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Globe

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The magazine of ETH Zurich and ETH Alumni

No. 1, March 2014

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Dear readers

Failure is one of the last things you would associate with ETH Zurich, and hardly a topic that you would expect to see in Globe. And yet failure is routine in academia. After all, behind every success story in science there is a lengthy process of trial and error.

Basic research is fraught with uncertainty. Scientists have to try out and discard many ideas until they eventually settle on one that produces a successful result. "The basis for this is a culture of failure and learning, isolated (...) from the expectations of industry and the public", as Stephan Sigrist so aptly wrote in the NZZ on Sunday, 16 February.

What sets the best minds in academic life apart is their ability not just to gauge whether an idea might lead to a new result, but also to deal psychologically with all the inevitable defeats. Knowledge of other projects that have not worked also plays a role here: those who are successful stand on the shoulders of those who have failed. And we mustn't forget that undergraduates and doctoral students also learn from research projects that have a negative outcome.

It goes without saying that discussions with colleagues are fertile ground for new ideas. These discussions are particularly fruitful if researchers with completely different scientific and cultural backgrounds bounce ideas off each other. ETH Zurich unites people from over 100 countries under one roof. It owes a great deal of its success to the fact that the most talented minds in the world are able to exchange and pursue their ideas here.

As a leading science and technology university, we need the world's top minds. Here in Switzerland, we can offer them an outstanding environment for their research. However, that is not enough in itself. If we want to attract new professors to ETH Zurich, it is just as important for us to provide prospects for the whole family. No professors are going to come to Switzerland if they have to leave their families behind, or if their partners are unable to find something suitable for them to do in Switzerland.

Only by continuing to attract the best minds to our university can we do our job: to spur on the Swiss economy with new findings in the face of stiff international competition. Switzerland's innovative strength is admired the world over. But only if the environment is right can we, as a university, help make sure that it stays that way with our daily trials and errors.

I hope you enjoy reading this perhaps rather surprising issue of Globe.

Ralph Eichler
President of ETH Zurich

Contents

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Silver with Citius

Beat Hefti and Alex Baumann clinched the silver medal with a solid performance in the two-man bobsleigh at the Olympic Games in Sochi. However, their success was not solely thanks to Hefti's driving skills, Baumann's brawn at the top and to their support team, but also to researchers from ETH Zurich: the Citius bobsleigh used by the Swiss team was actually developed by members of the Department of Materials for the Vancouver Olympics. After Switzerland came away empty-handed four years ago, however, the sleds were improved even further.

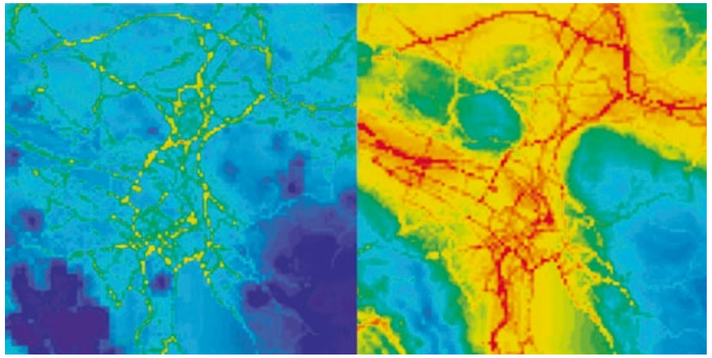
Baumann, incidentally, has just completed a Master in environmental science at ETH Zurich. He and Hefti also benefited from ETH expertise in the run-up to the Sochi Games: Christoph Glocker, a professor at the Institute of Mechanical Systems, and his doctoral student Georg Rempfler used complex calculations to recreate the Sochi track virtually so that Hefti could already spend the summer preparing for the big competition in the simulator. And as their medal-winning run on the actual course demonstrated, it certainly paid off.

Medicine

Old antibiotics back in vogue

Resistant bacteria that all antibiotics are powerless against are increasingly becoming a problem – so much so that science has turned to antibiotics from previous generations, such as the class of so-called aminoglycosides. However, they can have strong side effects. After all, they not only attack the pathogens, but sometimes human cells, too.

A team of researchers including some from ETH Zurich has now succeeded in modifying the action mechanism of these antibiotics in such a way that they can distinguish between bacterial and human cells more effectively. Tests in the lab have revealed that the modified agent barely harms human cells while the antibiotic effect on the pathogens remains intact.



There is less fine dust pollution in the spring (left) than in the winter (right).

Air quality

Sensor takes the tram

For some two years now, mobile air monitoring stations from ETH Zurich have been out and about on ten of Zurich's trams. These little boxes on the roofs of the vehicles record the proportion of ozone, carbon monoxide and fine particles in the air, thus providing data on the city's air quality. Because the sensors take a reading every five seconds on average, the researchers have managed to create pollution maps at an unprecedented resolution.

To plug the data gaps between the tram lines, the researchers developed models by combining their own measurements with other freely accessible data such as traffic volume and housing density. This yielded maps that are accurate to 100 metres.

The boxes will be criss-crossing Zurich and providing key data for another two years. The researchers hope to be able to evaluate the impact of measures such as a new bypass on air quality in the future.

Part of the new ETH Zurich building in Basel: an inner courtyard with a passageway.

Systems biology

A new home in Basel

ETH Zurich's Department of Biosystems is getting a new home. Their pentagonal teaching and research building is to be constructed on the Schällemätteli Life Sciences Campus in Basel by the year 2020, right next door to the two university hospitals and the University of Basel's Bio and Pharma Centre. The new location will bring ETH Zurich even closer to Basel's life sciences and clinical research. The "pentagon" was designed by the Munich-based architecture firm Nickl & Partner. Around 400 to 500 members of staff attached to eighteen chairs will eventually work in the new building.

ERC grants for young researchers

Four scientists from ETH Zurich have been awarded an ERC Consolidator Grant from the European Research Council. They stand to receive a total of almost CHF 9 million for their projects.

Ticker

The Sunbuddy app with sensor (right)

ETH Zurich spin-off

App against sunburn

ETH Zurich spin-off Bitsplitters has developed a system that measures UV radiation using a sensor and a Smartphone app: "Sunbuddy" registers exposure to the sun in real time. The sensor device warns the wearer about a high UV index via the Smartphone app and provides tips on protective measures. Currently available for iPhone 4S and 5. A version for Android devices is in production.

Foundations

Health commitment

Foundations under the umbrella of the ETH Zurich Foundation support ETH Zurich's health initiative. The Synapsis Foundation currently enables two outstanding doctoral students from the Neuroscience Centre to realise a special project at a leading international partner university. And the Starr International Foundation is continuing its commitment, funding research in the fields of metabolism and obesity.

Bio-inspired

Adaptable robots

A research group headed by Fumiya Iida, a professor of bio-inspired robotics, has a vision: intelligent machines that are capable of mastering complex challenges. The team demonstrated that this is theoretically possible using a robot that is able to study the temperature and elasticity of unfamiliar objects all by itself – using tools that it produces autonomously on site and in various configurations. The robot also has a camera, a mathematical algorithm andan integrated 3D printer that uses hot glue. In order to study the elasticity of an unfamiliar object, the robot manufactures hot glue rods of different thicknesses and presses them against the side of the object in question. The camera takes pictures of the rod's curvature and the software evaluates the images to determine the object's elasticity. The same robot can also gauge the temperature of various objects just as flexibly.

