT need real estate data as an input. This allows for more realistic forecasts of the impacts of new infrastructures.**

by M. Löchl / IVT

The most advanced land-use and transport models at IVT need real estate data as an input. This allows for more realistic forecasts of the impacts of new infrastructures. Banks and specialised consultants have such data and models, which are actually needed for purchase or sale of properties, financing, or the review of carrying values. However, those private models are not publicly available. Therefore, a different way was chosen by using the internet portal Comparis for acquiring residential bid rent data for Canton Zurich.

The data includes information about dwelling size and amenities (i.e. the availability of balcony, garden terrace or lift in the building). Moreover, the address of the property is included, meaning that the data could be enriched by spatial information like various accessibility measures, solar exposure and a visibility index.

With the data, it is possible to estimate hedonic price models and to calculate spatially disaggregated price values. The hedonic regression considers spatial correlation among the dwelling units. The model result is presented in Fig. 41 for all occupied hectares of Canton Zurich. There is a steep gradient observable in the City of Zurich and the municipalities along the Lake of Zurich in comparison to the outer municipalities in the canton. However, at the so called Gold Coast, you would expect the highest rent values. But this is not the case in the shown model because of the relevance of the travel time variable to the inner city of Zurich and the resulting highest rents in the downtown area of Zurich. Work on model improvement is ongoing.

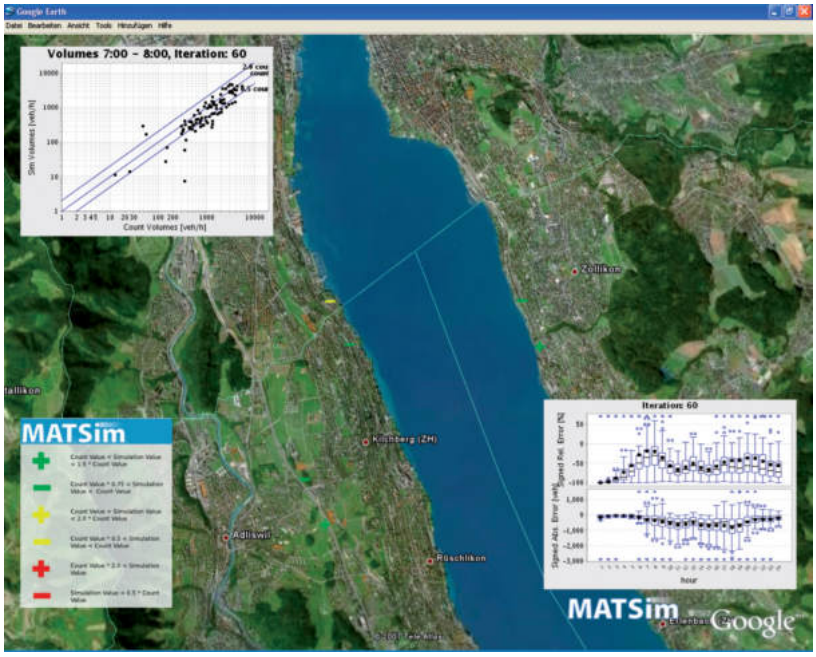



Fig. 38: Visualizing comparison results with Google Earth.

Fig. 39: MATVis-Replay: Switzerland, travelling agents at 8 a.m.

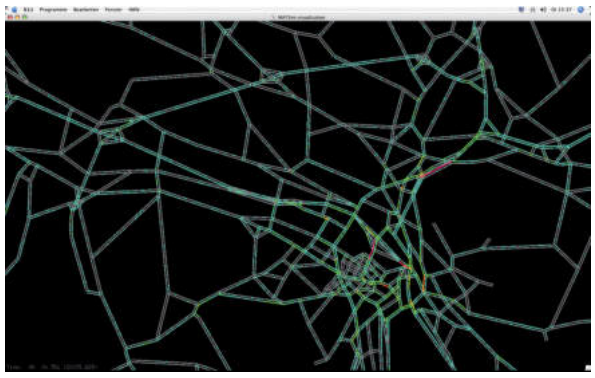


Fig. 40: MATVis-Replay: Zurich, travelling agents at 8 a.m.

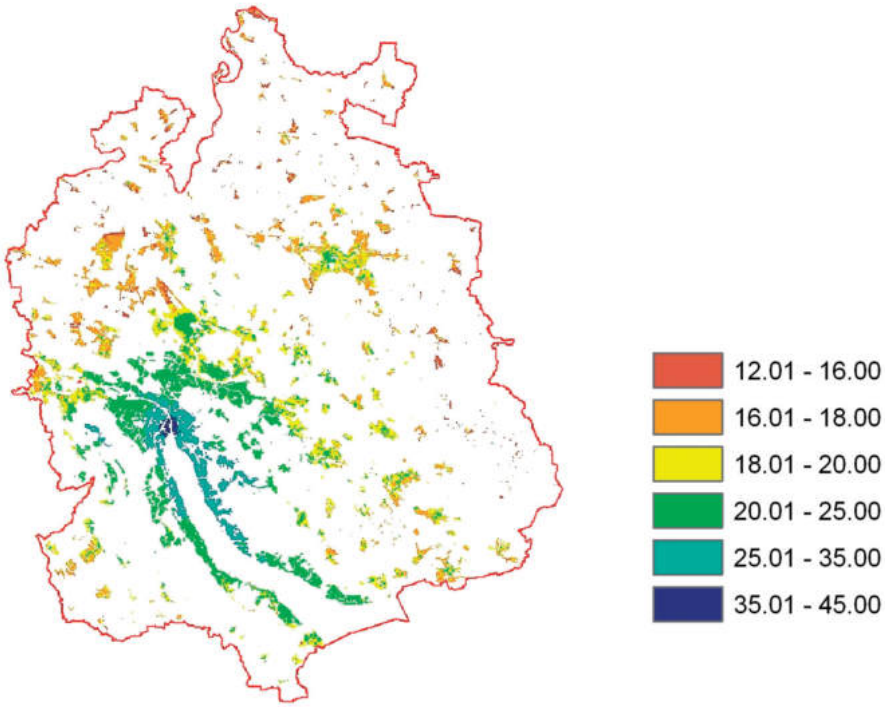



Fig. 41: Hedonic modelling result of monthly gross rent prices of dewlling units in CHF per sqm.

## Company decisions on choice of location

**The spatial distribution of companies and their employees plays an essential role in many different kinds of spatial and traffic planning problems.**

by B.R. Bodenmann / IVT

The spatial distribution of companies and their employees plays an essential role in many different kinds of spatial and traffic planning problems. For example, if future transport planning measures, such as a new highway connection, are being considered, then the (future) distribution of the residents, workplaces, shopping and leisure activities must also be taken into account. The Institute for Traffic Planning and Transport Systems of ETH Zurich is therefore intricately involved with this particular spatial planning issue. The company data is based on business registers in the three cantons of St. Gallen and Inner and Outer Appenzell.

Because of their connection to their customers and employees, companies seldom relocate and then usually in the vicinity. Smaller companies are comparatively flexible, however, they relocate more often and sometimes much further away. The few relocations that take place over great distances usually end or start in a large city. The agglomeration centers play an important role for companies: In these areas, urbanization effects lead to a more intensive generating of new companies, for example. In the growth phase of the company, cities can only offer rather unfavourable opportunities because of the limited number of larger sites. As a result, the companies affected increasingly relocate from the centre to the periphery. Fig. 42 und 43 show this process in the regions investigated. The city of St. Gallen, in particular, is an important producer of young companies (Fig. 42, darkest green) and at the same time supplies the surrounding area with businesses that are relocating (Fig. 43, darkest red). These effects can also be observed in smaller cities.

## Success factors of international construction joint ventures in South-East Asia

**International construction joint ventures (ICJVs) are generally established in order to execute mega projects.**

by Chr. Brockmann, G. Girmscheid / IBB

They usually comprise two partner companies from different countries, although frequently the cooperating engineers, foremen and workforces come from more than 20 different countries. As such, ICJVs are characterized by high levels of complexity and internationality.

Success factors in socio-cultural systems are governed by social rules and do not obey any physical laws. Social rules are based on the cognitive maps of the individuals involved, which represent their attitude towards specific interrelationships, in this case towards ICJVs. The cognitive maps in ICJVs can be determined by conducting ethnographic interviews and evaluating the results with the aid of grounded theory. A successful ICJV emerges when the cognitive maps are coordinated across all national and organizational borders when tracking clearly defined common goals.

In addition to the actual engineering tasks (organizational planning, design, work preparation, site installation, construction execution), a complex management model emerges from the perspective of the individuals involved in the ICJV, which comprises three further levels (management functions, basic functions, meta functions), which, in turn, are all influenced by five cultural factors (Fig. 44).

Each function, each action and each cultural dimension can be illustrated as a cognitive map, all of which demonstrate cross-relationships to each other. The management level of an ICJV is responsible for performing all tasks correctly at the same time: A complex answer is the only possible response to a complex environment.

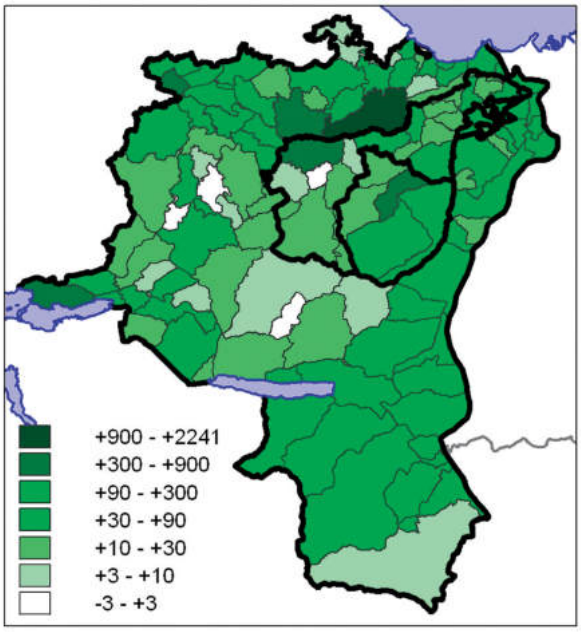



Fig. 42: Balance of company establishment and dissolution (1991-2006).

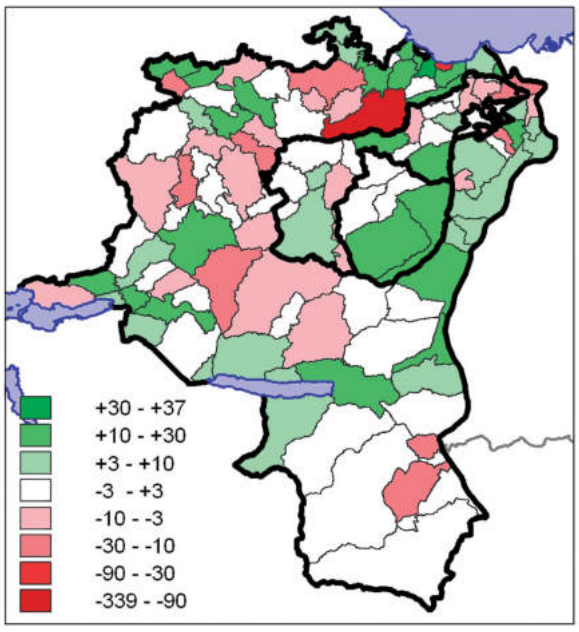



Fig. 43: Balance of company relocations (1991-2006)

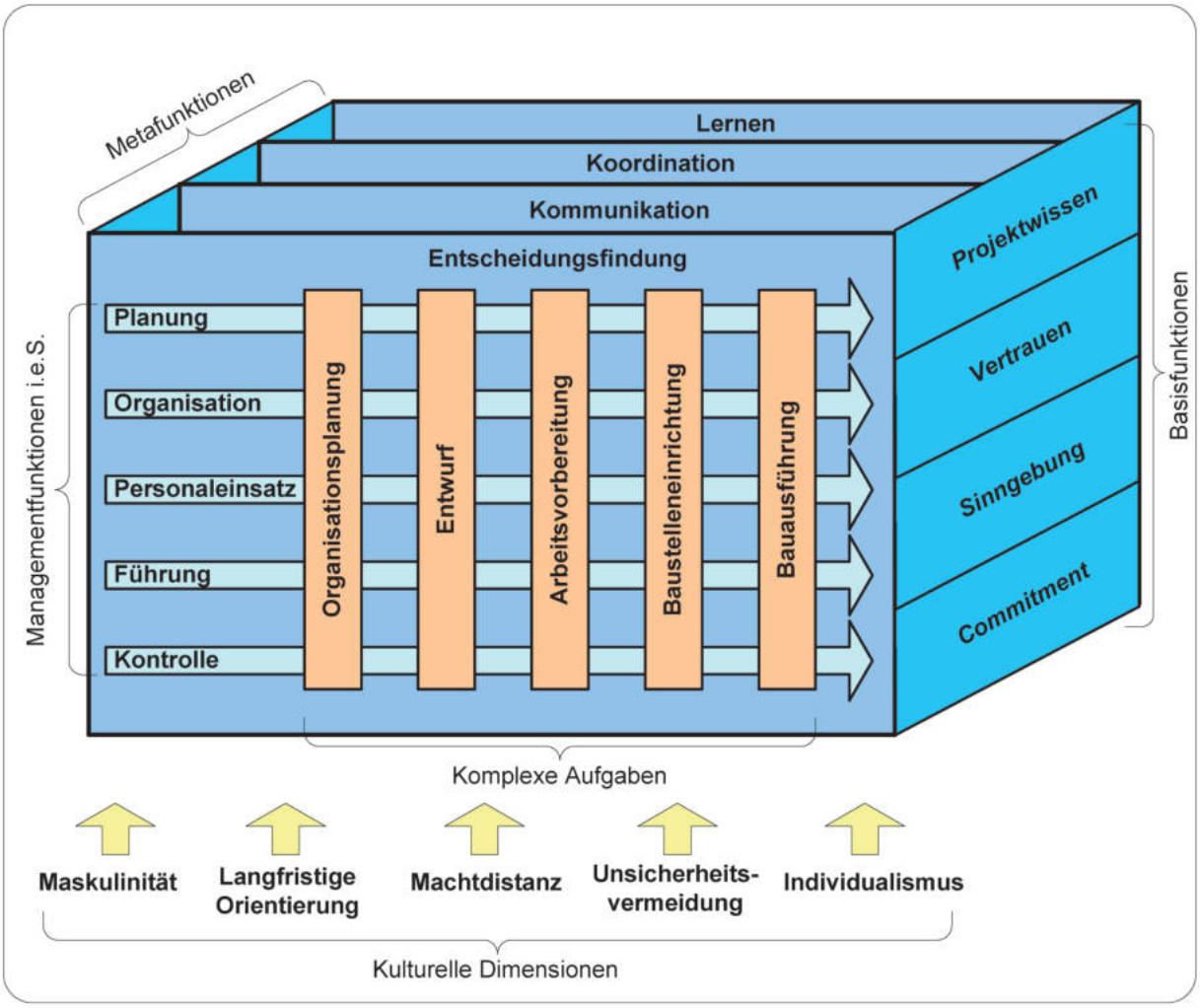



Fig. 44: International Construction Joint Ventures (ICJVs) in a complex environment.

