Banks and insurance companies, the shops along Bahnhofstrasse, perhaps the lake, too: that’s what springs to mind for most people when they think of Zurich. They don’t usually think of the city as a centre for medicine – but that could soon change. In recent years, ETH Zurich, the University of Zurich and the University Hospital Zurich have launched a number of initiatives that should put Zurich on the map as a global centre for medicine.

ETH Zurich has pooled its expertise into the Department of Health Sciences and Technology in order to meet the growing demand for medical engineering in an ageing society. Researchers in other departments collaborate closely with medicine, too. Besides chemists and biologists, mechanical and electrical engineers, physicists, computer scientists and materials scientists at our university are all helping to shape the medicine of tomorrow.

ETH Zurich has been working closely with the University of Zurich and the University Hospital under the umbrella of Hochschulmedizin Zürich (University Medicine Zurich (HMZ)) for almost two years. The idea: to make the most of the impressive resources that these three neighbouring institutions have at their fingertips.

HMZ promotes joint projects and networks that are in tune with the strategies of the individual institutions. They range over fields as diverse as cancer research, infectious diseases, imaging techniques, neuroscience, research on lifestyle diseases like diabetes, heart disease, and personalised and regenerative medicine.

An example from the field of personalised medicine can show just how close this collaboration really is. This is one of the medical fields of the future, and ETH Zurich and the University of Zurich are looking to take the lead with a new competence centre. Here, we can put our expertise in data security and analysing large amounts of data to good use. Our university is currently seeking a professor specialising in medical informatics. The post will be based in the Department of Computer Science but work at the University Hospital.

This issue of Globe will introduce you to several research projects, giving you a small glimpse of this vast field. I wish you happy reading. And good health.

Ralph Eichler
President of ETH Zurich
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Agenda

Globe is also available in English and German as a free tablet version
The poetry of technology

Modern technology, coupled with entertainment and poetry as a poetic spectacle: this is the message conveyed by the short film Sparked, which was realised by the Canadian Cirque du Soleil in conjunction with ETH Zurich’s Institute for Dynamic Systems and Control and the ETH-Zurich spin-off Verity Studios. The film features an electronics whiz in his workshop who becomes mesmerised by floating lampshades, which start spinning around him as if by magic. A great deal of sophisticated technology went into the magical movements of the flying lampshades. What the viewer can’t see: instead of flying by themselves, the lampshades are actually propelled by concealed quadrocopters, which move around the room autonomously thanks to an ingenious stroke of control engineering. The short was filmed in the Flying Machine Arena, a test environment developed by Raffaello D’Andrea’s group, where ETH-Zurich researchers devise new algorithms that enable autonomous flying robots to perform complex manoeuvres. And the fruits of this research have now made it possible to realise a poetic film with ambitious choreography.

Film footage and photographic material on the project: http://flyingmachinearena.org/sparked
Along with colleagues from the University of Leipzig, scientists from ETH Zurich have massively increased the resolution of magnetic resonance imaging (MRI) – down to the size of a single atom. Using an MRI machine they developed themselves, they succeeded for the first time in detecting a single hydrogen atom on the surface of a novel piece of measuring technology. Unlike conventional MRI machines, which measure magnetisation inductively with an electromagnetic coil, the scientists determined the magnetisation in their experiment with the aid of a diamond sensor in an optical measurement setup using a fluorescence microscope. In the future, the newly developed nano-MRI could be used to clarify the spatial structure of biomolecules.

The "grimsel" electric car has broken the world acceleration record for electric vehicles. The car accelerated from 0 to 100 km/h in 1.785 seconds and less than 30 metres. It took 30 students from ETH Zurich and the Lucerne University of Applied Sciences and Arts a year to develop and construct this record-breaking electric vehicle.

Direct seeding – an agricultural cultivation method where crops are sown directly into unploughed land – is only advantageous in dry regions, as a large-scale survey study involving scientists from ETH Zurich’s World Food System Center reveals. The study’s authors attribute direct seeding’s higher yield in dry regions to the protection against evaporation provided by the remnants of previous crops.

For the first time in 20 years, ETH Zurich has opened a new building on its Zentrum campus. Following four years of construction, the Department of Mechanical and Process Engineering and ETH Zurich’s Swiss Economic Institute (KOF) now share one of the most sustainable university buildings in Switzerland. The 10 upper floors and 3 basement levels house offices with around 450 workstations.

www.axpo.com/awards
**An app in 40 hours**

The roughly 350 entrants in the programmer marathon HackZurich all had the same goal: to develop an app in only 40 hours. The winner was an app that can be used to explore remote places by smartphone. HackZurich is the third hackathon organised by students from the University of Zurich and ETH Zurich.

**Biotechnology**

**Using thoughts to control genes**

Researchers at the Department of Bioengineering at ETH Zurich have developed a method that allows the genetic information to be used to control the production of certain proteins. The researchers have demonstrated that it is possible to control the production of certain proteins in a living cell using brain signals. The system could have applications in the field of regenerative medicine, where it could be used to control the production of certain proteins in order to promote tissue repair.

A small, integrated LED lamp comes on and illuminates a culture chamber with genetically modified cells. The light then makes them produce the protein required. First of all, the implant was tested on cell cultures and mice, controlled by the thoughts of different test people. In order to regulate the amount of protein released, the test people had to wear devices that responded to different states of mind. Meditation led to high amounts of protein, concentration to medium values.

**Epidemic**

**The mathematics of the Ebola virus**

New benchmark figures calculated by researchers at ETH Zurich’s Department of Bioinformatics can describe the Ebola epidemic in West Africa with mathematical precision. Using a statistical computer model they developed themselves, the scientists worked out various parameters, such as the incubation period and the re-production rate, based on the gene sequence of the virus in patient samples. The Ebola virus changes in the body on a daily basis, which means that the virus sequence differs slightly from one patient to the next. Knowing the various sequences, the scientists were able to determine the point in the past when an infection between the patients occurred, which in turn allowed them to calculate the parameters. The scientists’ data could help health authorities to contain the epidemic.

**Global warming**

**Groundwater also warming up**

The temperature profiles of groundwater are following those of the atmosphere, albeit in a milder, delayed fashion. This means that global warming is reflected directly in groundwater, as shown by the results of a new study conducted by German researchers and scientists from ETH Zurich. The consequences of their discovery for subterranean ecosystems are currently difficult to assess.

**Biotechnology**

**Decoding Better antibiotics**

Researchers from ETH Zurich have decoded the structure of the large ribosomal subunit of mitochondria in atomic detail. Ribosomes are cellular structures involved in protein synthesis—the attack point for certain antibiotics. For an antibiotic to be used in humans, however, it mustn’t attack the human ribosomes—only those in bacteria. This improved understanding of the structure should allow scientists to develop antibiotics that work even more specifically.

**Smartphone controls**

**As if by magic**

The fingers point left, spread apart, or mimic a pistol: thanks to a new app, smartphones can be controlled with such hand signals without any physical contact.

A new algorithm developed by ETH Master’s student Jie Song from the Department of Computer Science drives this hand-signal control system.

**Rehabilitation technology**

**Zurich spin-off funds chair**

ETH Zurich has set up a new chair of rehabilitation engineering and appointed Roger Gassert to the post. The chair is affiliated with the Department of Health Science and Technology.

In order to observe the surrounding area, his programme uses the device’s built-in camera. The information obtained—the shape of the gesture or parts of the hand—is reduced to a simple outline and compared to programmed gestures.

Finally, the programme performs the command associated with the signal. The student has just received the 2014 Swisscom Innovation Award and a prize of 10,000 Swiss francs for his work.

A new app lets the smartphone understand hand signals.
In the ice clouds

A doctoral student from ETH Zurich is researching how clouds form on the Jungfraujoch – for clouds are one of the main sources of uncertainty in climate models. Globe paid the researcher a visit at dizzying heights.

The weather couldn’t be worse. Nothing but a sea of grey. Not a trace of the Aletsch Glacier. Instead of a glorious alpine panorama, today all the Jungfraujoch can offer its guests are thick clouds. But that hasn’t deterred a handful of tourists from venturing onto the Sphinx observation terrace. The wind is lashing against their faces, and snowflakes are swirling through the air. It is bitterly cold. The visitors from all over the world just about manage to muster a brave smile for the camera. Two storeys further up – and inside, where it’s warm – Ulrike Lohmann and Larissa Lacher are gazing through the window at the clouds and they’re tickled pink. But this is no schadenfreude, it’s the enthusiasm typical of scientists who have a burning passion for their subject.