A fungus of the *Dictyophora* (stinkhorn) species in the rainforests of Belize

Rainforest

Fungi boost plant diversity

With up to 300 plant species per hectare, rainforests are the most biodiverse areas on Earth. An international team of researchers has discovered what keeps dominant species in check, thereby giving rarer plants a chance to thrive. Over 40 years ago, American ecologists came up with the theory that pathogens and insects keep prolific plants in the rainforest under control and prevent them from crowding out all the other plants. A team of researchers under Owen Lewis from the University of Oxford and Robert Bagchi, who completed the study at ETH Zurich, have now tested this hypothesis comprehensively for the first time on an entire plant community. In doing so, they were able to show that fungi are the driving force. Plant pathogens such as fungi spread more easily among individuals of the same species that grow close to each other, and thus cause density-dependent mortality. By limiting the number of plants from a dominant species, fungi provide equal opportunities in the plant community as less dominant species are not elbowed out.

Ticker

The ultra-thin electronic membrane adapts to different surfaces.

Thin-film technology

Keeping an eye on sensors

Researchers at ETH Zurich have developed especially thin and flexible electronic components that can even wrap themselves around a single hair. The researchers see one possible application for this novel thin-film technology in contact lenses that measure intraocular pressure, a risk factor for the development of glaucoma.

The researchers attached their thin-film transistors to contact lenses combined with strain gauge strips and studied whether the electronics could survive intact when bent on an artificial eye. Sure enough, the tests revealed that intraocular pressure could be gauged using this technology.

Spin-off year

In 2013 researchers from ETH Zurich founded 24 new companies, equalling the record set in 2009. 283 ETH-Zurich spin-offs have been launched since 1996. Last year, ETH Zurich spin-offs achieved a total of over CHF 80 million in investments.

Asbestos

New test for lung cancer

Asbestos fibres can penetrate deep into the lungs and trigger a severe form of lung cancer, mesothelioma. Using today's methods, the disease can only be diagnosed at a late stage, which makes the patient's prospects poor. An international team of researchers led by ETH Zurich scientist Bernd Wollscheid has now devised a way to detect this cancer strain early, based on a blood test. The researchers have identified six new markers that are found on the surface of the cancer cells, from where they can also enter the bloodstream. In order to be able to use the markers as a diagnostic tool, further measurements are now required on a larger number of test subjects.

The ash formations in La Garita Caldera, Colorado, developed around 25 million years ago when a supervolcano erupted.

Supervolcanoes

Explosion due to density difference

When supervolcanoes erupt, they really explode, leaving a giant hole measuring up to 100 kilometres in diameter – and not merely a cone like conventional volcanoes. They hurl ash and fragments of rock over 30 kilometres up into the atmosphere.

A team of researchers headed by ETH Zurich professor Carmen Sanchez-Valle has now identified differences in density in the magma chamber as the trigger for super-eruptions. The molten magma is less dense than the solid rock surrounding it, which creates excess pressure in the magma chamber. If this pressure is sufficient, it breaks through the crust above and initiates an eruption. The effect is comparable to the buoyancy of a ball underwater, filled with air, that is being forced upwards. The new results could help to assess supervolcanoes more effectively.

On average, supervolcanoes are active less than once every 100,000 years. The 20 known supervolcanoes include Yellowstone Caldera in the USA and Lake Taupo in New Zealand.

Report

FIRST Lab

Dust-free zone

Christine Heidemann

FIRST Lab, the cleanroom centre of ETH Zurich, is where the tiniest optical, electrical and acoustic components with dimensions of just micrometres and nanometres are developed. They are used in lasers or transistors that will make it possible to transfer large data volumes even faster in future. Research in the cleanroom calls for a great deal of preparatory work as well as skill and patience. Globe met up with two scientists and accompanied them in their work.

Down two sets of stairs. Through a cool and sterile stairwell with black doors that lead to an equally cold, cement corridor. Only a sign in the hallway directly over the entrance tells us what is hidden away here, two floors beneath the HCI building on ETH Zurich's Hönggerberg campus. The sign says: "Cleanroom centre FIRST." FIRST stands for "Frontiers in Research: Space and Time" and is ETH Zurich's cleanroom, opened officially in 2002. Silke Schön is a member of the FIRST operation team that manages the operation of the lab. This means that, together with her colleagues Yargo Bonetti and Emilio Gini, she is in charge among other things of the ongoing research projects, ensuring that users of the lab are trained and that all safety measures are observed.

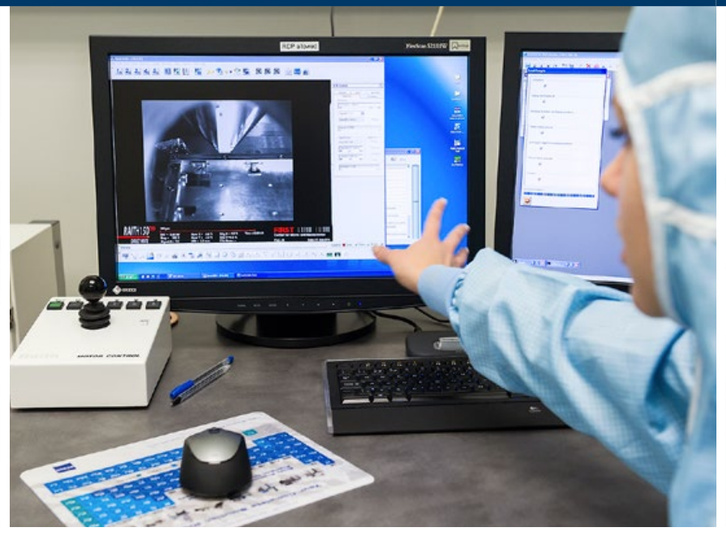
Maria Alexandrova and Pauline Simonet are regular visitors to FIRST Lab. They are two of the top 15 users of the cleanroom, and today marks another early start to their working day. We know this from the large white, magnetic board in the entrance hall. That's where all users have to attach a magnet with their names before logging in with their badge. These details let the security staff and firefighters know, even without any access to electronic information, how many people are actually in the cleanroom and thus how many would need to be saved in an emergency situation. "This is why we make sure that every researcher adds his or her tag before entering the cleanroom, and takes it away again when he or she leaves", explains Silke Schön.

Pauline Simonet is a doctoral student in the Nanophysics Group under Professor Klaus Ensslin at ETH Zurich. She works with graphene, a semiconductor that is considered a real miracle material because of its unique properties. It is used, for example, for touchscreens on smartphones and conducting paths on computer chips, as a material for batteries and solar cells or – as is the case in Professor Ensslin's group – for developing quantum systems. That's because electrons behave differently in graphene than in other semiconductors. Theoretical forecasts state that the lifecycle of their spin, or intrinsic angular momentum, should be longer. This would mean that stable qubits, miniscule units of storage in quantum mechanics, could be produced in graphene nanostructures. And that would be the first step toward controllable spin qubits in this material. Specifically, Pauline wants to find out more about the edges of the honeycomb-shaped structure of graphene. It is the make-up of these edges that changes on a nanoscale, which in turn influences electron mobility. As a result, she is manipulating the edges of graphene in a targeted manner to observe how the electrons respond.

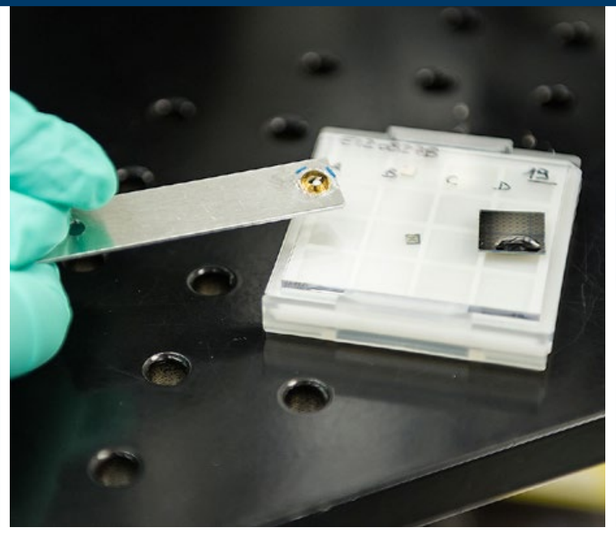
Maria Alexandrova is a doctoral student in the Millimetre-Wave Electronics Group under Professor Colombo Bolognesi at ETH Zurich. The group is known for the construction of high-speed transistors. What is different about their work is that, instead of the customary silicon or germanium, the researchers make their transistors using a combination of III-V semiconductor materials. FIRST Lab specialises in these; they are compounds comprising materials from the chemical group III, the boron group, and group V, the nitrogen phosphorus group. For example, the combinations used include indium phosphide and gallium nitride.