## New Approaches for Timetable Planning based on Automatic Passenger Counting

**The 8 S-Bahn Systems in Switzerland are due to increased service quality confronted with a strongly increasing number of passengers – on certain lines over 100% during the past 15 years.**

by S. Buchmüller, U. Weidmann / IVT

Therefore, critical service times and especially station dwell times have been increasing. This led to a risk of losing timetable stability on the whole network.

To secure stable and punctual services, a (more) precise operation and rolling stock planning is needed. Therefore, the Swiss Federal Railways (SBB) ordered a universal dwell time calculation model. This model allows planners to predict station dwell time by entering the type of rolling stock, the station infrastructure and the number and distribution of passengers.

In the first step, the dwell process had to be analyzed and was structured into 5 sub-processes. With these sub-processes the influence of vehicle equipment, passengers and railway operation could be separated and statistically quantified.

Using the SBB's on-board automatic passenger counting systems – about 30% of the rolling stock is equipped with these – over 3 million dwell processes (number of boarding/alighting passengers and sub-process times for each door) have been measured and recorded (Fig. 45, 46). With the measured data mathematical models for sub-process times have been derived including parameter estimation for the most relevant influence factors.

These models were implemented in a user-friendly calculation tool. The results will allow additionally to define the specifications for new vehicle concepts.

## Unstructured block ramps in alpine rivers – basic studies

**Increasing numbers of block ramps have been constructed in the alpine region and especially in Switzerland (Fig. 47).**

by T. Janisch / VAW

Block ramps are passable for fish and the macrozoobenthos and thereby restore the natural connectivity of river sections formerly divided by concrete constructions. These structures often replace concrete transverse constructions and consist of large natural blocks placed on a relatively fine underground gravel layer. The design idea follows natural steep channels featuring large isolated boulders stabilizing the river bed.

The geometry of these ramps is defined by the slope J, the equivalent ball diameter of a block D and the dimensionless block placement density which describes the distribution of the blocks. The calculation for such hydraulic structures occurs till now with different empirical computation methods, which were derived from model investigations. Borders are set to the applicability of these appendages to the respective range of validity. For this reason and in order to provide design guidelines for unstructured block ramps, model tests have been conducted at the Laboratory of Hydraulics, Hydrology and Glaciology (VAW). The aim of the investigations is a universal design formula, correlating the maximum dimensionless specific discharge $q^*$ at which the ramp is still stable, to the slope J, equivalent ball diameter of a block D and the dimensionless block placement density a.

The physical experiments are conducted in a hydraulic flume using geometric scaled ramps of different designs. The flow conditions and the reaction of the scaled block ramps are described by visual observations as well as measurements of flow velocities, the water level and the development of the ramp topography. The results from a wide range of experiments led to a new physically based design formula (Fig. 48), which can be used for all cases arising in the alpine region.

Fig. 45: Direction sensitive infrared sensors of the automatic passenger counting system (AFZ) of the Swiss Federal Railways (SBB).

Fig. 46: Heavily used S-Bahn-System taking the railway station Zurich Museumstrasse as example.

Fig. 47: Unstructured block ramp in the Simme river near St. Stephan (Kt. Berne).

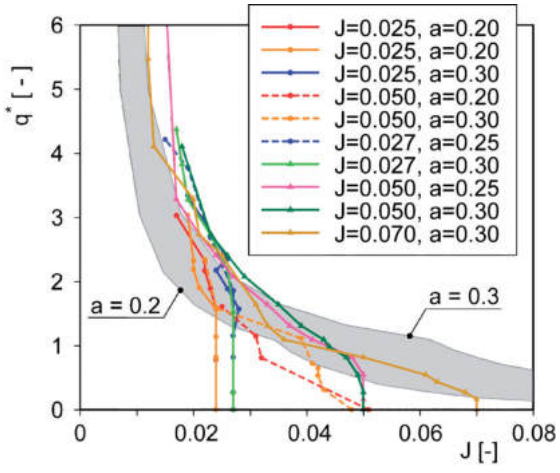



Fig. 48: Comparison of some selected results attempt with the computed curves from the theoretical model with two different use densities.

## CCES Projekt: Triggering of Rapid Mass Movements (TRAMM)

### IGT subproject: Hydrology of landslide triggering

by P. Kienzler, A. Thielen, S. Springman (PI) / IGT
in cooperation with WSL (M. Stähli), SLF (P. Bartelt), EPLF (D. Or, L. Laloui)

Landslides have caused enormous damage in Switzerland and mountainous regions worldwide recently. Triggering of landslides occurs frequently during heavy rainfall events when saturation of the ground causes an increase of weight and a decrease of frictional resistance mobilised along a shear surface. The influence of soil saturation on slope stability was demonstrated in Andrea Thielen's doctoral thesis for an experimental slope in northern Switzerland, where landslides were observed in the vicinity.

Saturation and drainage vary widely at different sites, controlled by a complex, dynamic interaction of flow in the soil matrix and preferential flow, both in vertical and lateral directions. Application of a blue food dye during sprinkling experiments allowed preferential flow paths to be visualised, and showed the degree of interaction between these paths and the surrounding soil matrix. The figure (Fig. 49) depicts different infiltration patterns from two locations. Infiltrating water can bypass the soil matrix and flow quickly into deep soil layers through vertical preferential flow paths (macropores). Lateral preferential flow can drain a hillslope effectively and thus delay, or even prevent, saturation. Understanding how different soils saturate and drain helps to evaluate critical combinations of slopes and precipitation characteristics that may lead to slope failures.

## Modeling river delta formation

### SNF Project: Modeling of river deltas

by H. Seybold, H. Herrmann / IfB
in cooperation with IfU (P. Molnar, W. Kinzelbach), UFC (J.S. Andrade)

How river deltas emerge and how they evolve are classical questions. Nevertheless computational modeling has proven to be very difficult as the system is highly complex and a large range of length and time scales are involved. Daily, monthly and yearly cycles must often be taken into account over geological time scales. This cannot be modeled with classical hydrodynamical methods such as finite elements. Recently "reduced complexity models" based on the idea of cellular automata have shown to be successful in modeling the time evolution of geophysical processes. Based on these ideas a model for simulating the formation and evolution of river deltas has been developed at the IfB and good agreements with natural deltas have been found (Seybold, Andrade, Herrmann PNAS 2007). The project is funded by the SNF.

The model describes a river flowing down a valley to the sea on a rectangular lattice where the nodal values correspond to the water level and the elevation of the landscape. The water flow is modeled in terms of the the continuity equation with nonlinear internodal conductivities. The change of the landscape is determined by a phenomenological erosion/deposition law.

Using this model, it is now possible to model the time evolution of a river delta over geological time scales, which gives a deeper understanding into the sedimentation and erosion processes leading to different delta types.

In geology three main types of deltas are distinguished: Those governed by the river, those by the ocean and those by the tides. By adjusting two erosion parameters, the model was capable to reproduce the pattern structure of deltas which are dominated by the river

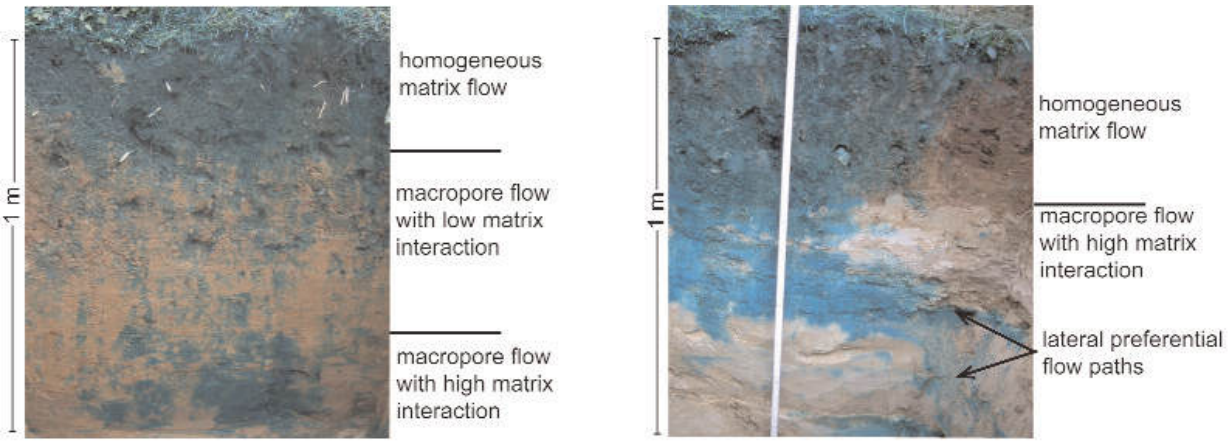



Fig. 49: Different infiltration patterns from two locations.

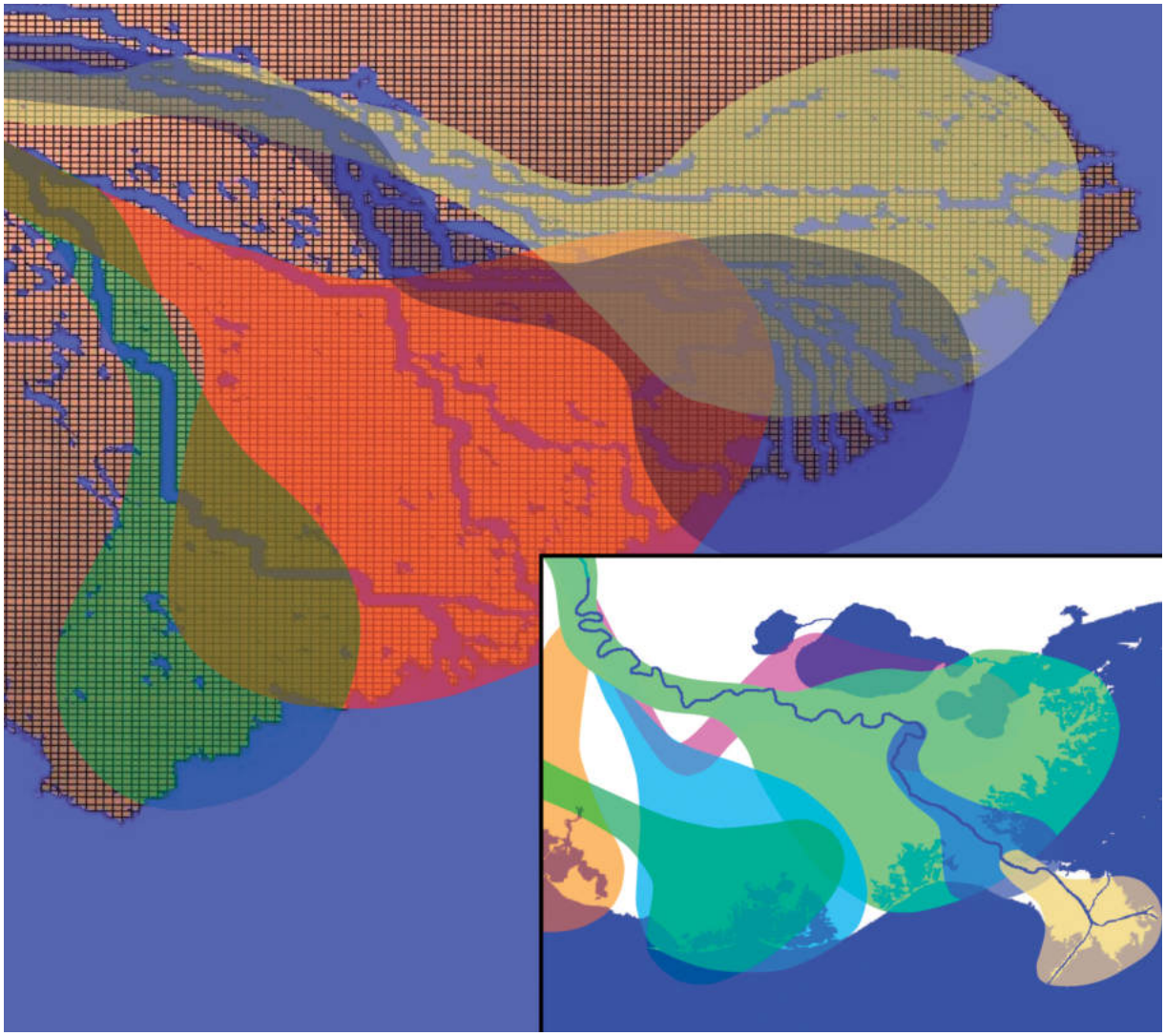


Fig. 50: The figure shows the different lobes occurring during the simulation compared with the lobe switching of the Mississippi River in the inset.

flow (such as the Mississippi) or wave actions (such as the Senegal). Furthermore the fractal dimension of the calculated pattern is very similar to the fractal dimension of natural deltas. The time evolution of the simulation showed the typical phenomena for the river delta change like the "lobe switching", where the river blocks its mouth and makes a major course change (Fig. 50).