Lohmann is an atmospheric physicist and a professor at the Institute for Atmospheric and Climate Science at ETH Zurich. She is visiting Lacher, her doctoral student, at the High Altitude Research Station Jungfraujoch. This young scientist is spending four weeks here at the Sphinx Observatory, 3,571 metres above sea level, in order to make climate measurements. She is interested in particles in the air that aid cloud formation. And if today’s weather is anything to go by, they are hardly in short supply up on the mountain.

Desert sand meets glacial ice

The blanket of clouds briefly opens to offer a glimpse of the snow fields outside the window. It’s not much, but enough for Lacher to be able to show her boss the reddish deposits in the snow. The two women dart from one window to the next before the clouds swallow everything up again. What has set the researchers’ pulses racing looks just like dirty snow to visitors from the city. But it’s actually dust from the Sahara. It comes from the last Sahara dust event, which carried sand northwards from Africa in May. The two scientists are interested in how the Saharan sand affects the formation of clouds on the Jungfraujoch. Because fine particles like Saharan dust in the air – known as aerosols – act as condensation nuclei upon which water or ice can accumulate, depending on the temperature and relative humidity. This is how cloud droplets or ice crystals are formed, which eventually combine to make entire clouds. These
“warm clouds” mostly consist of relatively small water droplets and are recognisable from their sharp outlines. Ice clouds, on the other hand, are composed of ice crystals that fall out of the cloud more readily on account of their size, which is why they typically have blurred outlines.

Lacher completed her Master’s thesis in Lohmann’s lab, and back then she was already studying Saharan dust events and their impact on the formation of clouds. She did this in Tenerife in the Canary Islands, which lies only 250 kilometres from the Sahara Desert. “Measuring the same Saharan dust event during two parallel measuring campaigns – initially in Tenerife and now here on the Jungfraujoch – that would be a great success”, says Lacher, and her blue eyes light up. Because this would enable her to study the ageing process of the aerosol particles and their influence on the formation of clouds.

Other kinds of fine particles can also contribute towards the formation of clouds, such as sulphates from volcanoes and salts from the sea, not to mention fine particles from exhaust gases and industry. Lacher made the journey up here just over a week ago to study their impact on cloud formation, bringing a chamber with her in which she can simulate cloud formation under controlled conditions. The cloud chamber has now been installed in the Jungfraujoch lab and connected up to all manner of pipes, wires and sensors. The chamber sucks in atmospheric air through an inlet pipe that starts outside on the roof. Depending on the air sample and the conditions in the chamber, ice crystals of different shapes and sizes form. These are then detected at the other end of the chamber and evaluated later on.

Measuring well into the night

The measuring device was only constructed by Lohmann’s research group a few months ago, based on a piece of equipment from the University of Toronto. There aren’t any commercial products as yet; the field is still far too young. “I find my research exciting because engineers are also on board”, says Lohmann. She had already come up with the idea of building a cloud chamber herself, albeit for an aircraft rather than a research station in the mountains. Gathering cloud data in a plane, however, is highly complex and expensive. What’s more, the measurements are limited to the duration of the flight. The Jungfraujoch is more practical as it is enshrouded in clouds 30 to 40 percent of the time – and these are the perfect prerequisites for Lohmann’s doctoral student to collect suitable data. Lacher begins her first measurements every day at noon and usually keeps on going until way after midnight. “Throughout the measuring campaign, I’m completely detached from normal life, so I soon got used to the new rhythm. And besides, it means it can have a lie-in”, says Lacher with a grin.

Her room up here on the Jungfraujoch is modest. A hut-caretaker couple runs the accommodation side of business. Lacher made the journey up here just over a week ago to study their impact on cloud formation, bringing a chamber with her in which she can simulate cloud formation under controlled conditions. The cloud chamber has now been installed in the Jungfraujoch lab and connected up to all manner of pipes, wires and sensors. The chamber sucks in atmospheric air through an inlet pipe that starts outside on the roof. Depending on the air sample and the conditions in the chamber, ice crystals of different shapes and sizes form. These are then detected at the other end of the chamber and evaluated later on.

Unpredictable clouds

Although Lacher has only been here for a week, she can already draw some initial conclusions about her measurements. In the afternoon, the air contains many more aerosol particles than at night. In the daytime, air close to the ground can sometimes be transported onto the Jungfraujoch by the upcurrent. It is polluted and contains far more man-made aerosol particles, but also biogenic particles such as pollen, which can sometimes cause increased ice formation in the chamber. At night, however, the air is much cleaner as the research station is in the free troposphere during this period and there are only very few aerosols for ice crystals to form upon.

This spatial and temporal variability of the aerosol particles renders the formation of clouds difficult to predict. As a result, clouds are in the main sources of uncertainty in climate models. The influence of clouds on climate change is also the subject of debate. During the daytime the clouds have a cooling effect because they reflect radiation. But at night, clouds have the opposite impact as they keep in the earth’s heat like a greenhouse.

For a long time, simulating clouds and aerosol particles in climate models was the main focus of Lohmann’s group. Meanwhile, they have taken things a step further and gathered the data for their models themselves. “I’m simply too impatient to wait for others to make the measurements I need for my models”, admits the spirited professor. That’s why modelling, field work and lab work are all integral elements of her studies. Consequently, the data that Lacher is gathering up here will be channelled into the climate models of Lohmann’s group.

Dusk is beginning to descend on the Jungfraujoch. The mountain finally offers a glimpse of its more generous side: suddenly, the cloud layer bursts open and the Aletsch glacier appears in all its splendour. The sun and the shade dance on its ice. Despite her deep fascination with clouds, Lacher is delighted with this sudden change in weather that has unveiled the true beauty of the alpine world. “I’m very fond of my temporary workplace up here”, she says. “Above all, it is a great opportunity to gather some extraordinary measurement data.” And as the sun gradually sinks behind the mountain tops, Larissa Lacher settles in for another night in the lab.
Hot spot Zurich

The conditions are second to none: one of the top technical universities in the world, the largest faculty of medicine in Switzerland and the University Hospital, all sitting right next door to each other. Whether it be an artificial heart, imaging techniques for use in Alzheimer’s research or new findings on infectious diseases: what doctors, engineers and scientists are jointly developing here should find its way to patients as quickly as possible.
Interdisciplinary, networked, successful

Markus Rudin works at the intersection of technology development, fundamental research and medicine. In his lab, Alzheimer’s research is just as much part of the daily routine as refining imaging techniques like MRIs.

Biologists, physicists and electrical engineers work side by side in his lab. ‘Everybody’s expertise is called for; it’s the only way we can move forward’, says Markus Rudin. This professor from the Institute for Biomedical Engineering conducts research into imaging techniques for the brain. At ETH Zurich he is based in the Department of Information Technology and Electrical Engineering, and at the University of Zurich in the Faculty of Medicine. The fact that Rudin is at home in several disciplines is also evident in his association with two centres of competence within Hochschulmedizin Zürich (University Medicine Zurich; see article on p. 20ff.): the Experimental and Clinical Imaging Technologies network and the Neuroscience Center Zurich. Both have the goal of consolidating research across the spectrum, from technology development to clinical application. Rudin’s own lab reflects this interdisciplinary.

Rudin’s main research interest is magnetic resonance imaging (MRI), a method that is well established in medicine as a key diagnostic instrument. The further development of the method, the functional MRI (fMRI), does not just display the anatomy: it also renders active brain regions visible, which allows researchers to observe the brain at work. “The fMRI has had a major impact on neuroscience. But it’s very challenging to interpret that kind of data”, says Rudin. This is because an fMRI does not directly measure neural activity. Nonetheless, fMRI data is extremely important for many branches of experimental and clinical neuroscience. It can help characterise diseases and to monitor and optimise courses of treatment. Functional measurements are also an important tool for neurosurgeons when deciding which regions in the brain must not be injured under any circumstances during operations.

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Rudin also uses the fMRI for scientific problems. In one of his most recent studies, he used an Alzheimer’s mouse model developed in Zurich to examine how different areas of the brain communicate with each other – a measure for the progress of the disease. The mice have a genetic mutation that triggers them to produce specific proteins that form the building blocks of the typical plaques seen in the brains of Alzheimer’s patients. While the various regions of the brain developed interconnections in healthy animals, in sick ones the process was almost completely absent – unlike in Alzheimer’s disease, where an initially healthy brain degenerates. “The suitability of the mouse model to study the progress of Alzheimer’s with regard to functional deficits is therefore limited”, concludes Rudin. However, it does describe what happens when too many of the proteins are produced. Researchers could thus use the model to study changes in how interconnections form in the brains of people with Down’s syndrome, since such plaques already appear in young people affected by this chromosomal condition.