These semiconductor materials can be used much more flexibly than the customary silicon, for example, as they can withstand higher temperatures and resist higher electrical fields. Ultra-high performance transistors like these can greatly accelerate and improve the data transmission rate in modern broadband and glass fibre net-

You cannot do anything in a cleanroom without a protective suit. Researchers Maria Alexandrova and Pauline Simonet (from right to left) in their cleanroom suits.



Maria Alexandrova prepares a sample for the dry etching process by affixing the sample to a wafer using vacuum grease. She demonstrates how the E-beam system for electron-beam lithography is programmed. This system can be used to create structures as small as 20 to 30 nanometres in size.



The metal holder with a gold ring has on it a film of varnish on which a graphene flake rests. The graphene flake has to be transferred to the small, square-shaped wafer in the middle of the sample box. To do this, Pauline Simonet uses the micromanipulator and lowers the sample holder (on the bottom right underneath the lens in the picture) in order to bring the film of varnish with the graphene flake into contact with the structured wafer below it.

works, in electronic testing and measuring systems and in space. However, the physical properties and thus the potential of III-V materials for transistor technology have not yet been adequately researched and we do not yet know enough about them. Maria Alexandrova wants to find out more by examining different combinations of III-V materials.

Humans as a disruptive factor

For Pauline and Maria, the cleanroom is absolutely essential. This is because every particle of dust, skin or hair can contaminate the tiny microstructures and nanostructures instantly and destroy months of work. Simply walking too fast, scratching, or a notepad made from recycled paper can lead to a rapid increase in the concentration of particles. Special filters and the obligatory blue protective overalls do keep most particles at bay, and there are sensors to sound the alarm if necessary. In addition, permanent positive pressure in the eight laboratories that branch off from the main corridor of the cleanroom ensures that no particles can fly in as soon as the door is opened. Nevertheless, "Humans are the greatest challenge for the cleanroom", explains Silke Schön.

While an average of between roughly 300,000 and 400,000 particles circulate in one cubic foot of normal air, this figure should be kept below 100 at special workstations in a cleanroom. However, not all workstations are equally sensitive. Excess particle concentration is particularly critical for lithography, which is one of the central methods used in semiconductor technology. A distinction has to be made between photolithography and electron-beam lithography.

The latter is the method of choice for the tiny nanometre-sized components that Pauline and Maria work with. With the help of lithography, the researchers design their samples, giving them a certain structure by exposing them using a special lamp or an electron beam. To do this, the scientists first apply a varnish to the sample and then put a mask over it to create the right shape. The exposed parts are then dissolved or etched away. Another alternative involves plating the sample with gold in order to create an electrical contact so that electricity can flow through the components.

In principle it involves the constant removal and application of layers until the desired structure has been created, for example for Maria's transistors. "Each step in the process must be performed with extreme precision", she says. This is because the development process until the transistor is finished takes several weeks and comprises more than 100 production steps. Today is the day that the indium phosphide wafer, an ultra-thin, monocrystalline basic substrate of the transistor, is to be given its precise structure. Together with her colleagues Rickard Lövblom and Ralf Flückiger, Maria will first dry etch the wafer in plasma and then wet etch it using an acid.

Coating procedures in an ultra-high vacuum

The basis of almost every component in FIRST Lab is formed by special wafers that are created there. Specialists such as Maria's colleague Olivier Ostinelli use a process referred to as epitaxy to grow various material coatings on a wafer in an oven. They do this using either a chemical reaction, such as metalorganic chemical vapour phase deposition, or with the aid of molecular beam epitaxy, which is carried out in a gigantic stainless steel vacuum chamber that has to be permanently chilled to around –190 degrees Celsius using liquid nitrogen.

It is not until the wafers have finished growing and the structures have been applied that Maria and Pauline can start their actual work. While Maria etches the wafer, all the while checking that everything is in line with her specifications, in the opposite lab Pauline has already placed her fully grown and structured gallium arsenide wafer, measuring 3 × 3 millimetres, on the micromanipulator. The tiny graphene flake measures just 14 × 5 micrometres. Pauline harvested it earlier from graphite and "packaged" it in an ultra-thin film of water. Now the task is to use the manipulator to take the flake and move it around on the wafer until the substrate and the graphene flake lie one beneath the other in the right position, 90 nanometres apart. They have to be positioned in such a way as to let Pauline stick them together and study the behaviour of the electrons in the graphene. This is a task that requires great skill and calm nerves, as the film of water can rupture at any time and destroy the sample.

A real-life cleanroom experience

Pauline endeavours to affix the edges of the graphene flake to the substrate using tweezers. But the film of water ruptures. Pauline has to prepare a new flake, and now it works. Anyone who works in FIRST Lab needs a lot of patience and stamina. But the lab gives the young researchers a unique opportunity to try things out for themselves. "Unlike other cleanrooms, we operate a training cleanroom where students and doctoral students can operate the devices themselves after appropriate training", explains Silke Schön. This is what makes the cleanroom so appealing to young researchers, something that is reflected in the demand for it. "With currently more than 300 users every year, capacity utilisation is far higher than originally expected", says Silke Schön. Nevertheless, she would like to see even more female users coming to the lab. Maria and Pauline are two of the approximately 20 percent of FIRST Lab's female users.

But the more users the lab has, the more contamination there is. On the way out, we pass the measuring station. In the room with the electron microscopes that we just left, the bar showing the number of particles is red, meaning that the number of particles has risen to over one thousand. Still just about tolerable for this room, Silke Schön assures us as we head on our way. ■

FIRST

The FIRST cleanroom centre was officially opened on 4 July 2002. The cleanroom itself is 400 square metres in size. FIRST Lab is funded by ETH Zurich and managed by Colombo Bolognesi, the FIRST coordinator. The FIRST coordinator is appointed for a period of three years by the FIRST management team, a group comprising ten professors. He or she reports directly to the Vice President Research and Corporate Relations. The cleanroom centre is used by the Department of Information Technology and Electrical Engineering, the Department of Mechanical and Process Engineering, the Department of Materials Science and the Department of Physics at ETH Zurich, but is also available for use by other persons. Over 50 research groups and more than 300 registered users work in the cleanroom centre every year.

www.first.ethz.ch →

Failure allowed

Researchers are no strangers to failure. Some already had to face this painful experience as students. It is inevitable that scientists do not find the ideal path straight away. After all, the outcome of their experiments is not foreseeable. Instead, those succeed who draw the right conclusions from their results as quickly as possible. In fact, many achievements actually stem from mistakes or errors. Having everything go according to plan is not the be-all and end-all. He who dares wins. Failure is all part and parcel of success.

To err is valuable

For the public at large, science is mainly perceived as a success story. Inside the scientific system, too, the preferred focus is on positive findings. But the consequences are not only positive.