## Lagrangian investigation of turbulent entrainment

Many turbulent flows in nature and technology are characterized by the coexistence of laminar and turbulent flow regions.

by M. Holzner, W. Kinzelbach / IfU

Many turbulent flows in nature and technology are characterized by the coexistence of laminar and turbulent flow regions. An important property of these flows, commonly referred to as "turbulent entrainment", is the process of transition of fluid from laminar to turbulent state through the boundary between the two regions. Despite extensive research the understanding of the underlying mechanism of turbulent entrainment is up to now incomplete. For example, the role of the large scales of turbulence as compared to the smaller ones is controversially debated. The reasons are mainly related to the difficulty of measuring the fine scales of turbulence and the choice of the proper frame of reference. Most of previous experimental studies are based on a fixed frame of reference (Eulerian approach). Consistent with the nature of the entrainment process, the present study is based on the Lagrangian approach. The technique, 3D particle tracking velocimetry, is an optical method, which follows the movement of a large number of tracer particles in the flow and determines the evolution of the full tensor of velocity derivatives along their trajectories (Fig. 51).

First the turbulent interface is detected and its properties are studied using time-resolved three-dimensional measurements of vorticity. Then particle trajectories are selected, which cross the sharp interface between turbulent and non-turbulent regions. They allow for the analysis of the role of vortex stretching versus viscous diffusion in the amplification of vorticity during the transition. The study reveals a dominance of viscous diffusion at the interface and shows directly that the entrainment process is a viscous process. As an illustrative example Fig. 52 shows a set of trajectories crossing the turbulent/laminar interface, as measured through 3D-PTV.

## Did the flood frequency increase in the recent years?

In 2005 extreme floods caused heavy damage in large parts of Switzerland.

by F. Naef / IfU

In 2005 extreme floods caused heavy damage in large parts of Switzerland. Severe flooding occurred already in the preceding years, with return periods for some events of over 100 years. Is such an accumulation of floods random or an indication of fundamental changes? A broad analysis of flood data was performed in a joint IfU and WSL project. The systematic discharge measurements, which started less than 100 years ago, were supplemented with historical data. Numerous descriptions of large floods in old newspapers, chronicles etc. were analyzed and used to reconstruct the flood history over several hundred years.

The graph (Fig. 53) shows the flood frequency over the last 500 years in 14 Swiss catchments. Over the centuries, periods of intense flood activities have been followed by quieter periods. As our experience has been formed in the relatively quiet period of the mid 20th century, we consider the accumulation of floods in the last years as exceptional. However, the frequency of floods has not yet exceeded the frequency of previous intensive periods.

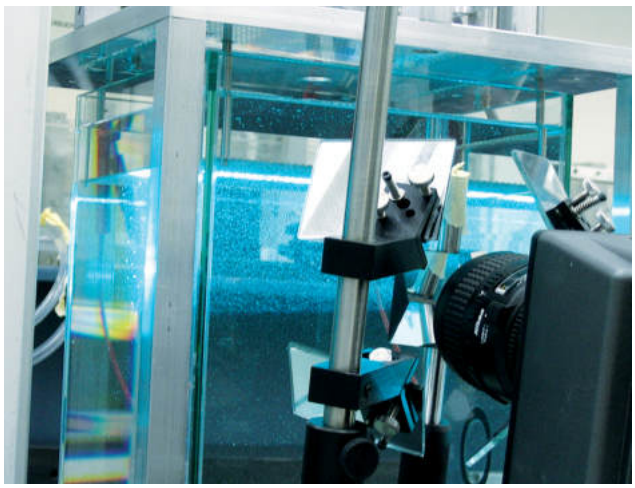


Fig. 51: The experimental setup consists of an oscillating grid that is used for the forcing of turbulence in a water tank and a high-speed camera system.

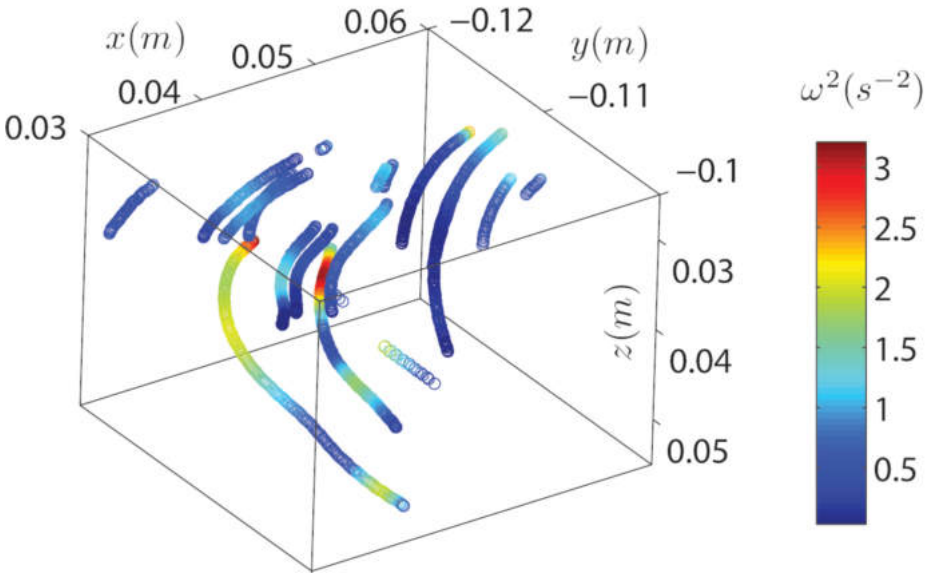



Fig. 52: Tracer trajectories crossing the turbulent / non-turbulent interface. The color represents the vorticity squared.

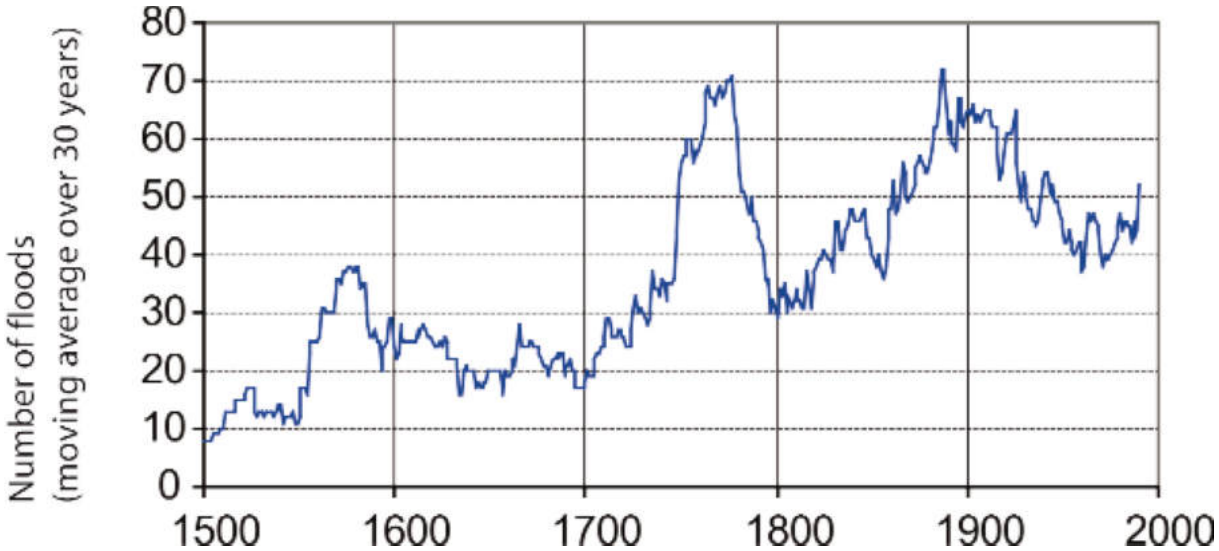



Fig. 53: Flood frequencies in Switzerland in the last 500 years. Shown is the 30 year-moving average of the yearly sum of the historic floods in 14 catchments.

## Dynamics of polar ice streams

In which manner big polar ice streams can double their flow velocity within years is a debated topic.

by M. Lüthi, J. Brown, M. Funk / VAW

With a flow velocity of 7 km per year, Jakobshavn Isbrae has been the most productive of Greenland's ice streams. It accelerated since the year 2000 and now flows with 13 km per year (1.5 m per hour) into the ocean. Also the mass flux has doubled to 46 cubic kilometers of ice per year. This corresponds to about 0.1 mm sea level equivalent per year.

Together with their US collegues, scientists of the VAW Glaciology section investigate the dynamics of the ice stream during several field seasons within a project funded by NASA and SNF. The question whether the ice stream reacts to increased ice melt at the surface or to higher ocean temperature was investigated with stationary GPS, autonomous GPS (with wireless datalink), passive seismics, and an automatic total station close to the calving front. Field work is challenging due to the dimensions and ruggedness of the glacier. Reflecting targets had to placed on ice towers from a hovering helicopter. Target positions measured several times an hour during a month showed that the frontal part moves at constant speed, barely influenced by the tides or meltwater input. Our observations support the hypothesis that the changing dynamics of the ice stream is due to processes at the calving front. (Fig. 54).

## A Model-Driven Web Feature Service for Enhanced Semantic Interoperability

With the development of large geodata infrastructures, there is a growing demand for the shared use of distributed data sets.

by P. Staub, A. Morf, A. Carosio / IGP

With the development of large geodata infrastructures, there is a growing demand for the shared use of distributed data sets. Web-based services for data exchange are specified among the process of standardisation of the Open Geospatial Consortium (OGC). These services (e.g. Web Map Service: WMS, Web Feature Service: WFS) allow for syntactic interoperability via standardised communication protocols and a standardised data-transfer format, respectively. On one hand, the structure of the provided data remains unchangeable. On the other hand, a user is typically interested in data that match his own data structure. In order to reach this goal, a semantic model transformation between the provided source model and the user's target model has to be carried out.

In a research project in collaboration with the TU Munich, a model-driven WFS was developed that is able to execute semantic model transformations and to provide the user with the desired data - according to his own model. A transformation language that is built upon existing concepts is the core of this application. With this transformation language, model transformations can be defined on the conceptual level of abstraction. Transformation models are sent to the service together with the target data model. The transformation module executes semantic transformations server-side and automatically configures a standard WFS according the target data model (Fig. 55). After an accomplished transformation, the user can obtain the provided data from the server. A prototype including models from Germany, Switzerland and the EU was implemented and tested for the shared use of heterogeneous, cross-border data in the Lake Constance area (Fig. 56). This new technology is a precondition for reaching the aims of the INSPIRE directive of the EU.

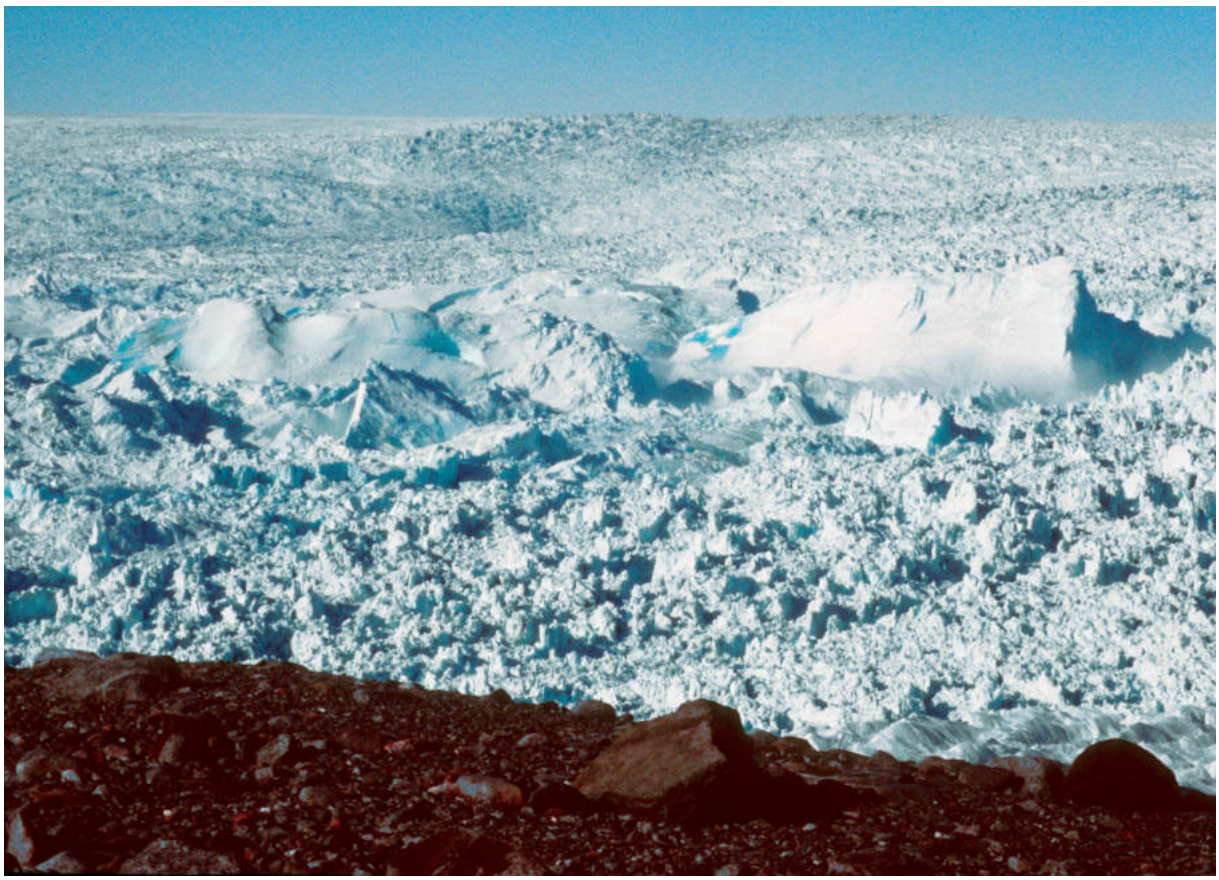


Fig. 54: The calving of an ice berg of 900 m length, 500 m width and 500 m depth induces strong seismic signals.

