Impact report

ETH Mobility Initiative

On track to a sustainable future.

ETH Foundation

Cover image: © ETH Foundation / Alessandro Della Bella
Pioneer Fellow Lukas Ambühl is developing a tool to simulate the transport system of any city (see p.22).

Journey into the future

Will the way we travel today – whether on foot, by bike, car, bus, train or plane – be how we get around in future? Digitisation, automation and technological progress are generating new transport solutions, which are now being investigated and put to the test.

We’re talking here not just of spectacular ideas, like self-driving cars and maglev trains, but of deploying the latest technology to optimise current transport systems and make them more sustainable. One thing is clear – if we’re to achieve the climate goals and at the same time meet people’s requirements for getting around, we must rethink mobility and push on with tailored, environmentally and climate friendly solutions.

For such a venture, science, industry, and public transport providers must join forces. By bringing together these parties, ETH Zurich’s Mobility Initiative is playing a pivotal role in developing new mobility solutions. So I’m delighted that this collaboration is right on track. Since our launch in 2018 with the Swiss Federal Railways SBB, we’ve been joined by Siemens, one private individual, and most recently by the AMAG Group. Their generous contribution has gone towards selecting and funding 18 research projects spanning innovative infrastructure maintenance systems, new mobility concepts and alternative energy sources.

Going forward, we intend to fund larger, interdisciplinary projects that can serve as models. These will focus on comprehensive mobility solutions, innovative, scalable approaches to traffic planning and entire traffic networks. We want to team up with more partners and expand into other research fields – some of international scope, such as sea or air transport.

Join us now for a tour d’horizon of the Mobility Initiative. We’d be delighted to have you on board!

Image: © ETH Zurich / Markus Bertschi

Professor Joël Mesot
President of ETH Zurich

Mobility

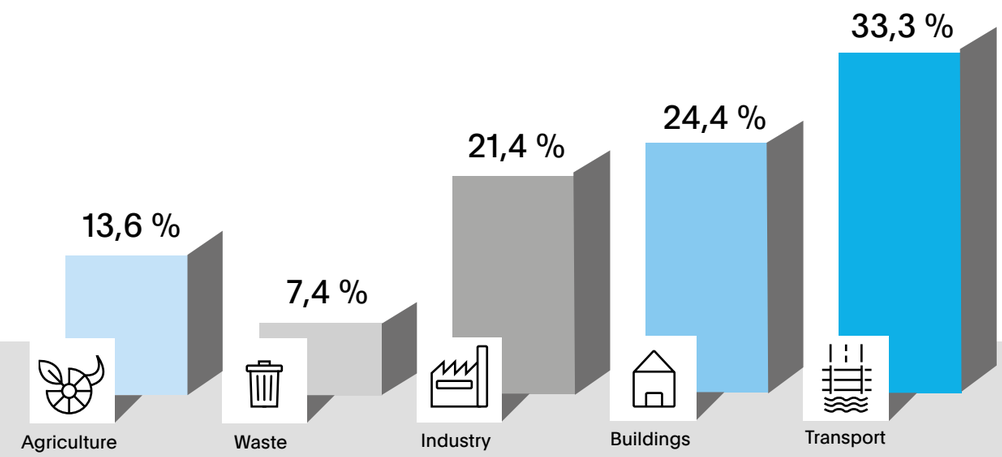
Dilemmas and downsides

Humans are essentially mobile beings; our urge to move forward, our aspirations and our curiosity impel mental, social and spatial mobility. In the last few decades, spatial mobility, which is closely linked to a region's economic growth and progress, has surged dramatically in many parts of the world. Yet the downsides of unrestricted spatial mobility are emerging ever more clearly: most significantly, a vast consumption of resources which brings in its wake drastic consequences for the environment and climate. Mobility is responsible for almost 30 percent of total CO_2 emissions in the EU, of which more than 70 percent are generated by road transport. In Switzerland, the share of mobility in total CO_2 emissions is even higher.

These facts highlight the dilemma in which we find ourselves. On the one hand, we have the devastating environmental impact and the goals set out in the Paris Climate Agreement to achieve net-zero greenhouse gas emissions by 2050. On the other, there's no sign of a reversal in the trend of steady traffic growth. On the contrary, forecasts predict that due to globalisation and the emerging developing countries, individual mobility and freight transport will even triple between 2015 and 2030.