Martina Märki

Leo Sternbach and his research group were at the end of their tether. For years they had been searching, on behalf of the US branch of Hoffmann-La Roche, for medication that could be used to treat anxiety – without any success. In 1957 the researchers decided to abandon their experiments. But first they had to do some tidying up. The staff came upon a sample, produced two years previously but which inadvertently had not been tested. More out of a feeling of scientific duty than any concrete hope, Sternbach had the sample tested in animal experiments. And, guess what, it did have an effect. Sternbach and his team were really surprised and took a closer look at the sample. The chemical compound was very different from that of the other samples. It was probably the result of an error or an inaccuracy in synthesis which had resulted in a completely different molecule structure. The result was benzodiazepine, the basis for very successful psychopharmaceuticals like Librium and Valium.

There is any number of similar anecdotes, all following the same pattern. Be it the invention of Post-it notes (the result of an unsuccessful attempt to develop a long-lasting glue) or the random discovery of the base material for Teflon during the search for a cooling agent for refrigerators: people love to tell stories of unsuccessful experiments, mishaps and chance discoveries which nonetheless led to new developments over and over again.

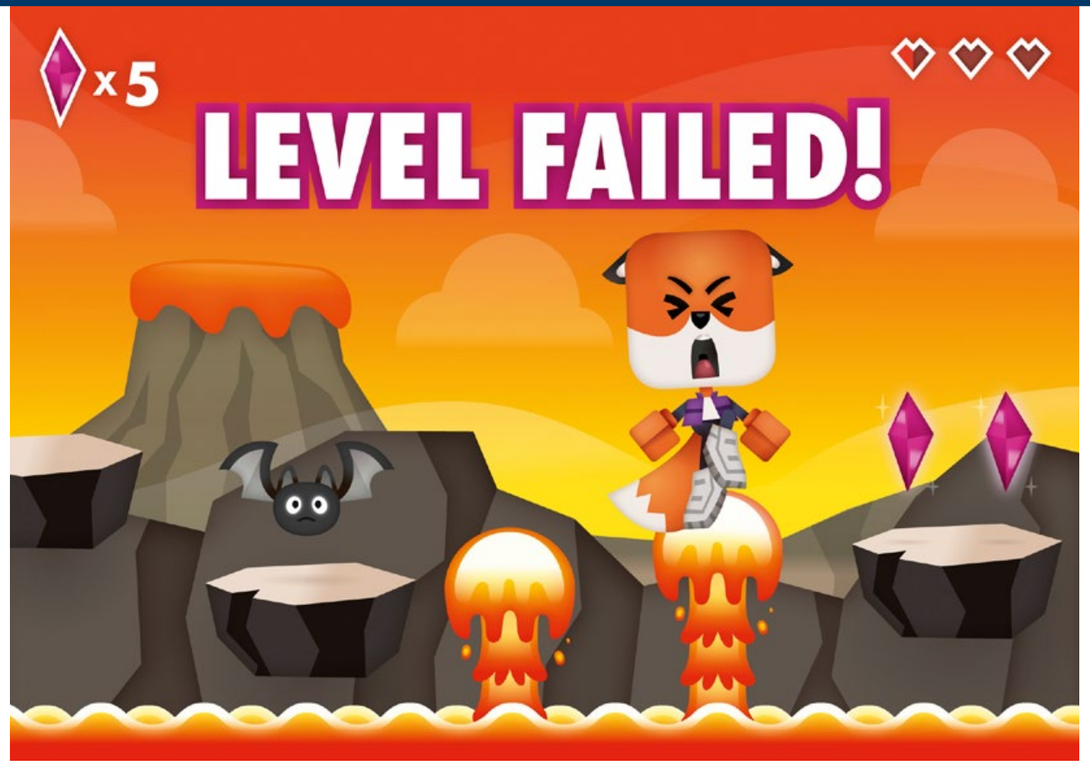
But where are the stories about all the failed and unsuccessful experiments, the errors and wrong tracks that have led to no spectacular increase in knowledge, but which are also part of everyday scientific life?

Anyone looking for them will scarcely find any. "You hardly ever read about unsuccessful research or failures. There is no room for that, no systematic location for dealing with scientific work", comments Christoph Hoffmann, lecturer and researcher in science studies at the University of Lucerne. In his recently published book "Die Arbeit der Wissenschaften" (The work of science) he writes that the image of scientific progress is overly dominant amongst scientists, too. In this context, if they admitted to failures and errors, these too would also always serve scientific progress in the end.

A famous failure

One of the most famous failed physics experiments, the Michelson-Morley experiment, is also, in the final instance, a success story, albeit for reasons other than the examples given above. At the end of the 19th century a conventional idea in classical physics was that the earth and all other elements in the universe moved in an absolute space which was filled with a mysterious medium called ether. In this medium, light waves were said to fan out like sound waves in air or waves in water.

One of the things the physicist Albert Abraham Michelson wanted his experiment to prove was the existence of ether, or of the ether wind that had to be formed when the earth ploughed its way through the ether. This idea meant that the speed of light in the direction of the earth's motion would differ from that perpendicular to it, just as the speed of a swimmer differs, whether he is swimming with the flow or perpendicular to it. Michelson conducted his experiment for the first time in Potsdam in 1881, using a sophisticated experimental set-up by means of which he was actually able to measure the speed of light with astonishing accuracy. To the great surprise of the physicist himself, however, there was no difference between the speeds. No impact of ether on the speed of light could be detected. So in his first publication, Michelson challenged the existence of the ether wind, and was heavily criticised for it by experts. That's why Michelson continued the experiment in the USA in 1887 together



with the researcher Edward Williams Morley, with even greater accuracy, but again with the same result. The scientists faithfully published their test series even though they were unable to explain them. Like their critics, they believed that inaccuracies in their measurement methods might be responsible for errors.

Since then the experiment has been repeated over and over with different techniques and increasing accuracy – always with the same zero result. The speed of light remained the same in all directions. It was Albert Einstein's theory of relativity of 1905 that explained why the speed of light is constant, and thereby rendered the idea of ether superfluous. Michelson, however, refrained from drawing the right conclusion from his experiment – that there is no ether – for the remainder of his life. Nonetheless, he was awarded the Nobel Prize in Physics in 1907 for his optical precision instruments.

Scientific deadly sin

Michelson's experiment ruffled the feathers of his fellow physicists. It was discussed, reviewed, replicated and tested for decades because the result contradicted the core theories and knowledge of the time. But what about all the projects, studies and experiments with no positive findings, which did not have the good fortune of getting right to the heart of a scientific paradigm shift, or of leading to a chance discovery? Is any note taken of them, and are they even worth taking note of?

For Wilfred van Gunsteren, Professor at the Laboratory of Physical Chemistry at ETH Zurich, the response to the second part of the question is clear. "Reports about mishaps, confirming a hypothesis or reproducing data, are of as much scientific importance as reports about successes" he stresses in his essay published in 2012 entitled "Die sieben Todsünden akademischen Handelns in der naturwissenschaftlichen Forschung" (The seven deadly sins of academic action in natural science research). This is not just "because [these reports] help others to avoid wasting time and energy on similar projects but because they are essential for scientific progress." For him, reporting only successful, positive or desired results is one of the seven deadly sins.

And this deadly sin tends to be encouraged by mechanisms in today's scientific community, as van Gunsteren observes. After all, the "basic principles of high-value qualitative research are increasingly in conflict with the pressure to succeed on scientists who compete for research funds and publication, particularly in the so-called high-impact journals."

Van Gunsteren is certainly not alone in his critical view of the current scientific system, particularly the role of high-impact scientific journals. Only recently, the freshly

selected 2013 Nobel Laureate in medicine, Randy Schekman, triggered a major response when he wrote a critical article in The Guardian calling for a break with the "tyranny of the luxury journals."