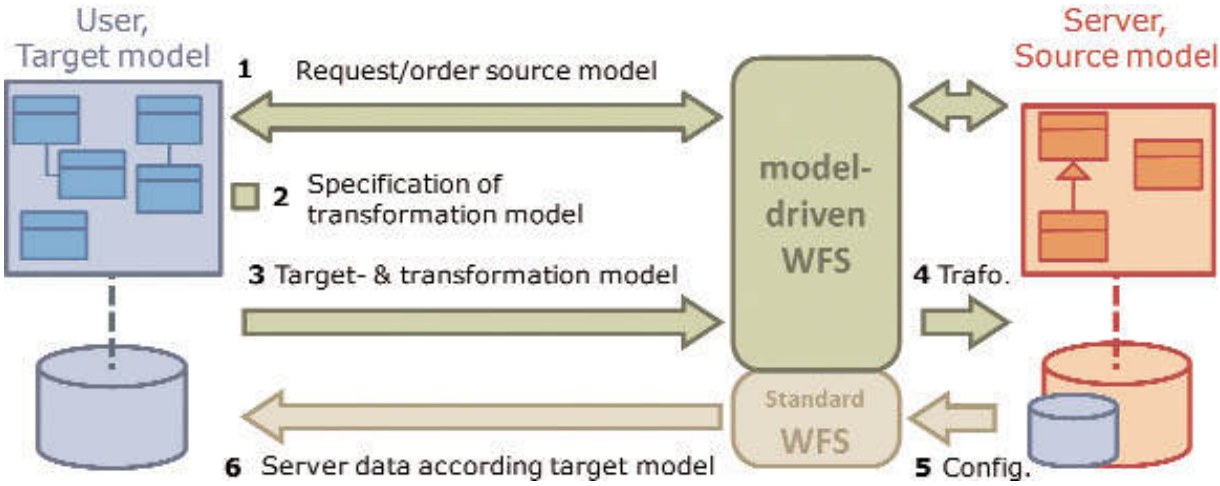



Fig. 55: Sequence of a semantic transformation including a model-driven WFS.


Fig. 56: Lake Constance Region testing-area with different datamodels.

## Trans-border investigation of the inner development potentials of settlements

**The task of reducing the consumption for new green fields is well known and also, in Germany and Switzerland, politically recognized through goals like «inner development» before «urban sprawl».**

by H. Elgendy, S. Wilske / IRL

The task of reducing the consumption for new green fields is well known and also, in Germany and Switzerland, politically recognized through goals like «inner development» before «urban sprawl». Implementing these aims can only be carried out locally due to municipal autonomy. However, it has been noticeable that municipalities active in the field of land management require accompanying measures on the part of regions, Cantons and Federal States through funds and various types of State and regional planning to support mobilising the potentials residing in municipalities. Hence, knowledge is required about the allocation, amount and structure of the settlement reserves as a basis for developing these accompanying measures (Fig. 57: an example of inner development)

The conventional monitoring of land-use development in Germany and Switzerland allows solely the data collection of urban sprawl and infill of vacant areas respectively. Important potentials, e.g. brown-fields or under-used sites, up till now, were not incorporated into the future-oriented coordination of measures of inner development process of the municipalities.

To achieve this, the project Raum+ aims at establishing an overview of the inner and outer development potentials which gives a robust and updatable overview of settlement potential extending across borders.

The preparation of the overview took place via surveying interviews in six regions of Baden-Württemberg in Germany and in the Canton of Bale in Switzerland (Fig. 58). The survey was supported by an interactive internet based information platform. The project is planned to run from autumn 2006 till autumn 2008.

## REUR: Spatial development of the lower Reuss Valley

**The lower Reuss Valley is the main settlement area of the Canton Uri. Over 80% of the Uri population (ca. 35,000 people) live and work in this area.**

by H. Elgendy, A. Häfliger, M. Nollert / IRL

Different infrastructures (for example motorways, railways and high voltage power lines) of regional, national and European importance are concentrated along the narrow valley (Fig. 59).

The local government's program (2004-2008) has set out the short-term and long-term goals for this region. According to these aims the improvement of living quality, tourism, improving accessibility as well as an integrated settlement, infrastructure and landscape development was of great importance to the Canton's future. To achieve these aims the department of justice began the spatial planning preconditions and a wide test plan was set up in the lower Reuss Valley in 2006.

The process was moderated with specialist accompaniment from Prof. B. Scholl. Assistants of the professorship participated in the process as a planning team (Fig. 60).

As a result of the long-term planning of the New Alp Transversal (NEAT) along the valley of Canton Uri, many other important development issues have been blocked for many years. The arguments about the route created a lot of uncertainty. Another issue was that the pressure of problems was not very strong in many municipalities so that an inter-municipal planning could be tackled as a whole or as individual issues. The clarification of the most important points of the NEAT route showed the main possibilities for the spatial development of the Uri Reuss Valley.

Fig. 57: Inner development potentials are mostly located centrally and well developed – here shown the former terrain of the railway Karlsruhe Südstadt.

Fig. 58: Project Raum+, participating regions and cantons.

Fig. 59: The lower Reuss valley

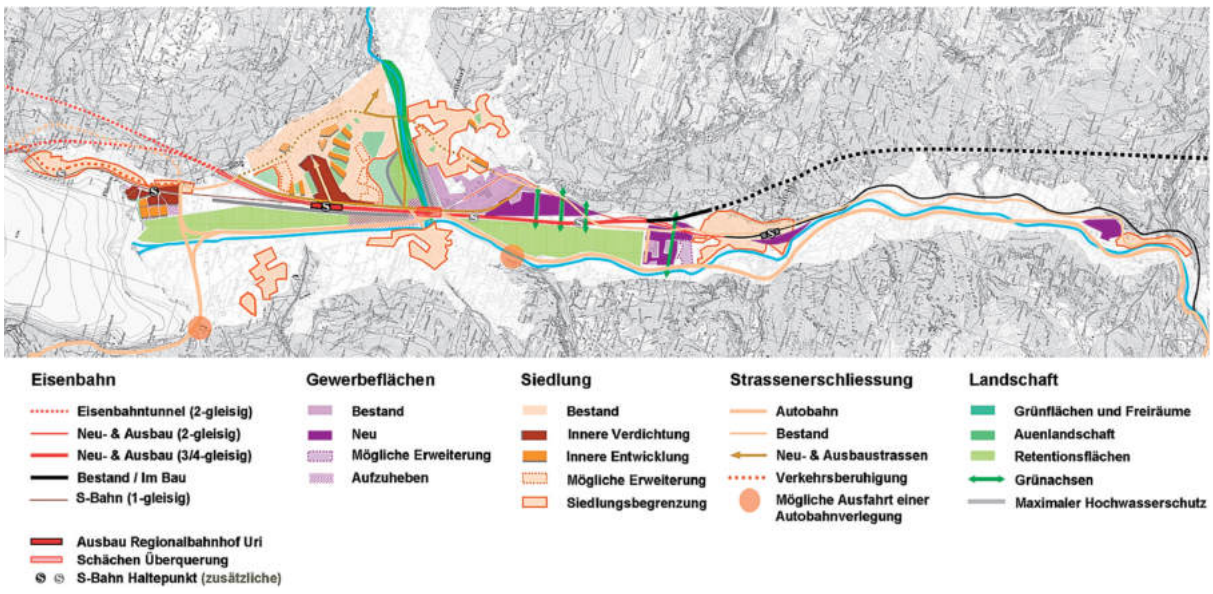



Fig. 60: Test plan contribution of the ETH team.

## Reconstruction of the Ancient Elevation of the Domus Aurea in Rome

**A Master Thesis for the generation of a digital elevation model (DOM) has been carried out in close collaboration with the German Archaeological Institute (DAI) in Rome.**

by T. Kohoutek, H. Ingensand / IGP

The Domus Aurea is placed at the Colle Oppio in the north-east of the Colosseum (Fig. 61) and encompasses 1.5-2 km$^2$. Most of the measurements were performed by satellite navigation systems (GPS/GLONASS) but also a tachymeter was used under trees or in narrow streets. After the measurements in different local systems a coordinate transformation was calculated to combine them.

The DAI is very interested in the point heights which are expected to shed light on the surface of the Colle Oppio in the ancient epoch when Nero's "Golden House" and Trajan's Thermal Baths were built. In order to reference the heights of the measured points, measurements in and around the Colosseum as well as in the Ludus Magnus (The Great Gladiatorial Training School) were made (Fig. 62).

In a last step, the measured point coordinates had to be associated with previous measurement data of the DAI at the Pantheon. Therefore, a static measurement over eight hours with GPS and GLONASS was executed to combine both nets in a post processing.

## Sea Surface Topography and Geodynamics

**The Eastern Mediterranean is a region of high geodynamic activity, exposed to considerable earthquake and tsunami risks related to different types of active plate-tectonic boundaries.**

by P. Limpach, A. Geiger, H.-G. Kahle / IGP

It is mainly characterized by the collision between the Eurasian and African lithospheric plates, closely related to continental subduction and formation of the Hellenic trench system.

It is commonly accepted that subduction is associated with mass anomalies causing pronounced undulations of the equipotential surface of the gravity field, which are reflected in the sea surface topography. In order to provide local-scale information on the short-wave structure of the marine gravity field, enhanced methods for precise sea surface height measurements, consisting in airborne laser altimetry, shipborne ultrasound altimetry and GPS-equipped buoys, have been deployed in the Eastern Mediterranean.

A detailed airborne laser altimetry campaign was carried out around the island of Crete, in the vicinity of the Hellenic Trench. Sea surface height results reveal very strong gradients of 20 m along a distance of 200 km. These gradients are a clear indication for strong gravity effects caused by the Hellenic Trench bathymetry and geodynamic system. The sea surface height observations should help to better understand the Hellenic subduction zone and to improve the Aegean gravity field model, which provides an important constraint on lithospheric structure and plate dynamics. (Fig. 63).


Fig. 61: Aerial photograph of the Domus Aurea (source: Google Earth and DAI).

Fig. 62: Measured points at the Domus Aurea (source: Leica geoOffice).

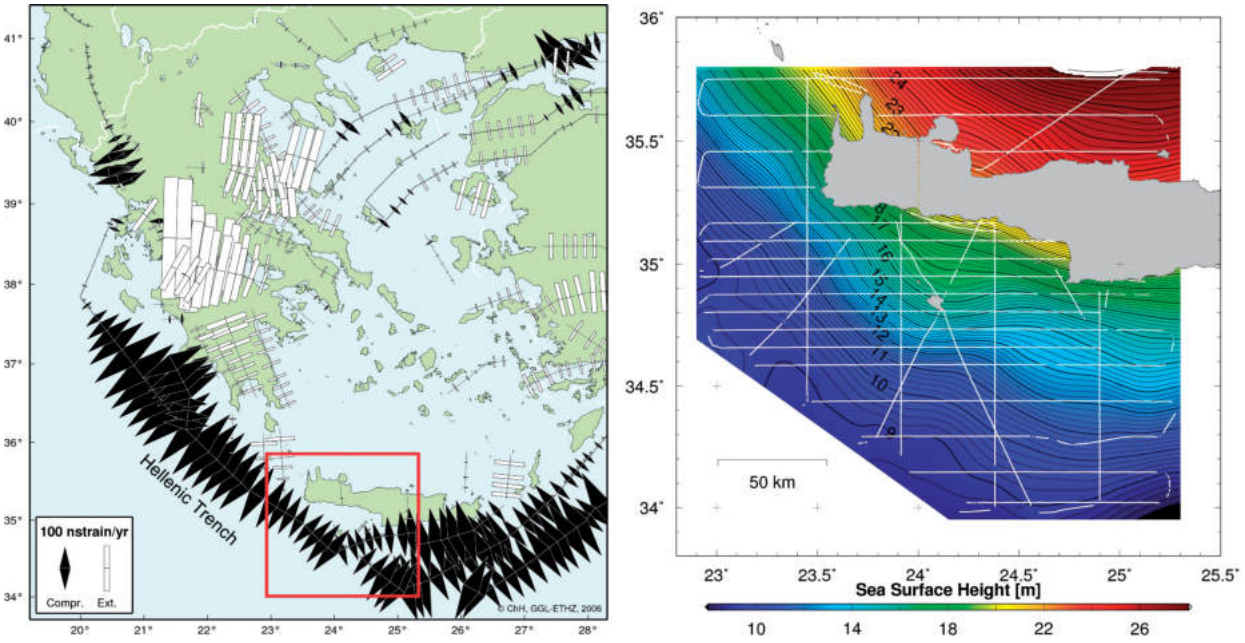



Fig. 63: Left: Normal strain field in the Eastern Mediterranean. The red rectangle depicts the area where the detailed airborne laser altimetry campaign for sea surface height measurements was carried out. Right: Flight-tracks with sea surface height profiles from airborne laser altimetry (white lines) and resulting sea surface topography.