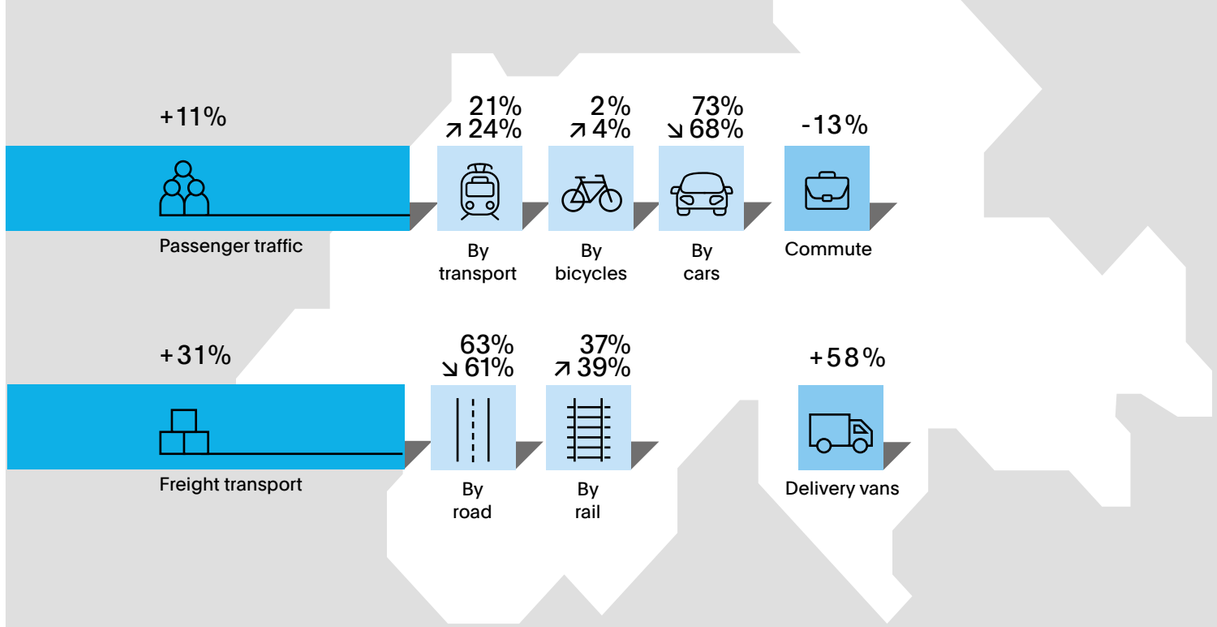
Clearly, new approaches are urgently needed to steer mobility in a more sustainable direction. When designing future mobility solutions, we must weigh up the social, economic and environmental aspects, and we must harness the immense potential of technological advances. And to develop and implement these solutions, science, industry and public transport providers must join forces. This collaboration is exactly what the ETH Mobility Initiative is aiming for.

Breakdown of CO_2 emissions in Switzerland by sector



Emissions for the transport sector include travel by car, truck, motorcycle, bus, train, ship and domestic flights. International air traffic is not included. Source: FOEN

Transport Outlook 2050, Switzerland: Trends 2017–2050



The diagram summarises the main findings of Transport Outlook 2050. Key drivers for the increase in transport use are population and economic growth. The population grows by 21 percent, the gross domestic product (GDP) by 57 percent. Compared to the population, passenger transport increases at a disproportionately low rate of just 11 percent. Freight traffic rises by 31 percent, with a particularly strong increase in van deliveries. People commute less but make more trips in their leisure time. Source: Federal Office for Spatial Development ARE

ETH Mobility Initiative

Teaming up for tomorrow’s mobility

ETH Zurich launched the Mobility Initiative together with the Swiss Federal Railways (SBB) in 2018. The two founding partners have been joined by Siemens, the AMAG Group and a private individual. The goal of the Mobility Initiative is to collaborate to lay the scientific groundwork for a transport system in Switzerland, Europe, and worldwide that is safe, reliable, fast, and at the same time environmentally friendly, cost-efficient, and socially acceptable. This, together with effective measures in other sectors, is essential for achieving the net-zero target by 2050.

More than 40 research groups work in mobility-related fields at ETH Zurich, particularly in the departments of Civil, Environmental and Geomatic Engineering, Mechanical and Process Engineering, and Information Technology and Electrical Engineering. Here they are investigating new drive and energy storage systems, lightweight materials and new forms of mobility.

Alongside research, a key element of the initiative are training and continuing education for the next generation of mobility experts. There are also plans to set up more professorships to forge new areas of research, and to create a Learning Lab for an exchange of know-how with representatives from industry, politics and the public.

Connected Car / Security / Control / Vision / Automation

Prof.
F. Dörfler
Automatic Control Lab

M. Elser
Vehicle Systems Group Empa

Prof.
J. Lygeros
Automatic Control Lab

Prof.
M. Pollefeys
Visual Computing

Prof.
S. Tang
Computer Vision and Learning

Prof.
F. Yu
Visual Intelligence and Systems

Traffic / Transportation Systems

Prof.
K. Axhausen*
Traffic Planning Transport Modelling

Prof.
F. Corman
Transport Systems

Dr.
A. Kouvelas
Traffic Engineering

Prof.
M. Raubal*
Geoinformation Engineering

Energy Efficiency / E-Mobility / Battery

Prof.
A. Bardow
Energy and Process Systems Engineering

Prof.
P. Ermanni
Lightweight Systems

Prof.
C. Franck
High Voltage Laboratory

Prof.
U. Grossner*
Advanced Power Semiconductors

Prof.
S. Hellweg
Environmental Impact

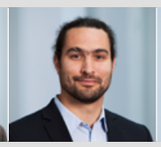
Prof.
G. Hug
Electric Power Systems

Prof.
J. Kolar
Power Electronic Systems

Prof.
M. Kovalenko
Materials for Energy Storage

Prof.
M. Lukatskaya
Power Systems Laboratory

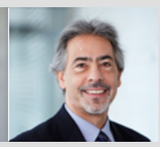
Prof.
M. Mazzotti
Carbon Capture and Storage