Systematic distortion

He claimed that journals such as Science, Nature and Cell were giving priority to sensational studies and were "as restrictive as fashion designers with limited edition handbags." Even worse: he says that as a consequence of the pressure to publish in these journals, scientists are being led astray and tend to embark on fashionable rather than really important research.

In January of this year, the renowned medical journal The Lancet published a remarkable series of articles which used the example of biomedical research to take a close look not only at the criticisms levelled at the world of publishing, but also at the other malaises in the current scientific world. The findings of the authors on the publication of scientific studies make you sit up and take note: for instance, only 50 percent of all health-related studies financed by the EU between 1998 and 2006 were actually published. The situation is not really any different when it comes to clinical and preclinical trials. And at least equally serious: studies with positive results are far more likely to be published than those with negative or non-significant results. Furthermore, studies with positive results are published far sooner. The reporting of trials with negative results can be delayed for several years.

However, the blame lies not only with the journals. The Lancet authors found more evidence that the scientists themselves contribute to this distortion. In some cases, they also don't think it's worth the effort to publish negative or non-significant results.

As illustrated by the numerous examples given by the Lancet authors, the consequences of this distorted publication practice are anything but harmless. It's not just that billions of invested research funds do not lead to publications which could be used by the scientific community, or that research pathways leading nowhere are neither identified nor is their funding stopped. In the field of biomedical research, the distorted state of scientific findings also has a concrete impact on costs in the healthcare system and the health of patients, whether because ineffective and expensive medicines reach the market or because risks and harmful treatment methods are not recognised. One example is the flu remedy Tamiflu. As a consequence of incomplete reports, public authorities around the world invested billions of dollars in stocks of this medicinal product to ensure they could handle flu outbreaks. After more extensive examination of the data, however, it turns out that this product is far less efficacious than stated in the published reports. And last but not least, with an improved publication practice, numerous duplications of work in research and unnecessary animal experiments could be avoided.

Hope for an open-access world

What can we do to correct the fatal mechanisms of the system? Nobel Laureate Schekman has announced that from now on he is going to boycott the major journals. The Lancet authors have put together more far-reaching proposals that are directed towards the roots of the evil. They call on institutions and investors to develop rules and incentives which promote and reward the improved and more complete publication of research findings. Moreover, they recommend investing in new forms of publication, in improved opportunities for data exchange and in the standardisation of electronic data archiving and reports. Their starting point is the idea that information and communication technologies should be better used to make data and results accessible in a simple and long-term manner for the scientific community.

Initial steps have been taken in this direction, along the lines of the open-access publications that have appeared in recent years. They are intended to guarantee free access to scientific literature. One groundbreaking example is the "Sponsoring Consortium for Open Access Publishing in Particle Physics" (SCOAP3) run by CERN, the European Laboratory for Particle Physics. Its members include representatives of Switzerland and a further 23 countries, 1,000 libraries and numerous research institutes as well as 11 major journals of high-energy physics. The SCPOAP3 Agreement, which became effective on 1 January 2014, grants everyone free access to all published articles. The new EU Framework Programme for Research and Innovation, Horizon 2020, likewise focuses on open access. In conjunction with Horizon 2020, all publications must be archived on a document server and made freely accessible.

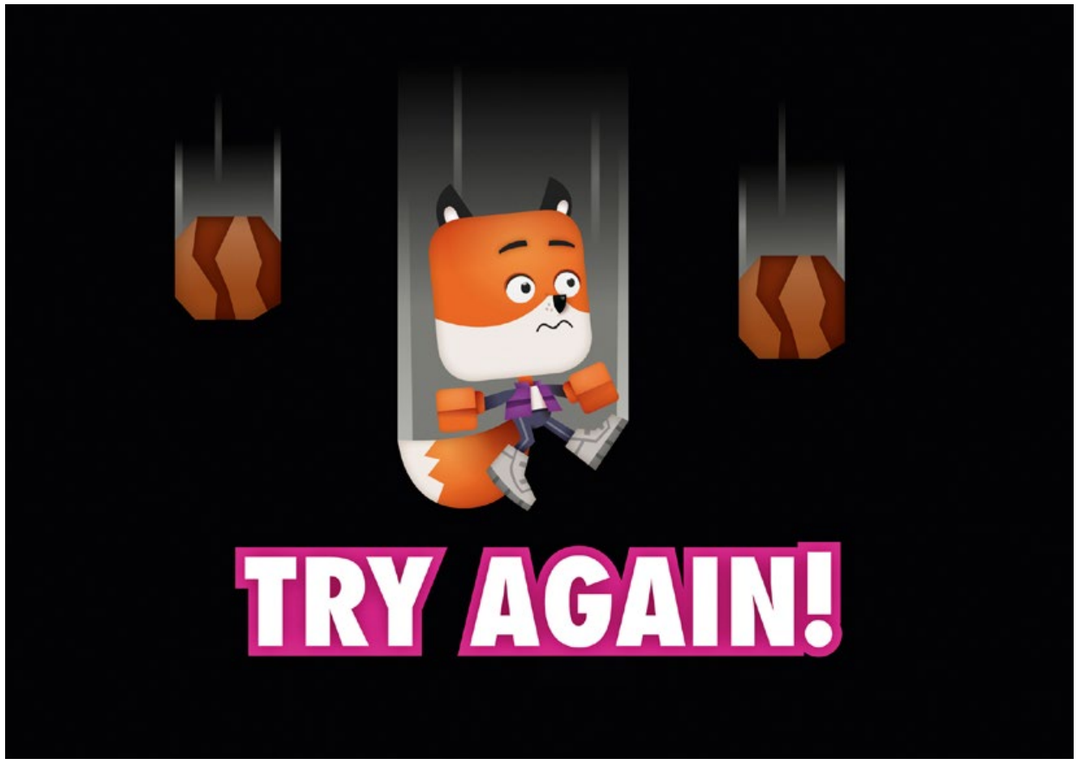
Social networks like Researchgate are another option. Researchgate, founded in Berlin in 2008, is an Internet platform on which researchers can exchange questions and publish their findings, but also post their raw data.

This platform will also be explicitly used for the publication of data on failed experiments in order to prevent errors being repeated in research. With its registered offices in Berlin and Boston, this platform seems to have hit a nerve amongst scientists. Currently, more than three million members use the platform, including the German Max Planck Society. And it's not just scientists who see the potential of the platform: in 2013 Bill Gates and other investors channelled 35 million dollars into the company.

The extent to which open-access platforms can really help solving the problem has still to be seen. At all events they contribute to the debate on new pathways for information dissemination in the science system. ■

Van Gunsteren's article:
http://onlinelibrary.wiley.com/doi/10.1002/ange.201204076/full

Fourth study of the Lancet-series
http://press.thelancet.com/research4.pdf



Smarter through failure

Behind news of success in science there is a lengthy process of trial and error. What this means in everyday life for students and researchers is discussed by Martin Vetterli, President of the National Research Council of the Swiss National Science Foundation (SNSF), Roland Siegwart, Vice President Research and Corporate Relations of ETH Zurich, and Hans Rudolf Heinimann, Prorector of Education at ETH Zurich up to the end of 2013.

Roland Baumann and Felix Würsten

Professor Vetterli, what does "failure" mean in research?

Martin Vetterli: Well, having a good idea is dependent on many other ideas that don't work and which end in failure. What research really means is that you try out several ideas that end in failure – until finally you have success at some point.

Professor Siegwart, do you agree with this?

Roland Siegwart: Absolutely. Science is supposed to create new knowledge. It's about penetrating into the unknown, and that's why failure is part of the scientific process. Failures teach us what doesn't work. As a researcher I had to learn the lesson early on that paths I'd embarked upon had to be abandoned. As head of research, I have to know how to guide young people through this experience. That is one of the main tasks of the PhD supervisor. They have to point young scientists along new paths in a timely manner to avoid them experiencing a catastrophic failure – for instance, a PhD student who still can't present any results after five years.