## GPS Tomography to Support Numerical Weather Models

**In current scenarios of global warming, a considerable increase of the intensity of storms is expected. To avoid personal injuries and property damages, high precision forecasts are, therefore, of great importance.**

by D. Perler, S. Lutz, M. Troller, D. Leuenberger, E.Brockmann, A. Geiger, H.-G. Kahle / IGP

Recent advances in modeling of the atmosphere allow numerical weather models to predict where and when a storm occurs. However, the magnitude of the events and especially the amount of precipitation is still very difficult to forecast. A main reason lies in the lack of dense spatiotemporal water vapor measurements. A new innovative approach to overcome this problem is GPS tomography. The delay of GPS rays in the atmosphere is proportional to the integral amount of water vapor along the ray. The spatial distribution of water vapor can be calculated by a tomographic method using GPS data. The observations are combined in a 3-dimensional model grid and formulated as an inversion problem.

In the project GANUWE (GPS Tomography and Assimilation in Numerical Weather Models), the Geodesy and Geodynamics Lab (GGL) has performed a validation of its GPS tomography software over Switzerland using GPS data from swisstopo (Fig. 64). More than one year of data was analyzed and compared with radio soundings from MeteoSwiss (Fig. 65 + 66).

The investigations have shown that water vapor profiles can be computed with high accuracy and that GPS tomography can contribute to an improvement of the prediction of severe weather.

## Terrestrial laser scanning for deformation monitoring

**In connection with feasibility studies for possible extensions of the Felsenau-Viaduct near Berne (Switzerland), load tests were performed by the ETH Zurich and local engineering companies.**

by H.-M. Zogg, H. Ingensand / IGP

In connection with feasibility studies for possible extensions of the Felsenau-Viaduct near Berne (Switzerland), load tests were performed by the ETH Zurich and local engineering companies. The deformation monitoring was implemented by the Institute of Geodesy and Photogrammetry (IGP). Besides traditional geodetic measurement methods, terrestrial laser scanning was introduced. Deformations like a lowering of the viaduct, torsions and deflections of the carriageway were expected under load. For terrestrial laser scanning in particular, deflections were observed. Due to the height and size of the viaduct, measurements by the terrestrial laser scanner were only performed on the viaduct itself (Fig. 67).

The result of a scan by the terrestrial laser scanner is a 3D-point cloud of the carriageway. For the detection of deformations, the 3D-point clouds, which were acquired under different loading conditions, were compared to each other (Fig. 68). The differences to the initial situation were calculated. Deformations of more than 9 millimetres for maximum load were detected.

In contrast to traditional geodetic measurement methods, terrestrial laser scanning is an interesting method for the detection of area-wide deformations. A big advantage of terrestrial laser scanning is the touch-less measurement principle. This enables the measurement for carriageways under high traffic volumes without stopping the traffic. Overall, it can be considered that deformations within a millimetre range can be detected by terrestrial laser scanning.

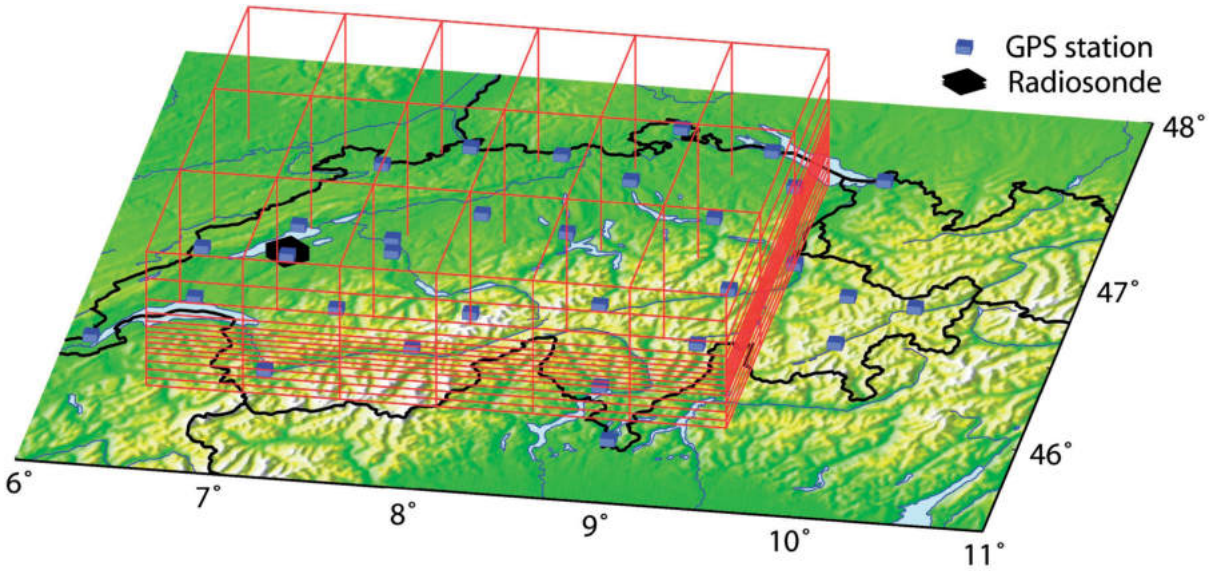



Fig. 64: Area of investigation showing the GPS receiver locations of the AGNES network of swisstopo and the radio sounding location from MeteoSwiss at Payerne. Moreover, the 3-dimensional model grid is plotted.

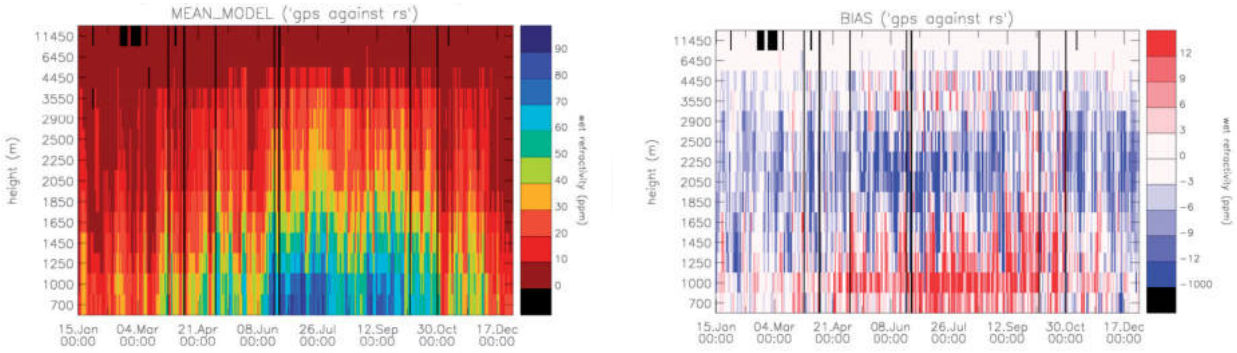



Fig. 65 + 66: Time series of wet refractivity profiles in the year 2006 over the radio sounding station Payerne. The quantity "wet refractivity" is proportional to the water vapor content. Fig. 65: Time series of water vapor along a profile over Payerne computed with the tomographic method using GPS data. The decrease of water vapor content with height can be clearly seen. Besides, the water vapor content is lower in winter than in summer. Fig. 66: Difference of water vapor content along the profile from GPS and radio sounding data. The results show that the values of wet refractivity computed by the GPS tomography are larger in the layer below 1500 m altitude and smaller between 1500 m and 3500 m than the ones from the radio soundings.

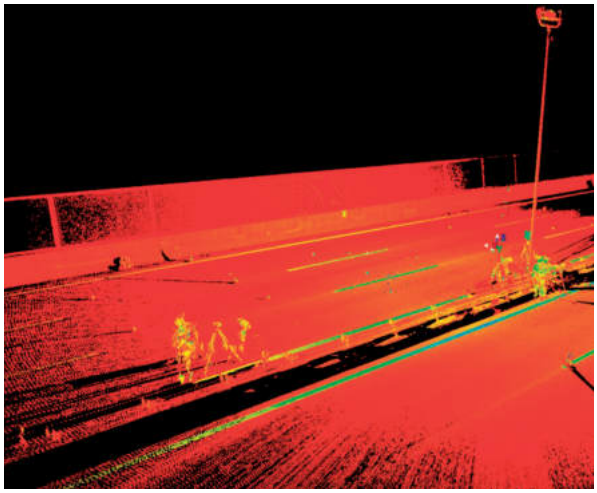


Fig. 67: 3D-point cloud as a result of the acquisition of the Felsenau-Viaduct carriageway by the terrestrial laser scanner.

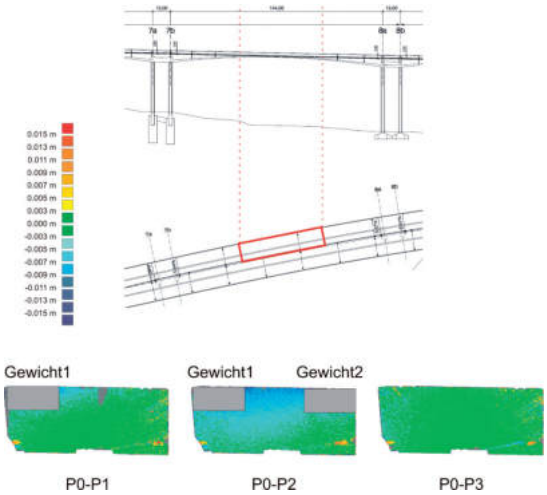



Fig. 68: Deformations of the carriageway detected by terrestrial laser scanning. The 3D-point clouds, which were acquired under different loading conditions (P1 with a loading of approx. 500 kN; P2 with a loading of approx. 1000 kN; P3 without any loadings), were compared to each other.

## High Precision Monitoring of Atmospheric Water Vapor with Solar Lunar Spectrometry

**The spatial and temporal distribution of water vapor in the earth's atmosphere is highly variable and thus cannot be modelled with adequate accuracy.**

by St. Münch, B. Bürki, H.-G. Kahle / IGP

Numerous geodetic and radioastronomic remote sensing techniques are microwave-based and in need of reliable information on the tropospheric water vapor abundance. Therefore a highly precise instrumental determination of the water vapor content is essential.

For several years high tech remote sensing systems for water vapor determination have been developed at the Geodesy and Geodynamics Lab (GGL). The most promising results were achieved with solar spectrometry. The measured sunlight transmittance of the atmosphere at selected frequencies leads to information on the tropospheric water vapor abundance (Fig. 69 + 70). Solar spectrometers are self-calibrating instruments and form accurate and independent calibration and validation tools for other measurement methods.

Currently a ruggedly designed SOlar LUnar Spectrometer for Atmospheric Research (SOLUSAR) is being developed in cooperation with the Institute for Analytical Sciences (ISAS, Berlin). Its improved light sensitivity allows the analysis of sun light under low-level radiation conditions. Additionally it is planned to integrate nighttime measurements by analyzing light reflected by the moon. The data is now being processed online, simultaneously to the measurement process.

To validate measurements of on-board radiometers of earth observation satellites, SOLUSAR will be deployed on satellite subtracks on a vessel. Hence a fully automated control cycle for light source tracking with the telescope has to be constructed and implemented.

## GPS Based Dynamic Environmental Monitoring

**Despite the decrease in road traffic emissions air pollutant concentrations of nitrogen dioxide, particulates and ozone often exceed the limit values at urban sites in Switzerland.**

by Ph. Kehl, A. Geiger, H.-G. Kahle / IGP
and J. Stähelin / IAC

Three research topics were being persued in this study: air quality monitoring, satellite based positioning (GPS) of a measurement system in an urban environment and the influence of road traffic emissions on the air quality in the city of Zurich (Fig. 71).

Fig. 72 shows the results of the analysis of data from five sunny work days in June/July 2005 during which the ozone limit value has been exceeded for several hours every day. $NO_X$ as a primary pollutant directly emitted by road transport correlates with the amount of traffic at specific places. Two busy places in the inner city of Zurich are represented by the measurements. The area around Hauptbahnhof (central station) is congested throughout the day. The area from Bürkliplatz to Bellevue place is an intersection of two major streets and high capacity lanes connecting down town with near quarters.

Besides of the correlation between traffic and pollution three meteorological and chemical effects can be seen. In the morning hours the nitrogen oxides ( $NO_X$) concentrations are rather high all along the track. When the inversion dissolves in the later morning the concentrations generally decrease except at busy places. The ozone concentrations increase with the position of the sun and reach the maximum in the afternoon. The third effect, best visible at the busy places, shows the titration of $O_3$ by NO below the inversion layer (Fig. 72).