Physical proximity promises success

Rudin carried out both studies in collaboration with scientists in the Zurich research hub. A new study on Alzheimer’s patients is in the pipeline, in conjunction with the Psychiatrist University Hospital of Zurich. For Rudin, Zurich provides the ideal location for medical research. Besides the two universities, there are also the university hospitals. “The geographic proximity is important. You already have less interaction with scientists who work in a different building”, says Rudin, speaking from experience. In-person discussions and a regular exchange of ideas are especially important in interdisciplinary projects. Moreover, participants can share expensive infrastructure. The disciplines also join forces when it comes to training. “The students should learn early to work in an interdisciplinary way and to form networks”, says Rudin.

Pooling skills nevertheless pays dividends in an international context as well. Zurich enjoys a global reputation as a top-level medical research hub, which frequently inspires international research collaborations with other leading scientists. This in turn increases Zurich’s appeal as a hotbed of medical research even further – a very promising cycle of development.

Institute for Biomedical Engineering:
www.biomed.ee.ethz.ch

Experimental & Clinical Imaging Technologies (EAGITE) Zurich:
www.cimst.ethz.ch

Neuroscience Center Zurich (ZNZ)
www.neuroscience.ethz.ch
Three of the most important institutions on Switzerland’s university medical research landscape lie within walking distance of each other: the University of Zurich, which boasts the country’s largest faculty of medicine and a top faculty of veterinary medicine; ETH Zurich, a world-class technical university; and, just over the road, the University Hospital Zurich, which unites over 40 clinics and institutes under one roof. As a university hospital, the latter is also involved in research and teaching. What’s more, the other four university hospitals in Zurich are also a mere stone’s throw away. Researchers like Åke Senning, the father of modern heart surgery, and Rolf Zinkernagel, an immunologist and Nobel Laureate, have made medical history at the University Hospital and the University of Zurich. And at ETH Zurich, prominent researchers include Richard Ernst, Nobel Prize winner in 1991, who made key contributions towards the development of modern imaging techniques, such as medical magnetic resonance imaging.

Many disciplines at ETH Zurich are involved in medical topics today. And the importance of the collaboration between medical engineering and clinical medicine has also skyrocketed in recent years due to technological breakthroughs such as gene sequencing, medicine-related robotics and imaging techniques.

Making the most of outstanding potential

“The close collaboration between engineering and medicine opens up whole new approaches in healthcare and creates enormous potential for the location of Zurich among the international competition”, says Roland Siegwart, ETH Zurich’s vice president of research and corporate relations. This applies in both a scientific sense and an economic sense, as the medical engineering sector ultimately contributes roughly as much to Switzerland’s gross domestic product as the tourist industry. “With the university, ETH Zurich and the five university hospitals, Zurich has tremendous potential to boost its national and international position in the medical工程学领域. Thus, we are also guaranteeing top-class healthcare in Zurich for the long term”, says Gregor Zünd, Director of Research and Teaching at the Zurich University Hospital.

Consequently, HMZ promotes ideas and projects that have a decidedly interdisciplinary character as well as being translational. In other words: representatives of the different institutions should collaborate closely on their projects. And it is all about converting results from basic research into developments that find their way into everyday medical life.

One aspect of HMZ’s work thus focuses on highly practical services. “Part of what we do is trying to connect researchers who wouldn’t find each other otherwise”, explains Schütt.

So we’re also a contact platform that helps find the ideal partner for a research topic.” The second part of HMZ’s activities is more interesting from a strategic standpoint. The aim here is to bring partners together across disciplines for strategically important, large-scale research projects or even centres. One of HMZ’s flagship projects is the Zurich

The connections between medicine, science and technology are becoming increasingly close – in Zurich, quite literally. The city’s three heavyweights of university medical research are looking to further expand on their unique locational advantage.

Three times the medical expertise

Martina Märki

No. 4, December 2014

Focus University medicine
Zürich. With 135 research groups, it is the largest joint Zurich network (see article on p. 28 f.), where 65 research Zurich, however, is personalised medicine. With the new Zurich (EXperimental & Clinical Imaging Technologies) (ZNZ) also forms an official part of Hochschulmedizin research is. Meanwhile, the Neuroscience Center Zurich medicine-oriented research at the university and ETH Zurich medical and biophysical processes can be observed in living magnetic resonance imaging. At the Animal Imaging to receive treatment that has been tailored precisely to his treatment. Here, engineers, scientists and doctors from ETH Zurich, UZH and several hospitals work together with the goal of developing better technologies for actual hearts.

The competence centers and networks of HMZ also enjoy an important status, especially with regard to long-term developments. “The competence centers and networks are designed to arrange and position the two universities optimal- mally with each other so that an actual collaboration results in the end,” explains Schütt.

Centres for topics of the future

A prime example of the strategic orientation towards the strengths of the participating institutions is the EXCITE Zurich (EXperimental & Clinical Imaging Technologies) competence centre, which was launched under the umbrella of HMZ (see article on p. 18 f.) and pools expertise to develop imaging techniques. Biomedical imaging can look back on a long tradition in Zurich. As the first joint institute between the university and ETH Zurich, the Institute for Biomedical Engineering (IBT) has a history of over 40 years and keeps setting new benchmarks in clinical magnetic resonance imaging. At the Animal Imaging Center, which belongs to both universities, complex biomedical and biophysical processes can be observed in living organisms. One example of a completely new focus area in Zurich, however, is personalised medicine. With the new competence centre, an official green light was given to this future topic this year. It should one day help every patient to receive treatment that has been tailored precisely to his or her individual genetic background.

Longer-established competence centres and networks of medicine-oriented research at the university and ETH Zurich have also joined HMZ, such as the Cancer Network, with around 60 research groups, or the Infection and Immunity Zurich network (see article on p. 28 f.), where 65 research groups tackle infectious diseases. Epidemics like AIDS, bird flu and Ebola just go to show how important this branch of research is. Meanwhile, the Neuroscience Center Zurich (ZNZ) also forms an official part of Hochschulmedizin Zürich. With 135 research groups, it is the largest joint competence centre of the university and ETH Zurich and is currently in the process of setting up a dementia research centre.

Campus expansion in the heart of Zurich

For the time being, the new dementia research centre will be housed on the university’s new Life Science Campus in neighbouring Schlieren, a 20-minute journey by suburban train from Zurich. While this is hardly on the other side of the world, the university, ETH Zurich and the University Hospital Zurich would prefer to capitalise more on their proximity in future and not have to drill any further towards the outskirts. The vision of a centre of university medicine right in the heart of Zurich is now to be followed up with building projects.

In September, the master plan for the intergenerational project “Berthold – The Zurich Centre for University Medicine” was presented to the public (see box). Jointly funded by the canton and city of Zurich, the University Hospital and ETH Zurich, the project aims to cement Zurich’s position as a unique centre of teaching, research and healthcare in Europe. Although the political process surrounding the construction project is not yet complete, those involved are confident: “The prerequisites for the university medicine of the future are good”, says Zurich governing councillor and health director Thomas Heiniger. There is no shortage of compelling arguments in favour of the project: ultimately, the unique proximity of the university institutions in the gravitational centre of Zurich can be exploited to create added social and economic value for everyone. The population stands to benefit from comprehensive, state-of-the-art healthcare, the students from the knowledge transfer between research, teaching and practice, and the economy from an attractive location.

Hochschulmedizin Zürich (HMZ) website: www.hochschulmedizin.ch

Zurich Centre for University Medicine

By the year 2050, a centre with up-to-date structural and operational infrastructure will be built in the vicinity of the university, the University Hospital and ETH Zurich. New buildings, parks and a traffic-free campus boulevard are planned. It will enable the university and the University Hospital to increase the area they use in the university zone by up to 40 percent compared to today.

Elegant solution for the knee

Martina Mark

A torn anterior cruciate ligament is the most common clinically relevant knee injury. Every year, more than 6,000 people are affected in Switzerland alone.

Current treatment methods, although numerous, often produce inadequate results. A new implant could provide the answer.

He doesn’t really like the sight of blood, Jess Snedeker confesses, at least not on TV. But as an orthopaedic biomechanics specialist and a profes- sor at both ETH Zurich and the Uni- versity of Zurich, he is frequently in the operating theatre with his team – watching as surgeons at Balgrist Uni- versity Hospital handle problems of the locomotor system, one of the hospital’s speciality areas. Perhaps it is because Snedeker’s lab is also lo- cated in one of the hospital buildings that he has been able to build such a good working relationship with its staff. “That’s extremely important to us”, the engineer explains, because crucial insights into developing a medical implant or instrument often come from direct observation. Take the centimetre-long, plug-like object lying on the table, for instance: it is about to be patented and then put to good use by thousands of knees follow- ing operations on torn cruciate ligaments.