Hans Rudolf Heinimann: There is another aspect. At the start of a research project there is an idea, and very often people fail to find anyone willing to provide the financial backing for it. Fortunately ETH Zurich gives Professors basic funding which means they can do things which other people are sceptical about. Failure may also mean that you have to abandon a doctoral thesis. This doesn't happen very often, but it does happen sometimes. For me, these are the hard cases that also really get to me emotionally.

So failure is a part of research – but it does have a negative connotation. Isn't that slightly paradoxical?

Siegwart: Well it's not as interesting to talk about failed projects as it is to talk about successful ones. I am convinced that good scientists fail early on and quickly learn from their mistakes. Although there are naturally major differences between areas of research. As an engineer I always find it fascinating to observe how experimental physicists at CERN can spend years preparing an experiment which can then go wrong in the end – I don't know how they deal with that on a personal level. In the engineering sciences, failure is often not simply black or white. You have chosen a path, and if it's not the right path, you correct it. For us there's scarcely any path that just comes to an end.

Heinimann: Failure also has something to do with the value system of the respective era. Isaac Newton, for instance, wasn't particularly proud of the axioms for which he is so famous today. He was proud of the fact that, based on the Bible, he could calculate the age of the earth. This example shows that the respective value system has a major impact on how failure is perceived.

How does the SNSF deal with a situation in which you don't know in advance whether a project will be successful?

Vetterli: I agree with Professor Siegwart that good researchers learn quickly. It is therefore highly unlikely that a top-calibre researcher will simply continue to produce one erroneous result after another for several years. Furthermore, there is one area where negative results are very welcome, and that's mathematics. If you can show that something doesn't exist then everyone is very happy, because they can turn their attention to other problems.

There are also negative results in medical research. However, for the most part it is the positive results that are published. Isn't that problematic?

Vetterli: That's an important point. I believe it would be beneficial for the credibility of this research area if all results were registered, whether positive or negative. This is all about open access to data. What's important is that in biomedical research other scientists are given access to study results about a cohort, even if the companies that financed the studies are not in favour. I very much hope that we will be able to achieve progress on this point in the near future. On the other hand, if we were to publish all the data in journals, this would unleash a real tsunami of publications.

Siegwart: I agree. Particularly in animal experiments it is important that we have access to data, and there will be increasing pressure from the general public in this direction. In the engineering sciences it is more and more the case that results are being compared. This is seen very positively by the community.

Heinimann: There are also innovative approaches to handling negative results. A colleague of mine asked his doctoral students to include a chapter at the end of their dissertation about everything that had gone wrong. I think it is very helpful when PhD students also reflect on what didn't go well.

The question of failure is also linked to the risks you take. Are we ready in Switzerland to support high-risk research?

Heinimann: Switzerland is in a privileged situation. In an international comparison, the Swiss National Science Foundation still invests relatively little in programmatic research where the research topic is already predetermined. So to a large extent we are still free to submit the best ideas, and we have to ensure that this continues.

Participants in the interview:

Hans Rudolf Heinimann, Professor of Forestry Engineering in the Department of Environmental Systems Sciences of ETH Zurich, was Prorector of Education from August 2007 to the end of 2013.

Roland Siegwart, Professor of Autonomous Systems in the Mechanical and Process Engineering Department of ETH Zurich, has been Vice President Research and Corporate Relations since 2010.

Martin Vetterli, Professor of Communication Systems in the School of Computer and Communication Sciences of ETH Lausanne, has been President of the National Research Council of the Swiss National Science Foundation since 2013.

"Good researchers learn fast." Hans Rudolf Heinimann, Roland Siegwart and Martin Vetterli (from left to right)

Furthermore, as already mentioned, ETH Zurich offers basic funding. This gives professors the opportunity to try out something new.

Siegwart: The funding situation in Switzerland is indeed considerably better, for instance, than in the USA. But we have one problem too: established researchers find it far easier to obtain funds for risky projects because of their performance track record, but we have to start with young people. Well, perhaps they should take fewer risks than older researchers because they still have their career in front of them. But we should support them and give them the opportunity to tackle higher risk projects, too. In our internal research support we try and avoid looking primarily at what somebody has already done and more at how good the proposed idea is. This way, we would like to promote high-risk, step-out projects in a targeted manner where someone leaves the field where he feels at ease, and switches to a new area.

Vetterli: I observe again and again that scientists tend to be conservative. Although they have great freedom, many researchers don't dare move far away from what they already know. This has to do with the incentive systems in the world of academia, too. It is much simpler to do more of the same than to jump in at the deep end and try something completely new. As far as basic financing is concerned: yes, we are in a privileged situation in Switzerland. Nevertheless, researchers in the USA are more willing to take risks. In theory, Swiss researchers have many freedoms, but in reality they don't use them in the way one would expect. I am not sure what the reason for this could be.

At the SNSF do you also observe that younger researchers tend to have a hard time securing funding for risky projects?

Vetterli: Yes, we do. Young people do have a hard time securing such funding. That's why we have special support programmes for them, like SNSF Professorships. In this way we offer targeted support to young people at a critical time in their career. Another thing which is completely different in the USA: as a researcher you become a professor at a far earlier age, and then you have the necessary freedom to develop. It is the young professors who have the most innovative minds in the entire academic system.

Siegwart: Yes, we can indeed still learn something from the USA in this. The fact that we take fewer risks in Switzerland has to do with our culture. In Europe, people are simply less prepared to take risks. As I said, internally we are endeavouring to promote high-risk, step-out projects, but this isn't yet functioning as we would like. It's difficult for peers to assess these projects. This also has to do with having the courage to trust in someone else that he will take this step successfully. When someone enters a new field, then he will already make mistakes in his proposal, because he is not yet familiar with that field. And we are quick to criticise: he doesn't even know what the state of the art is, we say. And, that has to do with our culture. Actually, we should force researchers to radically switch fields every ten years and to enter a completely new domain.

So it's not the fault of the people who distribute the money that too few high-risk projects are embarked on, but rather of the researchers who are not willing to take risks?

Vetterli: In our case, as a professor you are elected to a chair for a specific area. Then you become a leading authority in this specific field. And then that person has to sit on that chair for 30 years. Even if the area decreases in importance after ten years, that person has to continue working in it for another 20 years. In the USA you are simply a professor of physics or electrical engineering. So you can adjust in the corresponding area.

> "The fact that we take fewer risks in Switzerland has to do with our culture."
>
> Roland Siegwart

Siegwart: When it comes to appointing new professors, I always try and fight the idea that you have to appoint a successor. We shouldn't select a successor for someone, but simply look for the best people in a field and bring them to ETH Zurich.

Heinimann: Yes, there is this entitlement mentality. When filling open positions I see again and again that it's not about the best ideas, but about how we can keep resources in the existing circles. How can we break out of these mechanisms and look once again for the best ideas and minds, so that it's not about a chair with a specific label?

Siegwart: You can't change a culture from one day to another. But we can create new incentives. At our universities up to now there was only one professor per field. Perhaps we are more in need of a system in which there is a certain degree of internal competition?

This brings us to how we select people. This already begins at undergraduate level, where failure is a major topic for many.

Heinimann: In my capacity as Prorector of Education

and Teaching I have seen how people fail for the most diverse reasons. Of course, for those concerned this constitutes a tremendous shock. But this is where the Swiss education system really comes into its own: it's so flexible that there's always a way of finding and completing a course of training that corresponds to a person's skills. The really difficult cases are the ones in which failure is communicated too late, where we say with hindsight that we should have stopped things earlier.