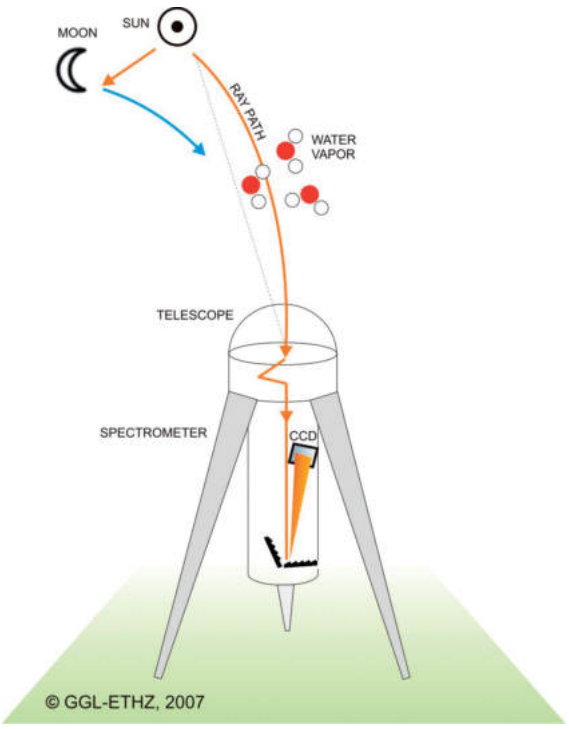



Fig. 69: Measurement Principle of Solar Lunar Spectometry: The telescope tracks the light source (sun or moon). The light is guided into the spectrometer via a mirror system and is then spread up by optical gratings and detected by a CCD sensor.

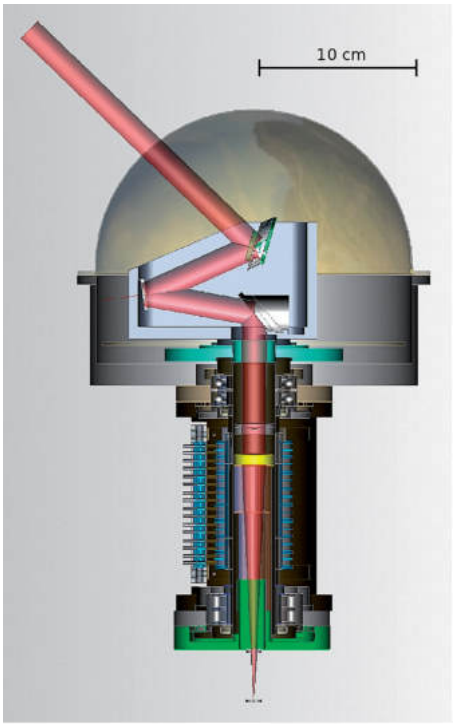



Fig. 70: Schematic Cross Section of the Spectrometer Telescope with the Optical Path (red).

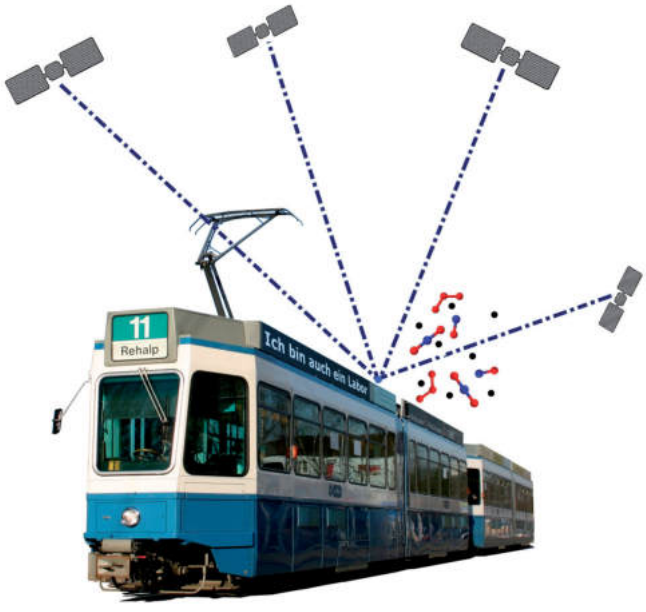



Fig. 71: The mobile laboratory with satellites and air pollutant molecules (montage).

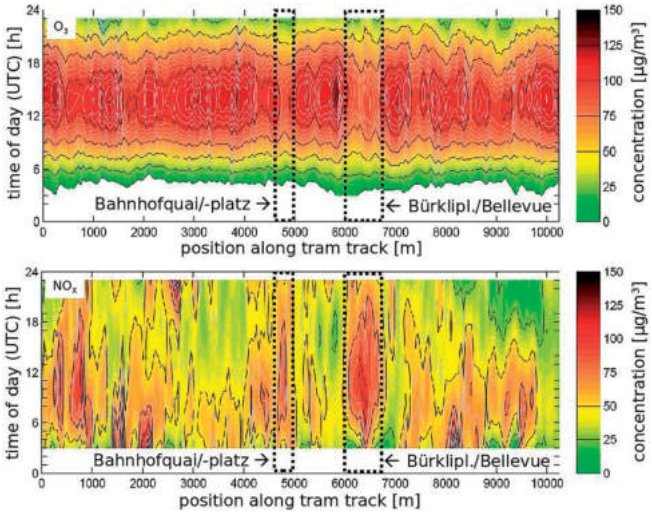



Fig. 72: Diurnal change of air pollutant concentrations along the track (tram line 11) for five days where the ozone limit value was exceeded for ozone ($O_3$) and nitrogen oxides ($NO_x$). Two hotspots are marked where the chemical connection between NO and $O_3$ is clearly visible.

## Development of a Range Imaging Camera with Internal Reference Path

**Distance measurements of Range Imaging Cameras (RIM) are highly correlated to temperature effects, which cannot be eliminated completely.**

by T. Kahlmann, H. Ingensand / IGP

The new ETH approach follows the implementation of an internal reference. The near infrared radiation from the light emitting diodes is routed to the RIM chip by a special fibre. Thus, a true reference distance measurement is given (Fig. 73, 74).

The implementation of a reference path allowed for a correction of the distance measurements affected by thermal and other influences.

## Real-time small movement detection with a single GPS carrier phase receiver G-MoDe

**For a large domain of applications, from the surveillance of constructions to co-seismic movements, detection and monitoring of small movements are of high interest.**

by S. Guillaume, A. Geiger, H.-G. Kahle / IGP

So far, differential satellite phase measurements with two carrier waves were applied, where network and reference systems are needed. The question arises, to what extent single GPS phase measurements are suited to detect small displacements and their spatial distribution without solving and eliminating the carrier phase ambiguities.

Furthermore reference networks and complicated corrections, like refraction, multipath, phase center variation, clock errors and orbits have not to be applied.

The new developed method is based on the prediction of single differences between satellites with appropriate Kalman Filters. The accuracy of this method is demonstrated by real 10-[Hz] observations with two l1-receivers.

The results indicate that horizontal movements above 5 [mm] and of short duration and oscillatory movements above 2.5 mm amplitude are significantly detected (95%). The method has a pending patent under EU rules. It opens interesting new applications in the domain of monitoring and alert systems. Examples are movements of constructions, like barrages, bridges and high buildings; land movements, like break-offs of rocks, cracks of landslides, surges and break-offs of glaciers, as well as displacements of the earth's crust in combination with earthquakes.

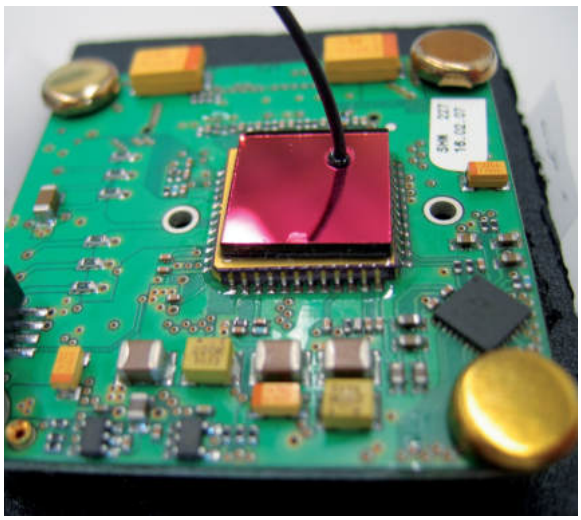


Fig. 73: Fibre mounted on the SR-3000 sensor. The fibre goes through the adapted IR-filter very close to the surface of the RIM chip.

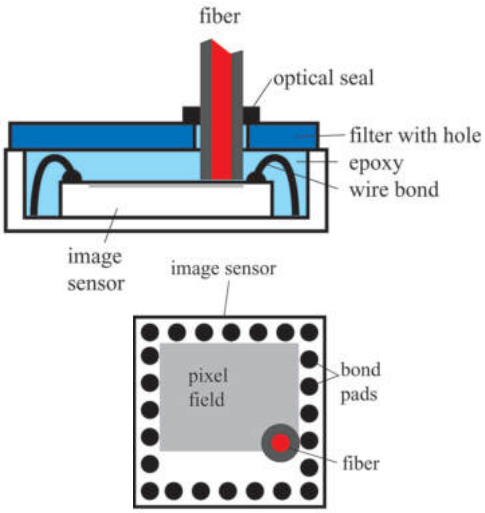



Fig. 74: Schematic presentation of mounted fibre.

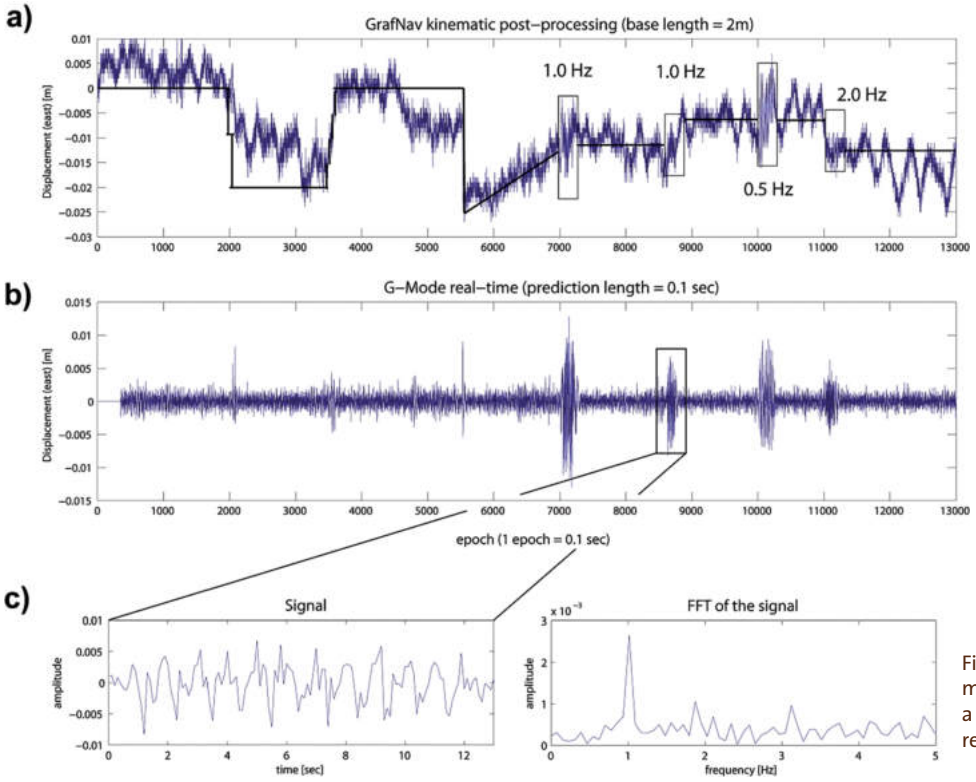



Fig. 75: Real-time small movement detection with a single GPS carrier phase receiver G-MoDe.

For testing the capabilities of this new methodology, GPS measurements were made with two receivers separated by two meters in order to compare the G-MoDe algorithm with the results of a standard GPS kinematic processing. One receiver was completely static while the other one was moved in different motion patterns (Fig. 75).

a) The blue line represents the position of the kinematic post-processing. The black line shows the true motion applied to the antenna.
b) Result of the G-MoDe processing.

Two kinds of displacements were tested: different rapid and small linear displacements and oscillations. These two types of motion are clearly detected with G-MoDe whereas the kinematic processing not matches precisely the true position.

c) Oscillation in the time space and in the frequency space. It proves that the frequency of the real movement is well retrieved by G-MoDe.

# Interview with Daniel Farinotti

**This year Daniel Farinotti from Gordola (Canton Ticino – Italian-speaking area of Switzerland), a small village at the mouth of the well known Valle Verzasca, finished studying at ETH Zurich. We spoke to him about his student days, his studies and his future plans.**

D-BAUG

*Daniel, what did you study?*
I studied Environmental Engineering at the Department of Civil, Environmental and Geomatic Engineering (D-BAUG).

*Can you tell us what does an environmental engineer does?*
As outlined in the ETH Zurich information brochure, an environmental engineer produces well-founded scientific and technical solutions for efficient and sustainable resource management, and also plans, implements and operates the necessary infrastructure.

*So you are a 'mixture' between a civil engineer and a natural scientist?*
Not exactly! It is true that the first two years of both study programmes are practically identical. However, in higher semesters the Civil Engineering programme concentrates on actually constructing technical buildings. For example, I can't build a house! The Natural Sciences programme is even more similar to what I studied, but an environmental engineer concentrates on the quantitative and applied aspects of Natural Sciences. The individual skills you acquire during your studies are undoubtedly determined by the electives you choose.

*Could you enlarge on that?*
I followed the so-called diploma programme as opposed to the newly introduced Bachelor/Master system. After having completed the first two years and having passed the two preliminary exams, I could choose two from a total of four majors (areas of specialisation). This makes up for about half of the courses to be followed. On the other hand, the remaining subjects could be selected individually. In principal, this meant that every student studying Environmental Engineering followed a slightly different programme. And, as a result, each student acquired somewhat different skills.

*Which majors were offered?*
As I said, it was possible to choose from four different majors: Material Flow and Waste Management, Soil Protection, Hydrology and Water Resources Management, and Urban Water Management.