Painful bone saws

There are a variety of methods to treat torn cruciate ligaments. Usually, the body’s own tendons are transplanted, but not all tendons are equally suitable for this purpose. And it is important to attach them securely to the bone – with screws, for example – so that they can withstand the tremendous forces exerted on the knee. Patients commonly face the problem of the graft loosening in the first few weeks after surgery because it doesn’t im- plant quickly enough. In this case, the knee has not been stabilised suffi- ciently despite the surgery. The most successful method to date involves replacing the torn liga- ment with a graft from the patellar tendon, as surgeons can remove the latter together with pieces of bone at- tached at both ends. Using these bone plugs, they fix the tendon to its new location via holes pre-drilled into the bone. The bone plugs grow in rapidly and stably. The drawback of this tech- nique, however, is that it is very painful to saw out the bone plugs from their original location, and the sites where they have been removed remain painful long after the opera- tion.

Promising bone substitute

Snedeker and his team have now developed a graft that replaces bone plugs and screws with an anchor that is partly composed of synthetic bone material. It is inserted in the same way as a bone plug. Thanks to the syn- thetic bone material, the anchor grows into the bone just as quickly as an organic bone plug. This allows the tendons to grow into the bone very effectively without actually having to remove any bone plugs. “This means we can spare the patients a lot of pain”, says Snedeker. Moreover, the method saves on the amount of time spent in the operating theatre and so also saves money – an important factor, especially from the perspective of the insurance companies.

One of the challenges of this develop- ment project consisted in combin- ing the chalky synthetic bone mate- rial with a more stable material so that it wouldn’t crumble, even when subjected to a lot of stress. The shape also needed to be ergonomic in order to make it as straightforward and intuit- ive as possible for surgeons to use. As Snedeker explains, developing an implant like this might have been possible even if his team weren’t directly affiliated with a hospital, but “the sur- geons are our best critics. If they find our instruments useful, we can ven- ture onto the market with confidence.”

The new implant is due to be launched on the market in autumn 2015. Snedeker’s colleague Xiang Li is currently in the process of founding a spin-off, ZuriMED. Both Li and Sneed- eker are optimistic about the market prospects: “We expect to sell around 20,000 implants in five years.” This nascent spin-off has gotten advice from the University of Zurich’s tech- nology transfer office and ETH Zurich’s iLab, which brings together talented young entrepreneurs from ETH Zurich, experienced figures from the business world and alliance partners in industry. “We are especially looking for Swiss industrial partners for the production side of things”, says Snedeker. With such a standout project, the chances look good.

Laboratory for Orthopaedic Biomechanics: www.biomech.ethz.ch/research/ snedeker_group
A heart transplant is the only treatment for end-stage heart failure, but donor hearts are in short supply. Artificial hearts suitable for long-term use could present an alternative – and this is precisely what heart specialist Volkmar Falk is working on in the Zurich Heart project, together with Edoardo Mazza and Dimos Poulikakos from ETH Zurich.

Professor Falk, how many of your patients are currently living with an artificial heart?

**Volkmar Falk:** I have just taken over a hospital in Berlin that runs one of the world’s largest programmes with heart assist devices. We currently have 40 in-patients with one of these systems, and we fit up to 180 systems a year. Many of our patients are suffering from a serious heart condition. Basically, our choices are: an immediate heart transplant, which is rarely possible today given the shortage of organs; treatment to tide the patient over until one comes along; or even long-term treatment with an artificial heart system.

**Professor Mazza, you’re an engineer. Do you know any patients with an artificial heart?**

**Edoardo Mazza:** I’ve had some contact with patients, mainly with Professor Falk, and was taken aback by what I saw. Especially by the fact that the technology really isn’t where it should be in this field. That was a great motivation for me to join the Zurich Heart project.

**Professor Mazza, as an engineer, what brought you to the Zurich Heart project?**

**Edoardo Mazza:** I’ve been working on medical projects for some time now, especially with colleagues from the University Hospital. This project is trying to tackle issues that directly relate to our research results. The notion of long-term therapy using an artificial heart pump is so technologically relevant and a real challenge for research. So the project was a natural choice for us.

**Is it a new idea, being able to use an artificial heart for long-term treatment?**

**Falk:** It’s certainly not revolutionary. There are already commercially available mechanical circulation assistance systems that have long been in use. And this is because there aren’t enough donor hearts available, as I mentioned. The great thing about the collaboration on Zurich Heart is that ETH Zurich is the first institution taking up this subject with such impressive expertise in all of the necessary technical fields. In the past, all too often research institutions only addressed individual aspects of the problem, such as energy transfer or surface change. ETH Zurich has the prerequisites in place to develop entirely new concepts as well as to research individual aspects – and to do both at the same high level. Thanks to this expertise, we also have a unique opportunity to set ourselves apart from the companies operating in the sector.

**“We can improve a lot with the aid of intelligent sensors and algorithms.”**

**Dimos Poulikakos**

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**How does the Zurich Heart project tackle these problems?**

**Poulikakos:** From the very beginning of the project, we pursued two main issues that are also intertwined. In the thread I run, we’re trying to improve the existing systems. Problems include haemolysis and thrombosis; we do not really understand the interaction between blood, tissue and the surfaces of the implanted devices, nor the haemodynamics involved. There is barely any reasonably adaptive control systems engineering between the pump and the patient, either. We could make considerable improvements here with the aid of intelligent sensors and control systems algorithms. And there’s the problem of the power supply: we’re looking into whether we can find a wireless solution.

**Mazza:** In parallel, we considered whether we could actually adopt a very different approach and create something completely new. We call this strand of research “alternative systems”, where we examine whether we could actually work with completely different materials than before. The soft, biomimetic pump we have in mind should approximate the body’s own materials and adapt better to the proportions of the human body, for instance. In other words, we are researching the possibility of “soft machines”. This line of inquiry is highly relevant for modern mechanical engineering. It’s a project with many new questions, for which we also need fundamental research.

**How do the different lines of research relate to each other?**

**Mazza:** All the optimisations that Mr Poulikakos mentioned – drive engineering, control systems engineering, sensors – we can also use them very effectively in a soft pump. We also share experimental set-ups and approaches right up to planning the lab and animal tests.

**Professor Falk, did you plan on doing something completely new right from the beginning?**
Falk: What we see in front of us in the hospital is actually quite shocking: the technology sometimes comes from the 1960s. So we started out by approaching the issue defensively, with the idea of improving the existing technological platform first. But then, in the highly stimulating intellectual atmosphere that ETH Zurich offers, I found partners who think very creatively and don’t immediately bow to conventions. Since then, we’ve developed a prototype for a petrol-powered artificial heart and worked with electromagnetically malleable polymers. Naturally, all the doctors just shake their heads in disbelief at first: that’s just not possible. But it’s precisely this free thinking that generates innovation. Whether it ultimately gets us to our goal remains to be seen. Some ideas will wind up in a dead-end. But the exciting thing is that we can actually go down this road in the first place – with highly motivated researchers.

Did you have to find a common language before you could work together, or were you on the same page from the word go?

Mazza: That’s a good question. The jargon within a specialist field is very efficient. But as soon as you want to be understood outside the discipline, you have to communicate in a completely different way, which takes special skills and a healthy dose of goodwill. Thanks to the tremendous motivation of all the doctors, scientists and engineers involved, however, we managed to overcome the language barriers fairly quickly.

Poulikakos: We were no strangers to working with doctors from other projects. The understanding we had with Professor Falk was outstanding from day one.

Falk: I have always worked very closely with engineers. During my time at the University Hospital Zurich I was delighted to have ETH Zurich just on the other side of the road – an institution where the expertise we wanted was right at hand.

Now you’re in Berlin, though, and ETH Zurich is no longer on your doorstep...

Falk: We already have a long joint phase behind us on the project, so we can put up with a bit of distance now. Plus, we put the project in good hands with Hochschulmedizin Zürich (University Medicine Zurich), which guarantees coordination. What’s more, in Berlin we gained a major partner with many patients and a great deal of expertise – a wealth of clinical experience that I will incorporate into the project. And we’ll continue to get more partners on board for individual issues in the future. The Zurich Heart project will keep on developing locally, nationally and internationally. The various locations are bound to be an advantage when it comes to raising competitive external funding as well.

Mazza: I can only agree. Needless to say, the close ties to the University Hospital Zurich remain important to us. Our colleagues there attend our project meetings and Professor Falk’s successor, Francesco Maisano, is enthusiastic about the project. In fact, we’re already planning other projects with him.

Are the results also brought into teaching?

Mazza: The project involves doctoral and other students who are doing projects in the field, and it confronts them with interdisciplinary issues. And we have compiled a list of lectures from various departments that we recommend to them.

“We’re hoping to find a successful approach in three years.”

Eduardo Mazza

Did you find a common language before you could work together, or were you on the same page from the word go?