Prof.
N. Noiray
Power and Propulsion Systems

Prof.
C. Onder*
Dynamic Systems and Control

Prof.
T. Schmidt
Electro-chemistry

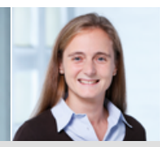


Prof.
A. Steinfeld
Renewable Energy Carriers

Infrastructure / Maintenance / Logistics / Built environment

Prof.
B. Adey
Infrastructure Management

Prof.
E. Chatzi
Structural Mechanics and Monitoring



Prof.
I. Hajnsek
Earth Observation and Remote Sensing

Prof.
D. Kaufmann
Spatial Development and Urban Policy

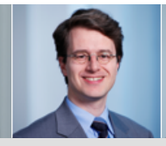
Prof.
K. Schindler
Photogrammetry and Remote Sensing

Prof.
S. Wagner
Logistics Management

Policy / Economics

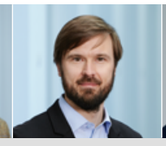
Prof.
T. Bernauer*
Political Science

Prof.
M. Filippini*
Energy and Public Economics



Prof.
V. Hoffmann
Sustainability and Technology

Prof.
A. Patt*
Climate Policy



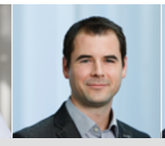
Prof.
T. Schmidt
Energy Policy

Prof.
M. Stauffacher
Science – Society Interface

Prof.
B. Steffen
Climate Finance and Policy

Autonomous Driving / Robotics

Prof.
E. Frazzoli*
Dynamic systems and Control



Prof.
M. Hutter
Robotics and Intelligent Systems

Prof.
R. Siegwart
Autonomous Systems Lab

* Current members of the steering committee of the ETH Center for Sustainable Future Mobility, CSFM (see page 10)

Partnership is the path to success

The Mobility Initiative hinges on the concept of partnership; the Partnership Council acts as a forum for workshops and regular meetings between ETH researchers and business and private partners supporting the initiative. Here they can discuss issues and identify project themes that reflect the interests of the various parties. A call for proposals for research projects is issued each year at ETH.

"By harnessing ETH's research strength, we can tackle issues we would never be able to master on our own. In addition, the interaction with ETH representatives and industry partners is inspiring and productive."

Dino Graf, Head of Group Communication at AMAG Group

"Mobility and the economy are linked: mobility is a key factor in strengthening the international competitiveness of the leading industrial countries. By bringing together universities and industry to collaborate in developing innovative, sustainable mobility solutions, the ETH Mobility Initiative advances Switzerland as a business location."

Gerd Scheller,
CEO of Siemens Mobility AG

Image: © Siemens

New Center for Sustainable Future Mobility

The Mobility Initiative forms part of the ETH Center for Sustainable Future Mobility (CSFM), founded in 2021. This new centre brings together ETH researchers working on mobility issues and acts as a hub for exchange with national and international research institutions. The idea is that researchers, industry partners and interested parties can interact not only with the public, policymakers and administrators, but also with the growing start-up community. The steering committee is made up of at least five professors from various departments and the academic director of the MAS I CAS in Future Transport Systems, each elected for a four-year term (see overview pp. 6 and 7).

The CSFM builds on the activities and achievements of the Swiss Competence Centre for Energy Research SCCER Mobility, funded by the federal government from 2013 to 2020 to address the 2050 climate goals. With ETH Zurich as the leading house, SCCER Mobility unites a number of research institutions in the ETH Domain and several universities in Switzerland.

CSFM
csfm.ethz.ch

"The Center for Sustainable Future Mobility is a new platform where a range of disciplines and institutions are joining forces to get to grips with formidable challenges in the field of mobility. I'm certain that this networking and collaboration will yield new solutions and approaches for a mobile society."

Detlef Günther, Vice President for Research, ETH Zurich

"We all share a vision of developing mobility solutions for the future."

Professor Kay W. Axhausen has headed the Mobility Initiative since 2021 and will direct the newly founded Center for Sustainable Future Mobility for the next two years. As Professor of Transport Planning at ETH Zurich since 1999, he focuses his research on mobility behaviour and transport planning. Kay Axhausen took over leadership of the Mobility Initiative from Konstantinos Boulouchos, Professor Emeritus of Energy Engineering, a driving force in setting up the initiative.