Material Flow and Waste Management looks at analysing and recording material flow in the environment, focussing in particular on the anthroposphere. Keywords for Material Flow are analysing material flow or life cycle assessment whereas Waste Management concentrates on managing refuse disposal, mainly urban waste. Soil Protection deals with the interactions of the pedosphere with Soil Science being a key subject. Hydrology and Water Resources Management investigate natural water cycles with courses being held on Hydrology, Hydraulics or Hydro-Engineering Systems. Particular emphasis is placed on modelling the various processes. On the other hand, Urban Water Management addresses water supply and water recycling. You learn about the function and planning of our drinking water supply or waste water treatment plants.

*Which of the majors did you choose?*
I decided on Material Flow and Waste Management and Hydrology and Water Resources Management.

*What influenced your decision?*
I had to decide after the second preliminary exam. At that particular stage, I was fortunate enough to have

good insight into all four majors. During the first two years, you had to attend courses on all the four areas of specialisation. As a result, it was not so difficult to decide, since at that stage I knew which areas interested me the most.

*How did you structure the remainder of your studies?*
I would say into two parts. Initially, I attended a lot of lectures on Renewable Energy. I then tried to somewhat familiarise myself with Climate Sciences. I indirectly integrated my diploma thesis into this second area.

*What exactly did you do during your diploma thesis?*
I carried out my diploma thesis in the glaciology group, Laboratory of Hydraulics, Hydrology and Glaciology (VAW). A power station in Valais wanted a runoff prognosis study carried out on a catchment area up to the year 2100.

*Diploma thesis, preliminary exams, many subjects with different directions. What were for you the cornerstones during your studies?*
Well, the most important point was actually deciding to study Environmental Engineering. When I finished grammar school (called 'liceo' in Ticino), I had to decide what subject area I wanted to pursue for my future professional career. I knew that I wanted to go on to third-level studies – most likely taking up technical sciences. This, of course, automatically excluded studying at university. Yet, I did not find it at all easy to choose a discipline at ETH what with 25 programmes to choose from! I could not decide whether I should study Mathematics, Physics, Electrical Engineering, Natural Sciences or even Sport. Then, during an open day at ETH Zurich, I came across Environmental Engineering which made me even more unsure than I had already been!

I then decided to enrol for Physics. However, during the summer break, I began to regret that decision and changed to Electrical Engineering. And, after two weeks studying Electrical Engineering, I immediately realised that it also was not the right choice for me. So, I went around to different lectures for 2-3 days and finally settled on Environmental Engineering.

*And was it the right solution?*
No, not really! During the second year, I didn't feel at all motivated. I often asked myself if that was really what I wanted to do in the future. Some subjects were very interesting while others, during my basic studies, often made me wonder whether I should in fact have actually studied Sport.

In the third year, I decided to take leave of absence for one year. I went to do military service for one year. Looking back on it now, I believe that this was the most important and best decision during my student days. After one year of military service when I could not determine my own daily routine from 6 in the morning until midnight, being a student seemed like a piece of cake! I began to enjoy the programme and the courses I had chosen lived up to my expectations. The fact that I myself could choose most of the subjects after the second preliminary exam got me interested again.

*Would you say then that motivation was the biggest problem you had to face during your student days?*
Yes, certainly. Basically, motivation is the key to resolving many issues. If you are really convinced about what you're doing, then you can reach the stars and you are willing to invest the time. How you reach your goal no longer seems such a problem.

Once I passed the preliminary exams, the pressure eased off. Each subject was then individually examined at the end of each semester and, consequently, it was much easier to prepare for the exams. Now and again, some subjects created more work than others during the semester. All in all, I found the Environmental Engineering study programme reasonably easy to manage.

*Does that also include your diploma thesis?*
Yes, I would say so. The diploma thesis involves a lot of work. It was, however, a very interesting time and I really learnt a lot from it.

*Daniel, you come from Ticino. What can you tell us about student life in Zurich?*
Well, to tell the truth, I didn't particularly enjoy student life. Especially during the first few semesters, I didn't take at all to living in Zurich. Even my first experience sharing a flat wasn't what you would call a positive experience.

Gordola, the place I come from, has approximately 4,000 inhabitants in comparison with Zurich's 380,000. That's almost 100 times more! Life in Zurich moves at a quick pace: people work hard to make a good turnover and everything must be done quickly. Even though Zurich is known for its excellent infrastructure, living there can be hectic at times. Just one example: when I first moved to Zurich, I couldn't understand why people were always running to get the tram. Trams run every seven minutes, so why run? In Ticino, of course, things are much more easy-going.

It also took me a while to get used to life at ETH. Particularly, getting used to attending lectures – the lessons I had at the "liceo" were much more interactive.

And, the most difficult of all, was listening to my fellow students speaking in Swiss German. Although I grew up bilingually – my mother is from Germany – German

and Swiss German are two completely different languages! It took me more than one year to understand that "schmöcke" doesn't mean "schmecken" (to taste), but rather "riechen" (to smell) and that "poschte" has absolutely nothing to do with the post, but actually means "einkaufen" (to go shopping)!

*In the meantime, however, you've gotten used to the place!*
Yes, more or less. I don't feel so homesick anymore. What helped a lot was finding the right flat to share. I live in Seebach, practically on the outskirts of Zurich, where I'm no distance at all from the country and can leave city life behind me. I still miss not having the mountains closeby. If I want to go hiking in Ticino, I can just start out from my own door. But in Zurich you have to travel for at least one hour before you even get to some decent hills!

On the other hand, Zurich is certainly a much better starting point to travel around Switzerland than Ticino is, which meant that I got to see a lot of Switzerland. Yes, Zurich is a good starting point to head off for the weekend.

From a professional viewpoint, at least initially, you have to live in a bigger town since Ticino is simply too small and not the best place to look for a job.

*Are you planning to go back to Ticino?*
Yes, sure, but not immediately. At first I'll have to get some work experience in German-speaking Switzerland or somewhere else. Ticino will always be there!

*And how do you see your future professional life?*
I have been offered two positions for doctoral studies: one in the glaciology group where I did my diploma thesis and one in Hydrology. I'd like to take advantage of doing doctoral studies as I may not have the chance again to do so. I'd like to take on the challenge of being involved in scientific research and getting to grips with environmental problems.

*Daniel, we wish you all the best and hope you will make the right decision. Thanks for the interview!*
You're welcome! And, "arrivederci"!

# Facts and Figures

## Organisation Chart D-BAUG

**Department Conference**

**Head of Department**

**Faculty Conference**

**Curriculum Committee**

**Institute Directors Conference**

**Conference on Examinations**

**Departmental Administration Offices, Laboratories, Workshops**

**Institutes**

- IBB Construction Engineering and Management
- IBK Structural Engineering
- IfB Building Materials
- IfU Environmental Engineering
- IGP Geodesy and Photogrammetry
- IGT Geotechnical Engineering
- IKA Cartography
- IRL Spatial and Landscape Planning
- IVT Transport Planning and Systems
- VAW Hydraulics, Hydrology and Glaciology

**Curricula**

- Civil Engineering (CE)
- Environmental Engineering (EE)
- Geomatic Engineering and Planning (GP)
- Spatial Development & Infrastructure Systems (SDIS)

## Institutes

### IBB Institute for Construction Engineering and Management


Prof.
G. Girmscheid


Prof.
H.R. Schalcher


Prof.
H. Wallbaum

### IBK Institute of Structural Engineering


Prof.
M.H. Faber


Prof.
M. Fontana


Prof.
P. Marti


Prof.
T. Vogel


Prof.
A. Dazio

## IfB Institute for Building Materials


Prof.
H.J. Herrmann


Prof.
J.G.M. van Mier


Prof.
P. Niemz


Prof.
B. Elsener

## IfU Institute of Environmental Engineering


Prof.
P. Burlando


Prof.
W. Gujer


Prof.
S. Hellweg


Prof.
W. Kinzelbach


Prof.
F. Stauffer


Prof.
M. Boller
(EAWAG)


Prof.
F. Siegrist
(EAWAG)

## IGP Institute for Geodesy and Photogrammetry


Prof.
A. Carosio


Prof.
A. Grün


Prof.
H. Ingensand


Prof.
H.-G. Kahle


Prof.
A. Geiger

## IGT Institute for Geotechnical Engineering


Prof.
G. Anagnostou


Prof.
A. Puzrin


Prof.
S.M. Springman

## IKA Institute of Cartography


Prof.
L. Hurni

## IRL Institute of Spatial and Landscape Planning


Prof.
W.A. Schmid


Prof.
B. Scholl

## IVT Institute of Transport Planning and Systems


Prof.
K.W. Axhausen


Prof.
U. Weidmann


Prof.
H.P. Lindenmann


Prof.
P. Spacek

## VAW Laboratory of Hydraulics, Hydrology and Glaciology


Prof.
H.-E. Minor


Prof.
M. Funk


Prof.
W. Hager

## Students D-BAUG (Date: November 7, 2007)

| | BSc | | MSc [1] | | Total | | | Doctoral Students | | | Dissertations |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Curricula | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | T | ♂ | ♀ | T | T |
| Civil Engineering | 320 | 63 | 81 | **23** | 401 | 86 | **487** | 83 | 22 | **105** | |
| Environmental Engineering | 126 | 48 | 45 | **25** | 171 | 73 | **244** | 19 | 9 | **28** | |
| Geomatic Engineering & Planning[2] | 53 | 22 | 42 | **14** | 95 | 36 | **131** | 27 | 12 | **39** | |
| **Total** | **499** | **133** | **168** | **62** | **667** | **195** | **862** | **129** | **43** | **172** | **36** |

1) Including diploma students
2) Including MSc SDIS

## Staff D-BAUG (Date: December 31, 2006)

| P | AP | TP | Senior Scientist | SA | Scientific Staff | Technical Staff (incl. ICT) | Admin. Staff | Apprentices | D-BAUG Staff total (capita) |
|---|---|---|---|---|---|---|---|---|---|
| 25 | 2 | 10 | 5 | 65 | 256 | 72 | 48 | 5 | 488 |

P = Professor
AP = Assistant Professor
TP = Titular Professor
SA = Senior Assistant
Scientific Staff = Doctoral students, Post-Docs, Assistants

*Figures without Student Assistants, Hourly Wage Employees, Trainees, "occupied Workplaces"*

## Master of Advanced Studies (MAS), Postgraduate Courses (ZLG), Courses

| | Institute | Title |
|---|---|---|
| MAS ETH | VAW / IfU + EPFL | Hydraulic Engineering |
| MAS ETH | IRL / IVT / NSL | Spatial Planning |
| ZLG ETH | IRL / NSL | Spatial Development |
| ZLG ETH | IGP/IKA | Spatial Information Systems |
| ZLG ETH | IBK / IVT et al. | Risk and Safety of Technical Systems (responsible body: D-MAVT) |
| PhD Programme | IRL | International PhD Programme "Research Lab Space", Perspectives of Spatial Development in European Metropolitan Regions, Curriculum 2007-2010 |
| Postgraduate Courses | IBB | Summer Academy Sustainable Construction |
| Postgraduate Courses | IBK/SZS | Practical Steel Construction |
| Postgraduate Courses | IGT | Master of Advanced Studies on "Tunnelling" (responsible body: EPFL, ITA) |
| Course | IBB | Blasting Excavation Methods |
| Course | IBB | Management of Construction Equipment and Inventory |
| Course | IBB | Management of Construction Companies |
| Course | IBB | Ecological and waste-minimizing Product-Design |
| Course | IBK | Seismic Design of Building Structures, University of Stellenbosch, South Africa |

## Master of Advanced Studies (MAS), Postgraduate Courses (ZLG), Courses (cont.)

| | Institute | Title |
|---|---|---|
| Course | IBK / BFH | Fire Safety in Timber Structures Research Aspects |
| Course | IfB | Fundamentals and Applications of Acoustic Emission |
| Course | VAW | Introduction to Glaciology and Field Techniques (for Students of Hokkaido University) |

## Workshops, Symposia, Congresses

| Date (in 2007) | Event | Institute | Topic |
|---|---|---|---|
| January 12 - 14 | Workshop | IGP | Internat. GIS-Cooperation Graz-Munich-Zurich |
| January 16 | Symposium | IRL | Exhibition and Symposium about the "Shaxi Rehabilitation Project" (at "Kornhaus" in Bern) |
| January 18 | Seminar | IVT | Ökonomie des Wachsens von Netzen |
| January 25 | Workshop | IfB | Journées de Physique Statistique, Paris |
| January 28 - February 1 | Conference (Co-Organisation) | IGP | Videometrics IX. Conference, IS&T/SPIE 19. Annual Conference, Electronic Imaging |
| February 9 - 10 | Workshop | IGP | Caravan / JAXA Training und Workshop "Geo-informatik für Katastrofenmilderung" |
| February 14 | Seminar | IVT | *Stadtraum und Verkehrsverhalten: Pendler-verhalten in den Niederlanden seit 1995* |
| March 1 | Congress | IBK | Day of Fastening Technology, "Fastenings for structural strengthening", HILTI AG and ETH Zurich |
| March 1 | Seminar | IGT, UTB | *Standsicherheit von Felsböschungen und –fundamenten* |
| March 1 - 2 | Symposium | VAW | Alpine Glaciology Meeting (AGM) |
| March 8 | Conference | IVT | Regions in change!- Regional transports in transition? |
| March 15 | Symposium | IBK | Steel-Concrete Composite Structures for Buildings |
| March 16 | Workshop | IRL | Spatial Development at Airport Regions, Visit of Student and Experts Group University of Leuven/Belgium at ETHZ |
| March 26 - 27 | Workshop | IBK / Stanford University / JCSS | Risk Acceptance and Risk Communication, Stanford CA, USA |
| April 17 | Workshop | IRL | Spatial Planning and Spatial Development in Switzerland, Visit of Student Group University of Antwerp/Belgium at ETHZ |
| April 17 | Workshop | IRL | Inner Urban Development in Milan, Speaker: Ilaria Tosoni, City of Mailand / ETH Zurich |
| April 18 - 21 | Forum | IBB | 2nd International Forum on Sustainable Construction in Shanghai |
| April 27 | Seminar | IVT | *Zukunft urbane Kulturlandschaften*, final event of the project Cultural Landscapes |