Siegwart: The Bachelor-Master system is also helpful. There are two ways you can fail. You can fail the first year exams, which means you're simply not suitable for ETH and you can look for something else. But you can also "fail" because you want to do something different. The Bachelor-Master system today makes a flexible transition possible; you can switch fields far more easily.

Gifted students in particular are supported by universities – at ETH Zurich, for instance, through the Excellence Scholarship and Opportunity Programme. Professor Heinimann, how do you ensure that the best students are in fact awarded a scholarship?

Heinimann: I was involved in this programme for some years. We adopted a similar approach to research and gradually worked out how to find the best minds. We saw that the people who made the final selection had grades which didn't tell us very much – because these students are all excellent. But we do ask all students who apply to write a proposal that outlines what scientific idea they would like to pursue within the framework of their Master. And there the differences are already very considerable. Wonderful projects have resulted from these proposals, which have even won international prizes.

We also asked ourselves what characteristics highly talented individuals possess. What we notice is that top athletes, who have the necessary academic competence, easily finished their studies despite the many other activities they were engaged in. They have something which psychologists call "high self-efficacy", and that is an important personality trait.

Do these factors also play a role after graduating?

Siegwart: My experience clearly shows that most award-winning scientists have a second mainstay apart from research. It need not necessarily be sport; it can also be music or something else entirely. This applies to industry, too. Many CEOs were active in sports in their youth. Grades are only really decisive at the beginning of a research career. As a PhD student you have to have mathematical-analytical skills, and grades don't tell you very much about that. But that alone is not enough. You also need creativity. When I choose a PhD student, then I look first at his grades because they can tell me whether some-

> "There is always a way of pursuing a course of study that corresponds to one's own abilities."
>
> Hans Rudolf Heinimann

one knows the basics about mathematics and physics. But then I also look at what projects the candidate has been involved in. Is he capable of tackling new problems and finding creative solutions? That is just as important, because science has a great deal to do with creativity too.

What role does creativity play for the SNSF?

Vetterli: Now, of course, we only look for creativity… (laughs). No, to be serious: creativity is important, but unfortunately it's the most difficult to evaluate. A successful researcher has to show not only that he can assert himself in his field, but that he is also capable of creating something new, something unexpected. To a certain extent he's like an artist.

And what is the situation for young scientists whose academic careers don't work out?

Siegwart: This varies from one field to the next. In the engineering sciences, it is easier to switch into industry. Today, careers there are also far less linear than in the past. It's more difficult, for instance, in biology where there are fewer alternatives. It's problematic if you only notice at the age of 40 or 45 that your research career is going nowhere. This has led to the demand that we should promote non-tenured staff more, which of course can't be the solution.

Heinimann: We have an effective remedy for this: assistant professorships for which the age bracket is positioned as far as possible at the beginning of a career. If things don't work out with a tenure track professorship, it is far easier for people to switch to another field when they are still young.

Vetterli: I agree. Researchers must find out as early as possible whether they're going to have a successful academic career or not. In Switzerland and in Europe it's still frequently the case that people find out too late whether they will be able to get a professorship or not. And that's not

just difficult for the people concerned, but also for Switzerland as a research location. In the USA the system is highly competitive but it is also very transparent. Scientists know very early on whether they will make it to a professorship or not.

Could we adopt this system?

Siegwart: In Europe we face a more difficult situation because each country has a different university system. If you are not a top star researcher in the USA who makes it to Harvard or MIT, then you can still go to another university.

> "Researchers must find out as early as possible whether they're going to have a successful academic career."
>
> Martin Vetterli

In Switzerland we have just two technical universities. If it doesn't work out there, then the researcher could head for Germany. But it would be almost impossible for him to go to Italy. In Europe there is no university market, no competition, and I don't think things are going to change any time soon. If we want scientists to be able to really circulate freely in Europe, then we would need a functioning university market.

Vetterli: I am slightly more optimistic. As a consequence of the Bologna Reform, mobility at Master and PhD levels has increased markedly. Eventually, these individuals will create a European university market. What makes me feel confident is the fact that even Germany has now introduced the tenure track system, and Germany is normally thought of as a very conservative country. If Germany succeeds in reforming its system, then other countries can do so, too. Of course, this all takes a huge amount of time but things are moving in the right direction. I am convinced that within one generation we will have a European university market.

To finish off, here's a personal question. Have you yourselves ever failed?

Siegwart: To be honest, it's a difficult question to answer. I have failed very frequently, but always very quickly. Fail faster, succeed sooner – that's my guiding principle. I often failed with proposed solutions but never with entire projects. I was also involved in a few spin-off companies. Some survived on the market, others failed or we had to start over. When things went wrong, we always realised this very early on, so that we never had a financial disaster.

Heinimann: Of course I failed – for instance when I was a fellow at the Collegium Helveticum. I thought I had a good idea which I wanted to tackle together with my colleagues in a multi-disciplinary approach. But that didn't work out. Inter-disciplinary cooperation is still one of the most demanding things. But this did not lead to any threat to my livelihood. I see this today as "evolutionary failure" and I believe we can learn a great deal from this fundamental principle of nature, namely that trial and error is part of it. It is important simply to learn from it. And if you fail, then it's sometimes worthwhile placing the problem on a globe, stepping back a couple of metres and then asking yourself about the real significance of it.

Vetterli: Oh yes, I failed repeatedly. I've also had experiences of start-ups. They are far harder than research. I didn't experience any major failure, but a great deal of frustration. I, too, had to accept again and again that transposing research results into the real world is a very risky game. I am soon to give a lecture in my laboratory in which I will talk about all the errors I made as a researcher so my staff can learn from this. It's going to be a very long list… ■

Dropping out is not the end of the world

ETH Zurich does not abandon its students. For almost all problems there is always a port of call, for instance an academic adviser or coach. However, the fear of failure is still considerable.

Christine Heidemann

Anyone who fails their first year examinations is confronted with the feeling of failure, in most cases for the first time in their lives. At any rate, this is the impression that many students have. For them it's a shock to their system, says Mirjam Kandler, Coach in the ETH unit "Student Orientation and Coaching" (SoC). Before going to university, most of them had ranked amongst the best in their high school and had easily passed all their exams. Then, suddenly, things don't go so smoothly, "The students suddenly question themselves and have doubts about their abilities." This is something the coach knows from numerous conversations.

The goal of the SoC staff is to support students in their choice of courses and in their first phase of study, but also during any potential reorientation – if, for example, it turns out that they made a mistake when choosing their courses, choosing to study at ETH or even choosing a university career in general.

Fewer students drop out

At present, around 30 percent of students in Switzerland drop out of their university course, according to the results of a study by the Swiss Coordination Centre for Research in Education (SKBF). According to this study, the number of student drop-outs has fallen steadily since the 1970s. The reason for this is the growing pressure of competition on the labour market. A school-leaving certificate (the "Matura") is no longer sufficient to secure a job. Women in particular are completing their studies more frequently today than in the past. Mirjam Kandler and her SoC colleagues offer various activities early on to avoid students opting for the wrong course, only to drop out later. In their travelling exhibition "ETH out and about", high school pupils can already gain an advance impression about what it means to study at ETH Zurich. To this end, ETH professors and students visit Swiss high schools, giving lectures and showing experiments from their respective disciplines. Furthermore, the SoC staff organises project weeks and study information days together with ETH departments. Anyone who is still unsure what about he or she would like to study can have the differences between the various subjects explained to them in a personal interview with a study adviser.

Speed and level too high

After registering for a course of study, the future students are invited to a "Prestudy Event" a few months before the term starts. This is where students find out what awaits them at ETH and what they should pay attention to when studying. They make contact with other future students and know to whom they can turn if they feel lonely or out of their depth.