Professor Axhausen, as head of both the ETH Mobility Initiative and the Center for Sustainable Future Mobility, what do you consider the initiative's main task? And how is it different from the competence centre?

The Mobility Initiative brings together ETH Zurich researchers with partners from public transport, industry and business. We all share a vision of developing mobility solutions for the future. The initiative is designed to stimulate exchange, exploit synergies and accelerate research. I believe it's crucial that the topic of mobility elicits even more attention and that technology is transferred from the university to the society. Last but not least, ETH Zurich must use its expertise to support the economy in coping with the enormous challenges ahead of us.

The new competence centre, of which the Mobility Initiative is a part, provides the national and international research community with an ideal platform for networking. It draws together the various activities in the field of mobility under one roof, so to speak, and offers a visible presence to the outside world.

What are the initiative's top priorities?

The need for mobility is set to increase, and this, coupled with population growth and the urgency to reduce greenhouse gas emissions, will entail enormous challenges. We've identified three priorities: First, finding environmentally and climate friendly mobility solutions. This means that fossil fuels must be replaced with more sustainable ones wherever possible. The second issue is infrastructure. In many places, capacity is stretched to its limits, causing traffic jams and delays. In addition, the cost of maintaining bridges, roads, railways and train stations is huge. The third, digitisation, is an opportunity rather than a hurdle. In addition to radically changing mobility, digitisation is opening up unimagined possibilities. In all three areas, ETH Zurich has top-level expertise. The exchange between research and practice puts Switzerland in a leading role for investigating mobility and implementing solutions for Europe and the world.

Isn't the initiative too narrowly focused on technological solutions?

We're aware that technology alone won't be enough to secure a sustainable system of mobility in the longer term – that will take a change in behaviour, too. But at ETH we also have the expertise to investigate consumer behaviour and evaluate possible measures; in fact, the relevant professorships are already on board the initiative. We're now striving to expand their number in order to cover all aspects of mobility and get the full picture.

So far, three companies and one private individual are partners in the Mobility Initiative. What do you hope to achieve by this collaboration?

As researchers, we're hoping for stimuli and impetus from real-life that can be shaped into specific research projects. It's not about solving a particular problem for any one company. The goal of the collaboration is a win-win situation where the company finds answers to its questions, and the university, and ultimately the public, gain insights.

As Professor of Transport Planning, where do you personally see a lot of potential?

Right now we're pushing ahead with the Digital Twin project. The first step is to digitally map Switzerland's entire transport system. This will mean we can then carry out simulations for a given region or city and test new solutions. I see this as a great opportunity, with a lot of potential for future research. But of course it's only one piece of a big puzzle – there's still plenty to do!

Research for an environmentally friendly, cost-efficient and socially acceptable transport system

Research on a sustainable transport system focuses on four areas:

Vehicles, innovative energy sources, infrastructure:

In reducing greenhouse gas emissions, the selection of energy sources is very important. Various approaches as to how renewable energy sources may be used for transport are to be developed and implemented

Digitisation and automation:

Digitisation is opening up promising ways of meeting mobility needs, for example through the clever combination of different forms of mobility or through new services and means of transport.

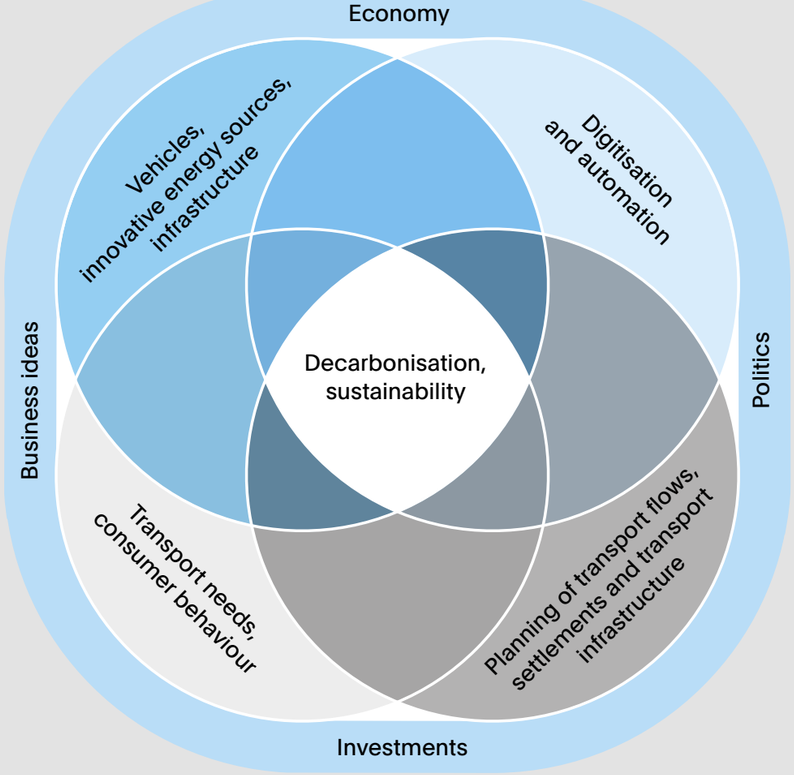
Planning of transport flows, settlements and transport infrastructure:

Capacity is stretched to its limits everywhere, whether in public transport or on the roads. The planning of transport infrastructure must therefore be approached as a whole.