**Workshops, Symposia, Congresses (cont.)**

| | | | |
|---|---|---|---|
| May 21 | Workshop | IRL | "Spatial Planning Practice in Switzerland" and "Guandu District: Spatial Development Strategy 2020" with experts from Guandu Urban Planning Administration (GUPA, China) |
| May 31 | Symposium | IBK / IVBH | *yes* Young Engineers' Symposium (IABSE) |
| May 31 | Colloquium | IGT, UTB | *Anspruchsvolle maschinelle Vortriebe im Fels* |
| May 29 - June 1 | Conference | IGP | ENC07-TimeNav, Geneva |
| June 14 | Symposium | IBB | Information Management |
| June 17 - 21 | Conference | IfB | Porous Media and its Applications in Science, Engineering and Industry, Kauai / Hawaii |
| June 24 - 28 | Workshop | IfU | Conflicts in Water Resources Allocation and Integrated Water Resources Management |
| June 24 - 29 | Conference | IVT | The 11th World Conference on Transportation Research, WCTR, Berkeley / USA |
| June 26 - 27 | Conference | IBB | European Facility Management Conference in Zurich |
| June 28 | Conference | IVT et.al | Is there a future for high speed rail? |
| June 28 - 30 | Seminar | IGP | Caravan/JSPRS Tutorials on Digital Photogrammetry "Current Status and Future Vision of High Accurate 3D Measurement Technologies" |
| July 1 - 4 | Conference | IfB | *Fibre Models*, Catania, Sicily / Italy |
| July 4 - 6 | Conference | IfB | Statics and Dynamics of Granular Media and Colloidal Suspensions, Napoli/Italy |
| July 9 - 12 | Conference | IGP | 8th Conference on 'Optical 3D Measurement Techniques' |
| July 9 - 13 | Conference | IfB | Statistical Physics, Genova |
| July 10 - 11 | Workshop | IGP | Internat. Committee Geoinformation, Politecnico di Milano, EPFL, ETHZ |
| July 12 - 13 | Conference | IGP | 2nd 3D-ARCH Conference '3D Virtual Reconstruction and Visualization of Complex Architectures' |
| July 13 | Workshop | IRL | "Yunnan Central Economic Region: Spatial Development Strategy 2020" with experts from Ministry of Construction and Yunnan Construction Department (MoC, YCD, China) |
| July 31 - August 3 | Workshop | IBK / University of Tokyo / CERRA | 10th International Conference on Applications of Statistics and Probability in Civil Engineering, ICASP10, Tokyo, Japan |
| August 24 | Workshop | IGP | GIS Workshop on Interoperability |
| August 27 - 29 | Congress | IfU | LCM2007, 3rd International Conference on Life Cycle Management |
| August 27 - 29 | Conference | IBB | Life Cycle Management |

**Workshops, Symposia, Congresses (cont.)**

| | | | |
|---|---|---|---|
| September 7 - 9 | Workshop / Field Trip | IGT | Valais Field Trip. HazNETH, Visp, Switzerland |
| September 8 - 15 | Symposium | IGP | 2nd Baltic Swiss Geodetic Science Week, Neringa/Lithuania |
| September 10 | Workshop | IRL | Swiss-German-Cooperation "Evaluation and Controlling in Spatial Planning" |
| September 11 | Congress | IBK | 13th Holcim Concrete Day, "Concrete and Natural Hazards" |
| September 13 | Conference | IRL | "Landmanagement für den Wasserbau - eine nationale Herausforderung" (co-organized with geosuisse, IGS, sia, VSVAK, BLW and CH-AGRAM) |
| September 21 | Workshop | IGP | ESRI-User-Group of ETH Zurich |
| October 17 | Workshop | IRL | Strategies of Spatial Development in Switzerland, Sino-Swiss Management Training Programm of University St. Gallen |
| October 17 | Workshop | IRL | "Spatial Planning Practice in Switzerland" and "Kunming Municipality: Regional City Network Master Plan" with participants of the Sino-Swiss Management Training Program (University of St.Gallen) |
| October 23 | Symposium | IBB | Innovations in Tunnelling |
| October 23 | Symposium | IfU | Modeling of Erosion and Sedimentation – Rivers, Glaciers and Deltas |
| October 25 | Symposium | IBB | Public Private Partnership PPP |
| October 25 - 26 | Workshop | IGP | Caravan/JAXA Seminar on “New Trends and Potentials of Geospatial Technologies” |
| October 29 - November 2 | Workshop | IRL | International PhD Programme "Research Lab Space"; PhD Workshop: "Perspectives of Spatial Development in the Limmattal (Zurich)" |
| October 30 | Seminar | IVT | TRANSLOHR: A new urban transport system |
| November 1 - 2 December 6 - 7 | Workshop | IVT | *Modellierung von Entscheidungen: Schätzung und Umsetzung* |
| November 8 - 9 | Congress | IVT | Jubilee congress *125-Jahre Verkehrsbetriebe der Stadt Zürich und Verkehrsforschung an der ETH Zürich* |
| November 8 - 9 | Conference | IVT et.al | Cities and Transportation - Innovations and Visions |
| November 11 | Symposium | VAW, LCH, EAWAG, WSL | River Engineering for Flood Protection, Environment, Society and Economy |
| November 15 | Conference | IGP | Caravan/White Elephant Special Session at ACRS 2007 on “Thesis/Paper and Proposal Writing and Presentation Techniques” |
| November 20 | Seminar | IVT | Mobility Management in Enterprises |

## Workshops, Symposia, Congresses (cont.)

| | | | |
|---|---|---|---|
| November 27 | Conference | IVT | *Kosten-Nutzen-Analyse Nachhaltigkeitsindikatoren Strasse* |
| November 29 | Seminar | IVT | Transport Planning in the South African Context |
| December 4 - 5 | Conference | IVT et.al | Public Transport Forum 2007: Imagine that there is Competition and Nobody Cares About |
| December 5 | Seminar | IVT | Designing Stated Choice Experiments: State-of-the-Art |
| December 6 | Seminar | IVT | *Neue Entwicklungen in der Entscheidungsmodellierung* |
| December 12 | Workshop | IRL | City Development of Istanbul, Speaker: Hale Mamunlu Mimar Sinan, University of Istanbul/Turkey |
| December 12 - 15 | Forum | IBK / University of Newcastle/ IFED | Engineering Decision Making, Third Forum – Optimal Strategies for Disaster and Hazard Mitigation, Port Stephens, NSW, Australia |
| December 13 | Colloquium | IGT, UTB | *Bergmännisches Auffahren von grossen Querschnitten* |

## Honours

| Name | Institute | |
|---|---|---|
| Prof. Dr. Geiger Alain, Guillaume Sébastien | IGP | Registered Patent holder at EU patent office |
| Prof. Dr. Geiger Alain, Limpach Philippe | IGP | Best Presentation Award, ION, Fort Worth, Texas, USA |
| Prof. Dr. Grün Armin | IGP | Honorary Professor, Wuhan University, China |
| Prof. Dr. Grün Armin | IGP | Member of the First Academic Committee of the State Key Laboratory of Mapping from Space (CASM), Beijing, China |
| Prof. Dr. Gujer Willi | IfU | Doctor Technices honoris causa, DTU, Lyngby |
| Prof. Dr. Herrmann Hans Jürgen | IfB | Fellow of American Physical Society |
| Prof. Dr. Lorenz Hurni, Dipl. Ing. Jenny Bernhard | IKA | The Henry Johns Award for the most outstanding article published in volume 43 of The Cartographic Journal |
| Prof. Dr. Marti Peter, Dr. Trümpi-Althaus Stefan: Jackcontrol AG (Spin-off ETH) | IBK | Innovative Product Award, No Dig 2007, San Diego/USA, North American Society for Trenchless Technology (NASTT) |
| Prof. Dr. Marti Peter | IBK | Honorary President, Society of the Art of Civil Engineering |
| Prof. Dr. Puzrin Alexander M. | IGT | MTS Visiting Professorship, University of Minnesota, USA |
| Prof. Dr. Hager Willi H. | VAW | Hydraulic Structures Medal, life-work, ASCE, Reston |
| Prof. Dr. Hager Willi H. | VAW | IAHR Council Member, co-opted, JHR Editor |
| Prof. Dr. Springman Sarah M., Dipl. Ing. ETH Mayor Pierre, Dipl. Ing. Banjac Robert (et al.) | IGT | "Full-scale field tests on geosynthetic reinforced unpaved roads on soft subgrade". Geotextiles & Geomembranes, International Geosynthetics Society, Easley, SC, USA. Best Paper published in Geotextiles & Geomembranes in 2006 |

Honours (cont.)

| | | |
|---|---|---|
| Prof. Vogel Thomas, Schellenberg Kristian G., Dr. Volkwein A., Roth A. | IBK | Simon Perry Award (Highly Commendable Paper Award), 7th International Conference on Shock & Impact Loads on Structures, Beijing, China |
| Dr. Chikatamarla Ravikiran | IGT | PLANAT-Research Award 2006: ETH Thesis No. 16315: "Optimisation of cushion materials for rockfall protection galleries, The National Platform for Natural Hazards PLANAT, Federal Office for the Environment FOEN, Berne, Switzerland |
| Dr. Holzner Markus | IfU | European Leonardo da Vinci Award for the best PhD thesis |
| Dr. Gamisch Tobias | IBB | Construction Engineering and Management Award 2007 |
| Dr. Busch Torsten | IBB | Construction Engineering and Management Award 2007 |
| Dr. Tront Jacqueline M. | IGT | Bio-energy for Bioremediation: Sensing the Subsurface Using Microbial Fuel Cell Technology. Outstanding poster and presentation award, Latsis Symposium: Research Frontiers in Environment and Sustainability |
| Dr. Baltsavias Emmanuel, Dr. Zhang Li, Eisenbeiss Henri | IGP | Hansa Luftbild Price for the best paper "DSM Generation and Interior Orientation Determination of IKONOS Images Using a Testfield in Switzerland", in: Photogrammetrie, Fernerkundung, Geoinformation, Vol.1 |
| Dipl. Ing. ETH Mayor Pierre | IGT | "Umsicht - Regards - Sguardi" - Honour for sustainable projects 2006 / 2007. Honour as participant in the project "Seeschüttung Urner See, Flüelen, Seedorf/UR". SIA Swiss Engineers and Architects |
| Allenspach Karin | IfB | ETH Medal for excellent Diploma Thesis |
| Dürrenmatt David | IfU | Otto-Jaag Water Protection Award 2007 |
| Ganz Michael | IGP | Geosuisse Price 2007 |
| Guillaume Sébastien | IGP | Certificate of achievement for winning the student paper competiton |
| Guillaume Sébastien | IGP | Willi Studer Price ETH, 2007 |
| Knobloch Markus | IBK | ETH Silver Medal for PhD |
| Kocaman Sultan | IGP | Best Speaker Award at the Asian Conference on Remote Sensing (ACRS) (Kuala Lumpur, Malaysia) |
| Löffel Kaspar A. | D-BAUG<br>D-MAVT | Willi Studer Price ETH, 2007, and<br>ETH Medal for excellent Diploma Thesis |
| Novak David | IGP | 2nd Price for young scientists of Photogrammetry Remote Sensing and Geoinformation, in Memoriam of Prof. Dr. Karl Kraus, 3-country conference SGPBF, DGPF, OVG |
| Peter Philippe | IfU | Swiss Federal Institute of Technology (ETH) Medal |
| Raveglia Elio | IBK | Mirko Ros Medal for the best PhD student paper, Outstanding Contribution Award (Yes Symposium) |
| Ryf Adrian | IGP | Award for best teaching D-BAUG by VSETH |
| Snozzi Leonardo C.N. | IBK | ETH Medal for excellent Diploma Thesis |

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www.baug.ethz.ch

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Prof. Dr.
J.G.M. van Mier

## Secretariat

E. Manna

M. Küpfer

## Curricula Environmental Engineering (BSc + MSc), Director:

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P. Burlando
(until Jan. 08)

Prof. Dr.
W. Kinzelbach
(from Feb. 08)

## Secretariat

S. Schirrmacher

## Laboratory for Environmental Engineering

D. Braun

M. Hanyecz

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H. Ingensand

## Secretariat

S. Schönherr

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**Secretariat**

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Doctorate
B. Cuperus

Planning &
Controlling
Dr. P. Dilger

Secretariat
E. Altenburger

Information &
Computer
Technology
Dr. X. Studerus

Information &
Computer
Technology
R. Alber

Mechanical
Workshop
P. Jenni

Electronic
Workshop
C. Senn

Material &
Chemical Stores
M. Frigeri

Zurich, March 1, 2008

## Masthead

**Published by**
Department of Civil, Environmental and Geomatic Engineering

**Editor**
Dr. Patrick Dilger

**Layout**
kgt.quaiser, Adliswil
Communication, Advertising, PR

**Photos**
Department of Civil, Environmental and Geomatic Engineering

**Printing Company**
ea Printing and Publishing, Einsiedeln

**1st Edition March 2008**
2200 copies in German,
1000 copies in English