Mazza: One key component of our soft pump is a so-called hybrid membrane. We’re looking for a solution as to how we can integrate an endothelium, i.e. a biological layer, into an artificial system, i.e. a machine, so that the blood flowing through it is exposed to physiologically “normal” conditions. We’re pursuing several paths. In about three years, we want to compare the different solutions in the hope of finding at least one successful approach. Once we have a suitable component, it can be used for our pump and perhaps even other fields of medicine.

The medical field is heavily regulated. How long will it be before you will actually be able to use one of these innovations on your patients, Professor Falk?

Falk: You’ve touched on a major problem there. It takes a shockingly long time before we can actually use something on our patients. Regulators are tightening approval standards for medical products almost every year. So we mustn’t be under the illusion that we’ll be presenting the Zurich heart to the media in a year or two. While we’re bound to be able to celebrate a few breakthroughs, it’s more likely that we will be providing technology to individual third-party suppliers so that it can find its way into practice as quickly as possible, such as good sensor technology. It’s important that we sustain our motivation over the long term – meaning beyond the usual doctoral cycle. And I have seen this commitment again and again in the conversations between the university and ETH Zurich, which is why I’m convinced that Zurich is one of the few places in Europe or even in the world where this might actually be possible.
What makes the HIV virus so unpredictable is its surface proteins, which change constantly and rapidly. The immune system responds quickly to the invader, and antibodies that bind specifically to HIV soon circulate in the blood. But the constant mutation of the HIV surface proteins forces the immune system to keep adapting these specific weapons. The HIV-coating proteins change very quickly, which prevents the circulating antibodies from recognising their targets and even new, adapted antibodies are soon unable to match the mutated viruses, either. It’s a race against time.

**Important jigsaw pieces**

Annette Oxenius is a professor of microbiology at ETH Zurich who has been studying HIV and other chronic viral infections for quite some time. She knows just how important the antibody response is. Because if the armies of antibodies fail to neutralise the viruses in time, then the viruses can invade cells. "HIV infects certain cells which conduct the orchestra of immune cells. If they are impaired, the entire immune response is thrown off balance", explains Oxenius. Then even harmless infections can be fatal, which is what makes an HIV infection so dangerous.

In a current study, Oxenius has teamed up with other scientists to examine the immune system’s antibody response in the event of chronic viral infections in both HIV patients and an experimental animal model. Their project, AntibodyX, has been underway for over a year. All the research teams involved contribute their own jigsaw piece to the interdisciplinary study. "It’s already quite clear that we can benefit a lot from each other" says Oxenius, taking stock.

Virologists from the University of Zurich, for instance, are studying how antibody response is triggered and sustained in HIV infection. They are working closely with infectious disease specialists from the University Hospital Zurich. Systems biologists from ETH Zurich’s Department of Biosystems Science and Engineering are also on board as key technology developers. Sat Reddy, who is also coordinating the study, is working with his team to develop new methods to enable research on the evolution of the antibody repertoire using so-called next-generation sequencing.

All the scientists involved in the project stand to benefit from this – including Oxenius’s team. Oxenius is studying the temporal development of the antibody response in mice infected with LCMV, an established model for chronic virus infections. This means that the antibody response can be examined in various phases of infection under controlled conditions. "The model enables contexts to be researched, which isn’t possible in humans", says Oxenius. Her data will represent an important supplement to the clinical aspect of the study in this area.

The findings brought to light by the AntibodyX project could make a key contribution towards the development of an HIV vaccination. For the constant mutation of the surface proteins is the main reason why there is no vaccine against the disease.

**Enriching expertise and exchange**

It is no coincidence that this interdisciplinary project brings together scientists exclusively from ETH Zurich, the University of Zurich and the University Hospital Zurich. "Zurich boasts a tremendous wealth of expertise, and traditionally there’s long been a great exchange of ideas here", Oxenius reports. But the scientists don’t just pull together on joint research projects. For the past six years, Oxenius and her colleagues have already been meeting up once a month to swap ideas in the Current Immunological Research in Zurich forum. "Master’s students are also involved so that they can get an idea of Zurich’s research scene early on and cultivate some important contacts", she stresses. Promoting young scientists is something that this professor cares about strongly, which is why she is also the co-director of the doctoral programme in microbiology and immunology at the Life Science Zurich Graduate School.

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Just over a year ago, the Infection and Immunity Zurich network was founded as part of Hochschulmedizin Zürich. "It didn’t take all that much effort. We already had strong ties as it was", reflects Oxenius. "However, forming the network enabled us to pool our strengths even more effectively and gave an even greater boost to the interaction between basic research and medicine."

What’s more, Hochschulmedizin Zürich is creating fresh financial incentives. Supporting so-called seed projects is something that Oxenius deems particularly worthwhile – these are pilot studies based on visionary ideas that can be funded for a year. The findings obtained as a result are intended to pave the way for raising further third-party funds. The prerequisite is that the projects promoted should straddle the worlds of basic research and clinical medicine. And that’s precisely where research in immunology and infectious disease is at home.
We focus on human health”, says Christian Wolfrum, an associate professor at the Department of Health and the environment. “We can’t prevent with the right diet.”

The degree has largely risen to her expectations: “During the first year, we had a few too many core subjects. But now, in the third year, I feel right at home. I’m getting to know the whole breadth of the subject and have plenty of options to choose from.” Last but not least, she also enjoys theatmosphere among the students: “The mood is relaxed and casual – probably because many of my colleagues are also doing the sports education course.”

As a sports enthusiast herself, there is no shortage of opportunities to swap experiences.

For her Master’s degree she will be specialising in molecular health sciences. She is already working as a student assistant in Wolfrum’s group one day a week as it is. “It’s my dream job: I like working in the lab and it confirms that I chose the right subject”, she says. She can also imagine continuing a career in research beyond her Master’s, be it in industry or academia: “I might well do a doctorate at some point.”

She can see why many women are interested in the degree. “Women are generally more interested in medically oriented topics, than men. For all those who don’t want to work with patients, like me, this subject is just the ticket.”

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George Rosenberg is currently the president of the student society HeS. He is also a pioneer, one of the first to tackle, such as the overaging society, how environmental factors cause diseases or how the food surplus affects nutrition and health.

Josua Dietrich also embarked on a classical engineering path at first: “I initially studied electrical engineering for four years. But I soon realised that I probably wasn’t going to spend my whole life in the profession.” Then,
when he heard about the new degree in health sciences and technology, he decided to switch. “From 2012 to 2013, alongside my degree, I worked for a medical engineering company that was developing a new device for blood-group tests. I found the boundary where biologists and engineers collaborate very exciting.” Dietrich is also involved in the HeaT student society while studying for his degree. For him, molecular health sciences offer the most exciting specialisation: “I’m interested in nutritional issues and would like to find out more about what different foods trigger in the body.” Which metabolic processes lead to the optimum physical condition for a particular activity? How do the substances in spices such as turmeric create their anti-inflammatory effect? And how can food ingredients activate healing processes in the body? These are the kinds of questions Dietrich is interested in. His favourite subject is tooth regeneration. As there is no professor at ETH Zurich who deals with this topic, however, he is currently considering whether he should switch to another university for his Master’s.

“One question that keeps cropping up is what I will actually do with this degree afterwards”, he says, since the occupational profile indeed is not as clear-cut for the new degree programme as for electrical engineering, for example. “Nonetheless, I believe that the degree will open many doors, whether it be in industry, pharmaceuticals, healthcare or – coupled with a teaching qualification – even education.” He sees his future more as a consultant: “I’d like to help people strike a decent work-life balance – in part by showing them how to maintain a healthy diet.”

Information on the degree in health sciences and technology:
www.hst.ethz.ch
A microchip that catches the eye

Giovanni Salvatore is researching the next generation of wearable computers at the Wearable Computing Lab. Not only might these soon be incorporated into our clothing, they could also revolutionise contact lenses and implants. Salvatore will be showcasing his results at the renowned AAAS Conference in California next February.

As they become increasingly common in our daily lives, “wearable computers” are no longer the stuff of science fiction: this year, Google launched a pair of glasses on the market with a built-in computer screen that is supposed to provide an augmented reality. And wristbands and watches that tell wearers all about their fitness and health are becoming increasingly popular. Many technology groups have discovered a lucrative market for wearables and are investing in the corresponding technology. According to Business Insider magazine, the commercial value of wearables already amounts to 5 million US dollars and could balloon to 12 million by 2018. Consumers seem thrilled by the new possibilities that sensor-fitted wristbands and glasses can offer.