Transport needs, consumer behaviour:

The behaviour of each and every individual shapes sustainable mobility. Changes in the way people live, work and spend their leisure time are particularly important here.

Main pillars of research for low-carbon, sustainable mobility



Funded Projects 2018–2021

Since 2018, a call for projects has been issued each year in collaboration with the partners of the initiative. As of autumn 2021, 18 new research projects have been selected and funded by ETH and our partners.

Projects so far have focused on topics such as how to use artificial intelligence and remote sensing methods to detect and repair damage to the infrastructure early on, and how to handle freight traffic in a sustainable way. Questions of how traffic planning and schedules can be optimised, and how different forms of mobility can be cleverly combined have also been tackled.

Once we have more partners, we will be able to widen the range of topics and bring on board researchers from the departments of Management, Technology and Economics as well as Environmental Systems Science to address the diverse aspects of mobility. For the medium term, the aim is to expand research to cover aviation and shipping, and to initiate larger, interdisciplinary projects.

2021

New forms of mobility in the new normal

The pandemic has changed the way we move, at least in the short term, and accelerated many trends that were just emerging. Bundling mobility services (Mobility as a Service MaaS), carpooling, or simply switching from commuting to working from home are all ways of curbing greenhouse gas emissions from mobility. This project aims to determine preferences for different forms of mobility by means of targeted experiments and surveys, using the MATSim simulation model. The findings will assist public authorities and transport service providers in their investment decisions.

Original title: Multimodality in the Swiss New Normal
Contact: Prof. Kay Axhausen, Institute for Transport Planning and Systems
Project duration: 2022–2024 (27 months)

Understanding the resistance to electric cars

A shift from petrol and diesel cars to electric vehicles (EVs) will help decarbonise the transport system in Switzerland. Yet currently the market share of electric cars is low, with consumers hesitant about purchasing. The project is to assess the effectiveness of non-monetary measures designed to increase acceptance of electric vehicles among owners of combustion engine vehicles. The most promising approaches will then be put to the test on AMAG car leasing customers. In this way, the project will provide car dealers and other stakeholders with valuable knowledge on how to speed up the adoption and use of electric cars.

Original title: Incentives for Electric Vehicles Adoption
Contact: Prof. Massimo Filippini, Chair of Energy and Public Economics
Project duration: 2022–2023 (24 months)

Infrastructure needs for autonomous driving

The project is investigating the infrastructure requirements for autonomous mobility-on-demand (MOD) systems, where a fleet of self-driving vehicles provides one-way passenger mobility services. It will provide communities, mobility providers and car manufacturers with comprehensive answers to inform their future investments and strategies.

Original title: Autonomy-enabling Infrastructure for Future Mobility Systems: an Inside-Out Approach
Contact: Prof. Emilio Frazzoli, Dynamic Systems and Control
Project duration: 2022–2024 (36 months)

Augmented reality for better maintenance

Troubleshooting, repairing and servicing trains is a demanding, increasingly complex process that requires in-depth technical knowledge of train systems. Augmented reality (AR) offers novel ways of supporting personnel in carrying out such tasks by making relevant information intuitively accessible and breaking things into manageable steps. This project will investigate how augmented reality can assist in maintenance and identify any hurdles that may be encountered on the way.

Original title: Interactive Augmented Reality-guided Maintenance Operation
Contact: Prof. Mirko Meboldt, Product Development and Engineering Design
Project duration: 2022–2023 (24 months)

Accelerating commercial production of solar fuel systems

Sustainable fuels for transport can be produced using a technology that harnesses solar energy to convert water and carbon dioxide into fuel. Recently, ETH researchers have demonstrated the entire process chain for solar fuel production at pilot scale; the project will now push this to the next stage. The plan is to conduct a comprehensive techno-economic feasibility study for industrial-scale production of transportation fuels using concentrated solar energy.

Original title: Towards commercial solar thermochemical production of sustainable drop-in fuels (SUNFUELS)
Contact: Prof. Aldo Steinfeld, Renewable Energy Carriers
Project duration: 2022–2023 (15 months)

Condition monitoring during operation

Continuous use in sometimes severe weather conditions weakens critical railway components. To detect any damage in time, vehicles are inspected regularly – but this entails outages and high operating costs. The project aims to develop technologies that can monitor the condition of vehicle components, such as the pantograph, train control system or wheelset shaft, while they are running. Special sensor technology and machine learning methods will be deployed here.

Original title: In-SErvice diagnostics of the cateNary/panTograph and wheelset axle systems through INtELLigent algorithms
Contact: Dr Paolo Tiso, Nonlinear Dynamics
Project duration: 2022–2024 (36 months)

2020

Detecting damage with computer vision

For some time now, SBB has deployed a computer vision model to detect damage to the rail network. To carry out this critical safety task, the model must be able to interpret digital images of inadequate quality. In collaboration with SBB and Siemens Mobility, SBB's computer vision model was tested and evaluated using adversarial machine learning.

Original title: Robust machine learning for safety-critical systems: Practical robust detection of railway defects using AI (RAIL)
Contact: Prof. Martin Vechev, Department of Computer Science
Project duration: 2020–2021 (12 months)

Driving assistance systems with early detection of obstacles

Today's driving assistance systems cannot reliably detect obstacles on or near to the railway tracks. Distance sensors such as 3D laser range finders (LiDARs) have a maximal range of 300 metres, which is not sufficient for trains due to the long braking distances. This project investigates the suitability of an actuated system of visual cameras combined with a distance detector (such as a long range 1D laser).

Original title: Long-Range Obstacle Detection for Early Alert Advanced Driving Assistance Systems (LROD-ADAS)
Contact: Prof. Roland Siegwart, Institute of Robotics and Intelligent Systems
Project duration: 2021–2023 (36 months)

Early detection of track infrastructure damages

A frequent cause of damage to track infrastructure is water seeping into the ballast bed on which the sleepers are laid. This project investigates combining three remote sensing methods in order to identify endangered track sections efficiently and in good time. Calculations show that this approach could extend the life of the affected infrastructure by 5 to 10 years – corresponding to annual savings in the order of 35 million euros.

Original title: Early Detection and Assessment of Railway Substructure Moisture Problems at National to Local Scale Using Spaceborne, Airborne and Train-based Remote Sensing Systems (REASSESS)
Contact: Dr. Othmar Frey, Institute of Environmental Engineering
Project duration: 2021–2023 (36 months)

Growing energy demand for transport

Over the next few decades, the electricity consumption of both the public and private transport sector is expected to surge. This is due to an increase in train connections, a higher volume of rail freight transport, and the electrification of on-road vehicles. The project has two objectives: Firstly, to compile an overview of the amount of electrical energy required by the railroads and supplied by the traction power grid. Secondly, to examine how charging facilities for electric vehicles can be provided by connecting them with PV systems or using the traction power grid at stations.

Original title: Power and Energy for the future railways (RailPower!)

Contact: Prof. Francesco Corman, Institute for Transport Planning and Systems, Prof. Gabriela Hug, Power Systems and High Voltage Laboratories

Project duration: 2021–2023 (36 months)

Optimising timetable and maintenance work

Traffic volume is predicted to rise in future, and to cope with this, railways must be optimised. What's crucial here is anticipating, preventing or eliminating potential disruptions by means of surveillance technologies, carrying out maintenance work on the infrastructure in precisely defined time windows, and drawing up timetables so as to minimise delays. In this project, a new approach to integrate train schedules and maintenance schedules is being developed. The goal is to achieve a timetable that is as stable as possible while making maximum use of any timetable reserves for maintenance work.

Original title: Maintaining train schedule STABILITY and managing time table reserves via digitalized railway intervention planning (STABILITY)

Contact: Prof. Bryan Adey, Institute of Construction and Infrastructure Management

Project duration: 2021–2023 (36 months)

2019

One-stop travel pass

Driving a private car is far less sustainable than using public transport – yet it's one of the main forms of travel worldwide, often due to lack of alternatives. A promising, little explored option is the grouping of various transport services into mobility bundles, from which the user then selects and books with a single travel pass. This Mobility as a Service (MaaS) concept could encourage a switch from private car use to more sustainable shared travel and emerge as a key strategy for decarbonising the transport sector. The project investigated yumuv, the SBB citybundle, to see if and how it changes travel behaviour. In addition to examining the traffic planning aspect, researchers looked at how mobility data can be efficiently presented and how machine learning methods can be deployed to analyse such data.

Original title: Empirical use and Impact analysis of MaaS (EIM)

Contact: Prof. Martin Raubal, Institute of Cartography and Geoinformation, Prof. Kay Axhausen, Institute of Transport Planning and Systems

Project duration: 2019–2022 (36 months)

2018

On-board monitoring for more efficiency

Every day, almost three million tons of goods and passengers are transported across the Swiss rail network. To keep everything running safely, SBB carries out regular inspections of track infrastructure using a sophisticated vehicle that calls for qualified personnel and meticulous planning. Working closely with SBB, the project team plans to replace the current method by installing tailor-made technology on existing line trains. Such continuous monitoring of the rail network would allow for preventive maintenance, avoid emergency repairs and significantly reduce downtime. Overall, this would improve safety and reliability while reducing costs.