Ultrathin, flexible electronics Giovanni Salvatore, a postdoc at ETH Zurich’s Wearable Computing Lab, is already researching the next generation of wearables – including intelligent contact lenses and implants. Before joining ETH Zurich as a postdoc in 2011, he studied micro- and nano-electronics in Italy, France and Switzerland, wrote his Master’s thesis at MIT’s Research Laboratory of Electronics in Boston and obtained a doctorate at EPFL in Lausanne. In Professor Gerhard Tröster’s group, Salvatore found the perfect environment to pursue his fascination with ultrathin, flexible electronics. The lab has a reputation for unusual inventions, including waterproof and bendable microchips that are no bigger than a grain of sand and could one day be woven directly into clothing during the production phase. Depending on the microchip and the sensors integrated in it, such textiles can gauge the wearer’s movements, temperature and circulation.

The researchers at the Wearable Computing Lab are united by a common mission: computers should get closer to people in future – and they should be so small, flexible and soft that the wearer no longer notices them. For this to work, however, the transistors, effectively the nerve cells of these computers, need to become even thinner, even faster and even more wearable.

Consequently, Salvatore is on the lookout for materials that are suited to developing tiny high-performance transistors. Normally, silicon is used as a semiconductor for such transistors. But because Tröster’s group works with temperature-sensitive plastic substrates as carriers for electronics, Salvatore had to look for an alternative. Then he stumbled across the material molybdenum disulphide, which has similar properties to the miracle material graphene: it can be processed as an ultrathin sheet, no thicker than half a nanometre, yet still remains very flexible.

At the same time, Salvatore’s team worked on making even thinner carriers upon which these transistors and sensors will eventually be mounted. They did this using parafyn, a chemically stable, biocompatible and transparent polymer which can be produced in sheets no thicker than one thousandth of a millimetre – that’s 50 times thinner than a hair.

On course for smart contact lenses

The result is a thin transistor in the form of an extremely bendable film. It can be pulled over virtually anything, including biological materials like skin or plant leaves. The researchers tested both before publishing their research results in Nature Communications at the beginning of the year. They were even able to demonstrate that the film can be rolled around a human hair with a radius of approxi- mately 50 micrometres without damaging the electronics on board.

Salvatore envisages an initial practical application for the transistor film in “smart” contact lenses that gauge eye pressure – a valuable early indication of glaucoma, a disease which can cause total blindness. The idea of using sensors on a contact lens to measure eye pressure is nothing new. The EPFL spin-off Sensimed has already done clinical tests for ophthalmologists on a similar system, though theirs is based upon a conventional, inflexible silicon chip that is attached to the lens. “Our film would have the advantage of being thinner, lighter and completely transparent”, says Salvatore. “Which would make it a lot more comfortable for the patient. However, certain issues still need to be addressed before such thin-film transistors can be used in contact lenses – or, taking things one step further, in medical implants. There is the question of how these mini-transis- tors should be powered, for example. “The prerequisite for broadening the use of such systems is for them to work wirelessly”, says Salvatore.

Medical and social challenges

Power could be supplied via electromagnetic waves that would be transmitted to the transistors from a smartphone by way of near field communication (NFC), for instance. Another option would be to siphon off the energy straight from the human body. For example, the electronic sensors in the lenses could be powered by fine temperature differences in the eye – or by the opening and closing of the eyelids. “We’re talking about minimal energy flows here, of course”, says Salvatore. “So we’re trying to design our transistors as efficiently as we possibly can by using suitable materials.”

There is at present a huge interest in wearable mini-computers, thin-film transistors and the fusion of humans and technology. Salvatore will be presenting his results at the annual conference of the American Association for the Advancement of Science (AAAS) in San José, California, in February. The AAAS publishes the renowned journal Science. The confer- ence is also geared towards experts from different disciplines as well as engineers. Salvatore sees it as a major opportunity. For the latest generation of wearable computers doesn’t just pose technical questions, but also a health, medical and social issue. What’s the situation with the biocompatibility of these materials, for instance – especially if they are supposed to be in contact with human tissue for longer periods of time? How much health data generated by microchips do wearers want to disclose about themselves? And how can we prevent this from being abused? “Our society will inevitably have to tackle such questions in the future”, Salvatore is convinced.

Giovanni Salvatore at the Wearable Computing Lab: www.if.ee.ethz.ch/people/gsalvato →
 ETH Zurich Executive Board

Passing the baton

Roland Bautmann and Constanze Möller

After seven years at the helm, Ralph Eichler is handing over the presidency of ETH Zurich to Lino Guzzella. And Roland Siegwart is to step down from the Executive Board at the end of the year. With Sarah Springman and Detlef Günther, the Executive Board of ETH Zurich also welcomes two new faces to its ranks.

When Ralph Eichler was elected president of ETH Zurich seven years ago, it was an unstated and politically turbulent time. Six months earlier, Ernst Hafen had resigned from the position, citing irreconcilable differences with the professorial staff. It was actually a completely fresh start, because ETH Zurich did not just gain a new president in September 2007. Peter Chen took over as vice president of research and corporate relations; Heidi Wunderli-Allenspach became the first woman on the Executive Board in the history of ETH Zurich when she was appointed as the new rector; and Gerhard Schmitt ensured continuity in his role as head of planning and logistics.

“Teamwork to keep the university in shape to face the challenges of the future”, is how Eichler defined his goal. The new president was far more interested in calmly moving ETH Zurich forwards with his team than staging a major revolution. Nonetheless, he had to cope with two large-scale building sites straight off the bat: the ETH Department of Biosystems Science and Engineering (D-BSE) in Basel, which was founded the year he assumed office, was experiencing teething problems; and there were management issues at the Swiss National Supercomputing Centre (CSCS) in Manno. However, he was up to the challenge and today these two units outside Zurich are key performers for ETH Zurich.

Thanks to his striking integrity, the president soon gained the trust of the professorial staff, not to mention the other members of ETH Zurich. This enabled him to develop the university organisationally – a particular challenge in an institution that is characterised by a distinctly bottom-up approach.

Poised for the future

Five years after taking office, Eichler opened two new departments: the Department of Health Sciences and Technology (D-HEST), which focuses on preserving and improving quality of life into old age; and the Department of Environmental Systems Science (D-USYS), which grew from the amalgamation of the agricultural and environmental science disciplines and devotes itself to the sustainable development of a world worth living in for future generations.

The president also implemented some organisational changes within the Executive Board. When Schmitt stepped down from the Executive Board after a year as vice president of planning and logistics, his portfolio was re-shuffled and Roman Boutellier appointed as vice president of human resources and infrastructure. At the same time, the Executive Board upgraded the position of CFO: Robert Perich took over as vice president of finances and controlling ever since.

As one of his main priorities was to boost entrepreneurial spirit at ETH Zurich, he introduced the Pioneer Fellowships in conjunction with the ETH Zurich Foundation. These help talented young researchers to translate results of their research into new products and companies, and to establish their own start-ups.

Boutellier, ETH Zurich was also able to considerably expand its scope in real estate planning and opened the new LEE building right in the heart of the city this October. Perich introduced an integral financial and resource management system geared entirely to ETH Zurich’s teaching, research and infrastructure needs.

Schmitt was appointed as senior vice president for ETH Global and quickly established the Singapore-ETH Centre for Global Environmental Sustainability (SEC) at ETH Zurich to further strengthen the existing research location in Singapore in 2010. So far, over 100 researchers from ETH Zurich have been involved in the Future Cities Laboratory project; a second project, Future Resilient Systems, has just been launched.

Novel collaborations

In his role as vice president of research and corporate relations, Peter Chen soon set strategic processes in motion and took the university’s contact with industry to new levels. One shining example is the public-private partnership he established with IBM Research in Zurich. In 2011 the two partners opened the Binnig and Rohrer Nanotechnology Center in Rüschlikon, where three research groups from ETH Zurich not only share infrastructure with IBM research teams, but also pursue joint projects.

It came as a great blow when Chen resigned two years before the nanocentre was inaugurated. In 2009 an expert commission appointed at his request confirmed his suspicion that a member of his research group had published manipulated results; the external commission cleared Chen himself of any misconduct.

Roland Siegwart stepped into his shoes as head of research and continued to strengthen relations with industry. As one of his main priorities was to boost entrepreneurial spirit at ETH Zurich, he introduced the Pioneer Fellowships in conjunction with the ETH Zurich Foundation. These help talented young researchers to translate results...
The newly elected members of the Executive Board

**The new president:** Lino Guzzella

Lino Guzzella, rector of ETH Zurich since 2012, is Ralph Eichler’s successor. As president of ETH Zurich he will bear legal and political responsibility for the university from January 2015. He prepares the appointment of professors, decides on the allocation of research funds and supervises the management of the Executive Board. His core duties also include representing the rest of the Executive Board. His core duties also include representing the university in his dealings with government authorities, political bodies and the general public.