Original title: On board Monitoring for Integrated Systems Understanding & Management Improvement in Railways (OMISM)

Contact: Prof. Eleni Chatzi, Institute of Structural Engineering, Prof. Francesco Corman, Institute of Transport Planning and Systems

Project duration: 2019–2021 (36 months)

Automated localisation for a better service

Digitisation and new robotic system technologies offer unimagined opportunities for railroads to optimise capacity utilisation and register train delays in real time using appropriate localisation methods. By equipping the vehicles with specially designed sensors and devising methods for estimating movement, this project developed a solution for accurate, continuous localisation. For customers, this means an improved service with fewer interruptions.

Original title: Vision-based localization and mapping for high-precision positioning of trains with on-board sensing (PROMPT)

Contact: Prof. Roland Siegwart, Institute of Robotics and Intelligent Systems, Prof. Margarita Chli, Vision for Robotics

Project duration: 2018–2021 (36 months)

Freight transport by rail – quo vadis?

The net-zero emission goal set out by the Swiss government entails decarbonising the transport sector. While freight transport by rail is highly electrified and has a good greenhouse gas balance, the railways cannot manage the fine distribution of goods in cities, and the ageing infrastructure needs to be renewed. Emerging customer demand patterns, a changing political and regulatory environment, and technological advances, such as digitisation and autonomous vehicles, will all affect the future of rail freight. Together with SBB Cargo, these challenges were closely analysed and possible solutions outlined. A number of specialist groups were consulted, and the results of the analysis used to model various scenarios with the aid of system dynamics.

Original title: Future Environmental Performance of Swiss Freight Transport – Impacts on Rail Cargo Competitiveness (FPFT)

Contact: Prof. Dr. Konstantinos Boulouchos, Institute of Energy Technology

Project duration: 2018–2020 (24 months)

Deep learning to improve infrastructure

Railway wheels and how they interact with the track are critical safety components; their maintenance and monitoring is of paramount importance. But rail-wheel interaction in real operating conditions is not fully understood, and wheel wear and damage not adequately represented in current models.
The project sought to deploy deep-learning algorithms to integrate information from heterogeneous data sources and use it to predict wheel deterioration.
This would reduce maintenance costs, increase safety and improve resource planning.

Original title: Integrated intelligent railway wheel condition prediction (INTERACT)

Contact: Prof. Olga Fink, Institute of Construction and Infrastructure Management

Project duration: 2018–2021 (36 months)

Efficient transport planning

As the world grows more complex, transport planning becomes ever more crucial. A decisive tool here is MATSim, the transport simulation model that ETH Zurich and Technische Universität Berlin have been developing for over a decade. Within the framework of this project, simulation runtime was improved by a factor of up to three, which means the model can now be used effectively for practical planning.

Original title: High-Performant Mobility Simulation on a National Scale

Contact: Prof. Kay Axhausen, Institute of Transport Planning and Systems

Project duration: 2018–2021 (36 months)

Automated train schedules

Demand for public rail transport is set to increase. The SmartRail 4.0 programme aims to get Swiss railways ready for the digital future and ensure reliable, sufficient services for customers. A key element here is the automated scheduling of railway network traffic. This project is investigating scheduling problems and designing fast solution algorithms to advance automated scheduling systems in this context.

Original title: Application and practical implementation of Railway Traffic Management Systems

Contact: Prof. Francesco Corman, Institute of Transport Planning and Systems

Project duration: 2018–2022 (48 months)

Bright business idea

Lukas Ambühl is developing a tool that can simulate the transport system of any town or city. Funding through an ETH Pioneer Fellowship has helped him along the path from doctoral dissertation to establishing a start-up.

Over half of the world’s population lives in towns or cities, and the number is set to rise. Increasing urbanisation poses huge challenges, one of which is efficient organisation of transport. How can we keep huge numbers of cars, bicycles, trams and buses moving? How can traffic jams be avoided? What impact do roadworks have – and what happens when self-driving cars are added to the equation? Good transport planning protects the environment and keeps stress levels low, as well as saving time and money. And last but not least, it makes it safer to be on the road.

Pioneer Fellow Lukas Ambühl, who holds a doctorate in civil engineering from ETH Zurich, is convinced that artificial intelligence opens huge opportunities here. With Transcality, he has a tool that not only digitally maps the movement of traffic within a city in real time but also simulates possible scenarios. This can greatly assist long-term transport planning. “Mobility is very complex, as it’s shaped by numerous interactions and dependencies. Static models aren’t really up to the task,” says the budding entrepreneur. By systematically and automatically processing data, his “digital city twin” can instantly simulate how interventions in the transport system, such as building a tunnel or creating a car-free zone, will affect the rest of the city.

One step ahead with the digital twin

In developing his algorithms, Ambühl can draw on two things: First, many cities already record data on a regular basis, measuring for example how many vehicles pass a particular intersection within a given period. Second, certain patterns in traffic behaviour, such as how traffic jams form, are always similar whether in Zurich, Berlin, or Tokyo. What makes Transcality unique is that it is a modular tool that collates data from various sources, and hence can be applied to cities of any size.

There’s certainly plenty of demand for it. Ambühl is already running two pilot projects – one in a large Swiss city, where he’s investigating the traffic-related impact of the reconstruction of a long stretch of motorway. The other in London, where he’s helping local authorities analyse why congestion is worse now than before Covid, despite there being fewer cars on the road. Transcality’s simulations can be used to test hypotheses and draw conclusions for future transport planning.

Strengthened in his resolve

It means a lot to Ambühl that he can use and test his tool in a real-life situation during this development phase. It is precisely the practical relevance that motivates him: “I want to actively shape the environment and solve problems.” He benefits from the extensive theoretical knowledge built up during his dissertation at the Institute for Transport Planning and Systems and also from a wide-ranging international network of partners from industry and administration.

Two things in particular encouraged Ambühl to venture into entrepreneurship: Firstly, he breathed the air of Silicon Valley during an exchange semester in Berkeley and was taken with the relaxed attitude towards start-ups and possible failures. Secondly, getting through the tough Pioneer Fellowship selection process and convincing the jury of Transcality's potential, gave him assurance that he was on the right track. “Funding is one thing, and the coaching is extremely valuable too, but what means most to me is the confidence placed in me and my project.”

Partners make it possible

Pioneer Fellows receive valuable funding from numerous foundations, companies and over 200 individuals. The Pioneer Fellowship Programme supports outstanding, ambitious researchers with entrepreneurial flair by providing mentoring, start-up capital and access to laboratories on their way to launching a market-ready product.

More about the programme: www.ethz-foundation.ch/pioneer-fellowships

Continuing education:

MAS | CAS ETH in Future Transport Systems

Alongside research, an important pillar of the Mobility Initiative and the new Center for Sustainable Future Mobility is continuing education. The MAS | CAS ETH in Future Transport Systems focuses on the development and implementation of integrated and resource-saving mobility solutions. The emphasis is on public and private freight and passenger transport by rail and road.

The MAS course consists of three interdisciplinary Certificates of Advanced Studies (CAS): CAS System Aspects, CAS Technology Potentials and CAS New Business Models. It complements the ETH continuing education programmes in spatial planning, transport engineering and spatial information systems, all of which are tightly linked to mobility.

Partners of the Mobility Initiative and interested companies can become members of the Advisory Board of the MAS | CAS ETH in Future Transport Systems; this gives them the opportunity to have a certain number of employees participate in the continuing education courses each year.

The degree programme was launched in 2017. To date, 53 students have completed the course.

More information: mas-mobilitaet.mavt.ethz.ch

“Shaping sustainable mobility is a huge challenge. Systems thinking and a targeted use of new technologies are imperative here. The MAS ETH in Future Transport Systems equipped me with the theoretical and practical knowledge essential for tackling the implementation of new forms of mobility.”

Rita Nenniger, PostAuto AG

“Thanks to the MAS programme, I’ve thoroughly got to grips with mobility of the future. The combination of case studies from my professional practice with state-of-the-art science led to new insights and fruitful discussions with my colleagues. All in all, I took home a lot of knowledge that I can apply in my work at Zurich Transport Authority.”

Silvan Weber, Head of Market Development, Zurich Transport Authority (VBZ)

“The CAS ETH New Business Models is a wide-ranging course with direct practical relevance. It addresses existing and new aspects of mobility in a methodical, academic and practical way. I enjoyed the theoretical side and was inspired by the new trends and thought-provoking ideas that the speakers presented. The networking and interaction in class was valuable, too. So, all in all, a programme I’d highly recommend!”

Manuela Hofstetter-Schären,
Sales planner (offers) Central Switzerland, SBB

Image: © SBB

We’re setting off – will you join us?

To meet the targets of the Paris Agreement and avert the worst of climate change, a huge, concerted effort is needed. As mobility accounts for a large share of Switzerland's total greenhouse gas emissions, addressing this area is crucial, and is one of ETH’s priorities for the coming years. The Mobility Initiative will play a pivotal role in bringing things on track for a sustainable future.

Input from talented, competent and inventive researchers must be harnessed to drive the change – and this requires financial resources. To realise the Mobility Initiative’s ambitious plans, approximately CHF 100 million over the next ten years are required. ETH itself is contributing about half of the funds; current partners SBB, Siemens, AMAG and a private individual have donated a total of CHF 18 million. To raise the remaining funding, we’re looking for more partners – companies, foundations or private individuals – who are keen to forge the path to sustainable development.

Let us tell you more about the initiative and how you can get involved!

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The ETH Foundation

Together with committed private individuals, companies and foundations, the ETH Foundation promotes teaching and research at ETH Zurich, and in this way helps push the boundaries of knowledge and speed up innovation. Donations to the ETH Foundation make extraordinary things possible, strengthen ETH Zurich’s leading position, enhance Switzerland’s innovative power and contribute to finding solutions for the major challenges of our time.

A heartfelt thank you!

On behalf of all researchers involved, we would like to sincerely thank our partners for their commitment.
We look forward to continuing this valuable cooperation.

SBB I Siemens I Prof. Dr. em. Alexander Wokaun I AMAG

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