Born in Zurich in 1956, Guzzella studied mechanical engineering at ETH Zurich in what is now the Department of Mechanical and Process Engineering, where he has been a professor of thermodynamics since 1999. Before eventually deciding on an academic career, he spent several years in industry.

**The new rector:** Sarah Springman

Sarah Springman succeeds Lino Guzzella as rector. After Heidi Wunderli-Allenspach, she is the second woman to hold this position. As rector, Springman will be the Executive Board member in charge of the teaching portfolio. The rector is responsible for admission to courses at all levels and organising and managing study-related matters, including the examination process. She is also responsible for collaboration with secondary schools.

Springman was born in London in 1956 and studied engineering at the University of Cambridge. She spent five years working as an engineer on various geotechnical projects in England, Fiji and Australia before resuming her academic career. She has been a full professor of geotechnics at ETH Zurich since 1997.

**The new vice president of research and corporate relations:** Detlef Günther

As Roland Siegwart’s successor on the Executive Board, Detlef Günther will be responsible for strategic research supervision and funding as well as the transfer of technology, with a view to enabling ETH Zurich’s research results to find their applications. He will be in charge of collaboration with industry and represent the Executive Board on research policy committees.

Günther’s appointment brings a chemist to the Executive Board. A 51-year-old German national, he took his first degrees and his doctorate at the Martin Luther University of Halle-Wittenberg. He embarked on his career at ETH Zurich in 1995 in the Department of Chemistry three years later. He has been a full professor for trace element and micro analysis at the Laboratory of Inorganic Chemistry since 2008. He was head of the Department of Chemistry and Applied Biosciences from 2010 to 2012.

from Master’s and doctoral theses into innovative products and marketable services. The Innovation and Entrepreneurship Lab, launched in 2012 on his initiative, takes it one step further. In the two lab incubators, entrepreneurs-to-be receive coaching and advice from successful role models.

**Eighteen new degree courses**

“Consolidate” was the new rector’s motto in 2007. In the aftermath of the Bologna reform, all degree courses had to be revised. Under Heidi Wunderli-Allenspach, ETH Zurich diversified its course offerings, developed cross-departmental courses and increased students’ freedom of choice. In all, 18 new degree courses have been created in the last seven years, the pinnacle being the introduction of the new degree in health sciences and technology, for which 170 students instantly enrolled – over half of whom were women.

The rector pooled the consulting services for existing and prospective students to form the Student Orientation and Coaching unit. And she initiated the Educational Development and Technology unit to help lecturers develop innovative courses.

Upon her retirement in 2012, Wunderli-Allenspach handed over a well-oiled setup to her successor, Lino Guzzella, who continued to reinforce the significance of teaching within ETH Zurich. Together with his team, he increased the quality of teaching even further with the aim of giving graduates of ETH Zurich the tools to take on responsibility in industry and society.

**Friends of ETH Zurich**

ETH graduates become alumni, many carve out a career, and some would like to give something back to their alma mater. Eichler has fostered a trusting relationship with alumni, but also with other decision-makers in industry. He has constantly widened ETH Zurich’s circle of friends, which has also manifested itself in an increase in donations to the ETH Zurich Foundation. And a big dream of his came true when, thanks to two generous donations, he was able to open the ETH Institute of Theoretical Studies (ETH-ITS) last year, which invites top scientists from all over the world to take up research placements at ETH Zurich.

**Long-term impact**

“Progress in science is made in small steps”, wrote Eichler in his foreword to the 2012 annual report. Consequently, his decisions will resonate for a long time to come. One thing is already clear; however: ETH Zurich has attracted an enormous amount of competitive funding in recent years. In the case of the Advanced Grants, for instance, which the European Research Council (ERC) uses to support projects by established researchers, ETH Zurich is keeping pace with the universities of Oxford and Cambridge at the top. ETH Zurich has become more attractive as an educational institution. Whereas around 800 external students applied for a place on Master’s programmes in 2007, some 2,500 Bachelor’s graduates from other universities wanted to tackle a Master’s at ETH Zurich last year. Finally, the university rankings also indicate that ETH Zurich is on the right track, with the university constantly climbing the tables in both research and teaching.

Three new members, including one woman, now take over the reins for research, teaching and the presidency. The new team inherits an excellently positioned institution from Ralph Eichler and can channel all their energy into carrying ETH Zurich further forwards at the service of society.
Health talk

Innovation to control exploding costs

What contribution can research make towards sustainable healthcare? The ETH Zurich Health Talk tackled this question on 1 October, as part of the Hochschulmedizin Zürich (University Medicine Zurich) medical network. Not only did researchers present new results, they also engaged in lively debate. At the Challenger Forum, for instance, ETH professors Markus Rudin, Robert Riener, Wolfgang Langhans and Annette Oxenius (from left) faced critical questions from leading figures in industry, politics, associations and administration.

ETH Day

Two new honorary doctors

At the traditional ETH Day, ETH Zurich awarded honorary doctorates to two brilliant researchers for their academic achievements: Peter J. Bickel, a professor of statistics at the University of California, Berkeley (left, next to Lino Guzzella, rector of ETH Zurich), was honoured for his outstanding contributions to various fields of statistics and for his ground-breaking work on mathematical statistics and its applications. Nick McKeown, a professor at Stanford University, received the honorary title from ETH Zurich for his pioneering work in the field of computer networks, especially his contributions to the architecture of Internet routers and software-defined networking as a promising approach for the Internet of the future. Outstanding teachers were also honoured at the event: Professor Michael Eichmair from ETH Zurich’s Department of Mathematics was presented with the Credit Suisse Award for Best Teaching for his inspiring lectures.

Alumni business events

Negotiating change

At the alumni business events not one, but two top-class CEOs explained how their companies are asserting themselves in today’s changing business climate. In her talk, Suzanne Thoma, CEO of the BKW Group, revealed how her energy company is repositioning itself on the liberalised energy market. And Susanne Ruoff, CEO of Post (pictured here with Michael Balmer, CEO of the ETH spin-off Senozon), explained how her company tackles the diverse challenges of its individual business divisions and how it benefits from strategic partnerships with innovative technology companies.

Alumni ball 2014

A glittering night at the ball

The traditional ETH Zurich Alumni Ball is held in the Dolder Grand Hotel every two years at the end of September. This year, the theme of the evening was “Autumn leaves”. After a welcome drink on the hotel patio followed by dinner, the guests got caught up in the festive ambience and celebrated well into the night. A professional band provided the dance music, and an ensemble featuring the managing director of the ETH Zurich Foundation, Donald Tillman, on saxophone also provided musical entertainment. Anyone who fancied a break from dancing could try their luck at the casino gaming tables or relax in the cozy lounge.

Seismological Service

Earthquakes in Switzerland

For a hundred years, the Swiss Seismological Service (SED) at ETH Zurich has been the official government office responsible for earthquake monitoring. To mark this anniversary, the SED has been showcasing its activities to the general public in a series of campaigns, including an open day and the attractive special exhibition unforeSeeable at the focusTerra earth science museum. This exhibition not only offered interested visitors exciting insights into the SED’s multifaceted work with earthquakes – the natural hazard that poses the greatest damage potential in Switzerland – it also traced the country’s earthquake history.

No. 4, December 2014
The reason why he is so busy: “Avaloq is right at the heart of an industry that has changed radically since the financial crisis.” In the medium term, the near-collapse of the financial system in 2008 actually turned out to be a unique opportunity: “It’s a bit like the aftermath of the crisis in the Swiss watch industry,” explains the Avaloq CEO. “We need to completely reinvent banking – and Avaloq is in the eye of the hurricane.” Fernandez goes on to mention Swatch boss Nicolas Hayek several times during the interview. They both hail from successful immigrant families (Fernandez’s parents originally came from Spain to work in Switzerland). And they also share a passionate entrepreneurial spirit with the ambition of revolutionising an entire industry.

Avaloq’s current success still feeds off an insight which the fresh ETH graduate gained at BZ Bank back in the early 1990s. He had just completed his degree and got talking to representatives of the bank at a contact event: “They were looking for 20 computer scientists for a banking team of 15 people. I thought that was quite interesting.” Fernandez began to write financial mathematics programs for pricing derivatives. Three years later, he embarked on a project that would change his life: the quest to find a suitable IT processing system that could cope with the bank’s increasing IT demands. An international best-practice search left him disillusioned: “Back then, over 90 per cent of banks

The first thing I want to know during our conversation is what a typical working day looks like for a CEO whose turnover and workforce have quadrupled in the last six years—and who today is in charge of 1,600 employees in 20 countries. Fernandez lays a print-out from his diary on the table. There are 13 meetings scheduled for today: to discuss personnel development, corporate strategy, marketing, research and development. He probably won’t be home until after midnight again—like last night. “When Avaloq was founded, I assured my wife that it would only be like this in the early days. That was almost 20 years ago”, he says.

“I knew immediately: there had to be a better way.”

Francisco Fernandez
were building their own software – unsophisticated individual solutions with terrible software architectures." What he saw there had nothing to do with what he had learnt at ETH Zurich. "I knew immediately: there had to be a better way, and there was a tremendous amount of market potential." After a management buy-out of B2 Informatik in 1991, Fernandez became an entrepreneur virtually overnight. Between 1994 and 1997, his four-strong team developed an initial software solution for the Swiss banking industry. In 2001 the company changed its name to Avaloq and from 2005 onwards expanded on the international market with a branch apiece in Luxembourg and Singapore. Then the financial crisis hit.

After many banks all but crashed, banking became more labour-intensive and expensive; margins shrank. The new regulations meant a lot of work, while client requirements continued to increase. This suited Avaloq’s offering perfectly: ever since, the automation and standardisation of business processes have been vital for survival rather than just a good option. The Avaloq Banking Suite is in use at 150 banks. Over 3 billion Swiss francs are handled in 1991, Fernandez became an entrepreneur virtually overnight. Between 1994 and 1997, his four-strong team developed an initial software solution for the Swiss banking industry. In 2001 the company changed its name to Avaloq and from 2005 onwards expanded on the international market with a branch apiece in Luxembourg and Singapore. Then the financial crisis hit.

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Between abstraction and application

Felix Wüsten

The Seminar for Statistics held a symposium in November to mark its 50th anniversary. Today, the seminar’s four chairs cover a broad range of topics and perform key teaching tasks outside the Department of Mathematics.

From experimental physics, engineering and environmental sciences to biology, medical engineering, and the social sciences: these days, almost every field of study at ETH Zurich needs statistics. Which makes it all the more astonishing that when the Seminar for Statistics held a symposium to celebrate its anniversary last November, it had in fact “only” reached the ripe age of 50. Non-experts could well expect the field to have enjoyed a far longer tradition at ETH Zurich.

And indeed its origins can be traced back much further. As early as 1869, the great thermodynamics specialist Gustav Zeuner, a professor of technical mechanics and theoretical machine research at ETH Zurich and its former rector, published his Abhandlungen aus der Mathematischen Statistik (Essays on Mathematical Statistics). And the mathematician professor Walter Saxer, who served as rector from 1939, also examined statistical issues in his work on insurance problems. Saxer was also instrumental in establishing statistics as a subject in its own right.

In 1948, the time had come: Arthur Linder, who had held a lecturership at ETH Zurich since 1938, was appointed as an associate professor of statistics at ETH Zurich along with his Chair for Statistics at the University of Geneva. In particular, he focused on applications in biology and the agricultural sciences. However, the need to cement statistics more firmly at ETH Zurich remained. The Executive Board attempted to lure Erich Lehmann to ETH Zurich in the late 1950s –原来 he was a professor in Berkeley at the time. When he declined, the Executive Board decided to take a courageous step and gave the new chair to 30-year-old Peter Huber, who had obtained a doctorate in pure mathematics at ETH Zurich before switching to statistics. Huber had just completed a ground-breaking postdoc project at Berkeley in 1964. With his appointment that same year, ETH Zurich established its link to modern statistics – making that year the reference point for celebrating “50 Years of Statistics at ETH Zurich.”

How much abstraction is needed?

Whether statistics actually belongs to mathematics has been the subject of debate at ETH Zurich since the beginning, confirms Hans-Rudolf Künsch, a professor of statistics who retired last summer: “Statistics comes alive in its application, which is why the question keeps cropping up of how far one should venture towards abstraction.” None-
ETH Zurich's reputation is growing

Felix Wonster

As various university rankings confirm year after year, ETH Zurich stands among the top universities in the world. It owes its good performance in part to its reputation in the academic world and also among employers – which is precisely where alumni can contribute towards a positive result.

Ranked 12th in the QS World University Rankings, 13th in the Times Higher Education (THE) World University Rankings, and 19th in the Academic Ranking of World Universities from Shanghai Jiao Tong University: ETH Zurich performed well in the global university comparison again this year. In the three most important rankings, it managed to retain or even slightly improve its position from last year, underlining its position as the top university in continental Europe. Nevertheless, these slight improvements should also be taken with a pinch of salt: “At this level, it is easy to climb or drop one or two spots in the rankings. The differences among the world’s top universities are very slight in the areas that these indicators measure”, says Urs Hugentobler from ETH Zurich’s Controlling department.

Reflecting on your strengths

Hugentobler regularly deals with the various rankings in his work, evaluating them in detail based on their individual indicators. Switzerland’s higher education policy does not attach too much importance to the rankings, which he sees as a good approach: “It would be a mistake to tie university funding to these rankings, for instance”, he says. “And it would also be problematic if ETH Zurich were to gear its strategy primarily towards improving its performance in these university comparisons.”

Despite the fact that university rankings frequently come up against criticism for relying on factors of questionable relevance, they still attract attention within ETH Zurich. For one thing, positive results help to sell the “ETH Zurich” brand internationally and to position the university as a leading research and educational institution. And rankings are also helpful for self-reflection: “For us, it is always interesting to see how the ratings have changed for the various assessment criteria. The rankings are a bit like an early-warning system, showing us where we might want to ask questions to improve ourselves”, explains Hugentobler.

Eye-opening details

The rankings clearly show, for example, that ETH Zurich cannot match the student-faculty ratios of the top private-funded universities in the US and the UK. By the same token, however, they also reveal that ETH Zurich ranks right up there with the most international universities in the world.

While the detailed breakdown by subject also provides important tips, the results in a particular field shouldn’t simply be attributed to the department with the same name. The fact that ETH Zurich does so well in chemistry is not only down to the Department of Chemistry and Applied Biosciences, but also to chairs from other departments that publish in journals under the rubric of “chemistry”. Incidentally, this is precisely where alumni can make a key contribution to boosting the university’s renown: by having their employers take part in the survey, for instance. “The authors of the rankings primarily base their surveys on companies that recruit internationally”, explains Hugentobler. “This makes the support of alumni abroad especially useful for ETH Zurich.”

High concentration of top universities

In this respect, it is striking that it is not just ETH Zurich that performs well in the global rankings, but several other Swiss universities as well. In the THE Rankings, for instance, ETH Zurich is joined by EPFL and the universities of Zurich, Bern, Basel, Lausanne and Geneva to make seven Swiss universities in the top 150 universities in the world. The authors of the THE Rankings also find this high concentration of leading universities exceptional. They even think ETH Zurich may one day succeed in breaking the stronghold of American and British universities at the top. However, they also point out that the Swiss universities’ good performance is by no means guaranteed. The ranking authors particularly regard the looming isolation of the country within Europe as a serious threat to Switzerland’s current success as a hub for higher education. ■
Alumni events

Whisky seminar
An exciting introduction to the fascinating world of Scottish whisky production.
28 and 29 January 2015
ETH Zurich Zentrum, Alumni Pavilion

Innovation
Panel discussion as part of the "HSG meets ETH" series
12 March 2015
Zunfthaus zur Waage, Zurich
www.alumni.ethz.ch/hsgmeetseth

Resolving conflicts
Careers seminar with Thomas Nast
21 April 2015, 8:30 a.m.–5:00 p.m.
ETH Zurich Zentrum, Alumni Pavilion

Lead, delegate, motivate
Careers seminar with Gerhard Grieb
19 May 2015, 8:30 a.m. – 5:00 p.m.
ETH Zurich Zentrum, Alumni Pavilion
Information on all alumni events:
www.alumni.ethz.ch

Exhibitions

Saurichthys
Fossilised hunters of the prehistoric seas
An exhibition in conjunction with the Paleontological Institute and Museum of the University of Zurich
5 January–1 March 2015
focusTerra, Sonneggstrasse 5, Zurich
www.focusterra.ethz.ch

Architecture and art

Theatre Objects – a Stage for Architecture and Art is the first in a series of exhibitions designed to initiate a dialogue between architecture and contemporary art. Co-organised by the LUMA Foundation and ETH Zurich’s gta Exhibitions, the show offers ETH Zurich’s renowned Department of Architecture an opportunity to enter into a dialogue with the public.

ETH events

Cyber security and safety:
Targets within reach?
3rd dialogue event of the ETH Risk Centre
Speakers: Prof. David Basin, ETH Risk Centre; Barry Pavel, Brent Scowcroft Center, Atlantic Council; Stefan Arn, UBS Wealth Management; Prof. Srdjan Capkun, ETH Zurich
16 January 2015, 10:00 a.m.–4:10 p.m.
ETH Zurich Main Building, Room E53
www.riskcenter.ethz.ch

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