The latter happens particularly in the first weeks at university. In most cases, freshers feel that the speed or level is too high when compared to school. Then the coaching team gives them tips, for example on how they can study more efficiently or how they can make contact with older students. In the course of university study there are several peaks when the students made more use of coaching, reports Kandler. After the initial phase, the second peak usually occurs prior to the first semester holidays, mostly just before Christmas. "The students are unsure about how to spend this time productively, how to establish a balance between studying and relaxing."

Finding alternatives

The coaches have to show a great deal of empathy when students fail their first year examinations. It's all about listening and finding out what the problem is. However, it's not about making suggestions, but about providing food for thought. For instance: what were the reasons why it didn't work out? Perhaps the wrong study method? Did the job on the side take up too much time? Turning negative emotions into positive energy is the task of the coach. And in most cases they are successful. "Many students turn this 'failure' into a wake-up call", Kandler knows. True to the motto "Now more than ever!" they pick themselves up and start again. Experience shows: years later, former students even say that failing an exam was all just part and parcel of studying at ETH.

If the second attempt to pass the first year examinations is unsuccessful, many students feel as if they have had the carpet pulled from under them. This is particularly true of the ones who don't have a plan B and who have placed all their bets on a Bachelor degree", says Kandler. In this kind of situation, the SoC coaches are important ports of call when it comes to helping and finding alternatives for the students. The student advisers offer support, particularly when the students would like to stay at ETH and switch to a different course of study. Or they help them to find a new pathway outside ETH, for instance at another university or a university of applied sciences. "For example, we advise the students to go and listen to a lecture, and refer them to the appropriate study adviser", says Kandler.

Above all, it's very important for them not to put pressure on themselves. Their path might indeed take them in a non-academic direction. Sometimes, it emerges in the course of conversation that the student from the start didn't have the right motivation for a course of study. Perhaps parents were the driving force behind a decision to go to ETH. Deciding to withdraw from the course doesn't mean that the student has failed, however. "It is important for us to put across the message that they can continue on their path successfully, even without a 'university seal of approval'", says the coach. Just how successful that can be has been demonstrated by numerous celebrities like Bill Gates, Steve Jobs, Mark Zuckerberg, Steven Spielberg or Mick Jagger, who all decided against getting a degree. ■

Student Orientation and Coaching:
www.ethz.ch/soc →

Learning from mistakes

Psychologists from ETH Zurich have been studying what prompts mistakes in hospitals and elsewhere, how they can be avoided, and what doctors and nurses can learn from them.

Christine Heidemann

The operation is in full swing. Doctors and surgical nurses are working intently; everything is going according to plan. Suddenly, the patient's oxygen saturation changes and his values start falling. Will the anaesthetist notice in time before there is any risk of complications? If not, will one of his colleagues alert him? Whatever the outcome, however, this particular patient will be fine. Because the team is working on a dummy to simulate an operation that went wrong in real life.

Unaware of the real case, the team is merely instructed to perform a particular operation. The project supervisors transferred all the data from the real patient to the dummy to create an identical situation. Will the result be the same? Will the operation fail?

Occupational and organisational psychologists Gudela Grote and Theo Wehner from ETH Zurich have supervised similar simulations professionally in several projects, and evaluated video recordings of them with the respective surgical teams. Together with the doctors and nursing staff, they are trying to find out what prompts mistakes, how they can be avoided and what we can learn from them.

Near-errors are sufficient

In the simulations, making mistakes is absolutely allowed – even if Wehner is convinced that a near-error is sufficient to learn from it – especially as "phew, that was a close one!" is regarded more positively than "I've made a mistake." After all, for Wehner making a mistake is all too often still equated with failure. "And in European culture, failure is a big no-no that has to be avoided at all costs." As a result, mistakes are only reluctantly made public – even though others might benefit from it.

Take hospitals, for instance, where mistakes are alarmingly common, as was recently revealed by a report from the scientific research institute of the AOK, one of the largest health insurance companies in Germany. It states that around 19,000 people die in Germany every year as a result of medical errors – that's five times as many as on the roads. Organisational problems, stress, the wrong drugs, infections: the list of reasons is long.

Practising on dummy patients

One fundamental reason, as the psychologists from ETH Zurich have discovered in diverse studies, is a lack of communication. Based on simulations, for instance, Grote and her colleagues were able to demonstrate that the performance of anaesthesia teams depends greatly on their ability to communicate openly with one another and constructively express doubts regarding the performance of colleagues – "speaking up", as the psychologists call it.

Around 30 teams comprising one doctor and one anaesthesia nurse participated in a study conducted at University Hospital Zurich. They were set the task of anaesthetising dummy patients for an operation and inserting a breathing

tube into the windpipe – a routine situation, in other words. As in the case mentioned at the beginning, however, the study supervisors complicated the exercise by manipulating the blood pressure, pulse or respiratory rate. Based on the video recordings, the psychologists from ETH Zurich studied how the participants had communicated, while doctors evaluated the team performance from a medical perspective. Grote's research team focused on typical hospital situations such as the following: during an operation, an anaesthesia nurse gets the impression that something is wrong or suspects that the assistant physician is making a mistake. But she doesn't voice her concerns – either because she daren't, given her position, or because she fears negative repercussions. The experts observed the same reluctance among assistant doctors towards the senior or chief physician.

Open communication helps

However, one thing is clear from the studies: fewer mistakes occur in the operating theatre in teams that communicate more, and more openly. "It's everyone's actions that favour or prevent mistakes, not one individual's level of expertise", says Wehner. In other words, errors normally can't be blamed on only one person, as we are all too ready to do in everyday life. Even if, as in the above examples, "it was the anaesthetist's fault" would be the easiest and most obvious conclusion when things go wrong. Evidently, however, it isn't that simple. It's the cooperation, the team effort, that is the key to the success or failure of an operation.

It is primarily rigid hierarchical structures that stand in the way of an open error culture. Ever so slowly, however, a culture of destigmatising mistakes and making them public is emerging in medicine, too. For instance, we are starting to see something in hospitals that has long been routine in aviation: "critical incident reporting systems." They enable doctors to report critical incidents anonymously, which can be viewed by other medical practitioners so that they can learn from them and avoid similar mistakes in future. Nonetheless, according to Wehner these systems are still few and far between.

Successful mistakes

In certain situations, however, errors can paradoxically also lead to success. Sometimes it is precisely unconventional actions that go against all the rules which make someone succeed instead of fail. Take the pilot who defied all the regulations and performed an emergency landing on the Hudson River when his plane developed engine problems shortly after take-off in New York, saving the lives of all 150 passengers on board: today, he is hailed as a hero. If the landing had gone wrong, however, he would have failed at his job and been lambasted for insubordination.

As well as mistakes, there are also misconceptions, as Wehner explains. The former are made by people who actually know better; the latter are made by those who lack the necessary knowhow. To put it another way, if I know how to enter a motorway but suddenly find myself driving down the wrong side of the road, I am making a mistake. When Columbus christened America the West Indies, however, he was under a misconception; he didn't know any better at the time.

Mistakes are considerably more difficult to understand and analyse. Discovering their causes is one of Wehner's favourite topics. As an expert, sometimes he spends years beavering away at a case to find out what prompted someone to act in a certain way. And what might seem utterly incomprehensible at face value often turns out to be something quite plausible in the end: we're simply human.

Error-friendly technology

Error-friendly technology can "forgive" many human operating errors. This is why, as Wehner points out, collaboration between engineers and scholars in the humanities and social sciences is so important. We have to give erroneous ideas more leeway in the development of machines and equipment – which is one reason why Wehner joined ETH Zurich in the first place.

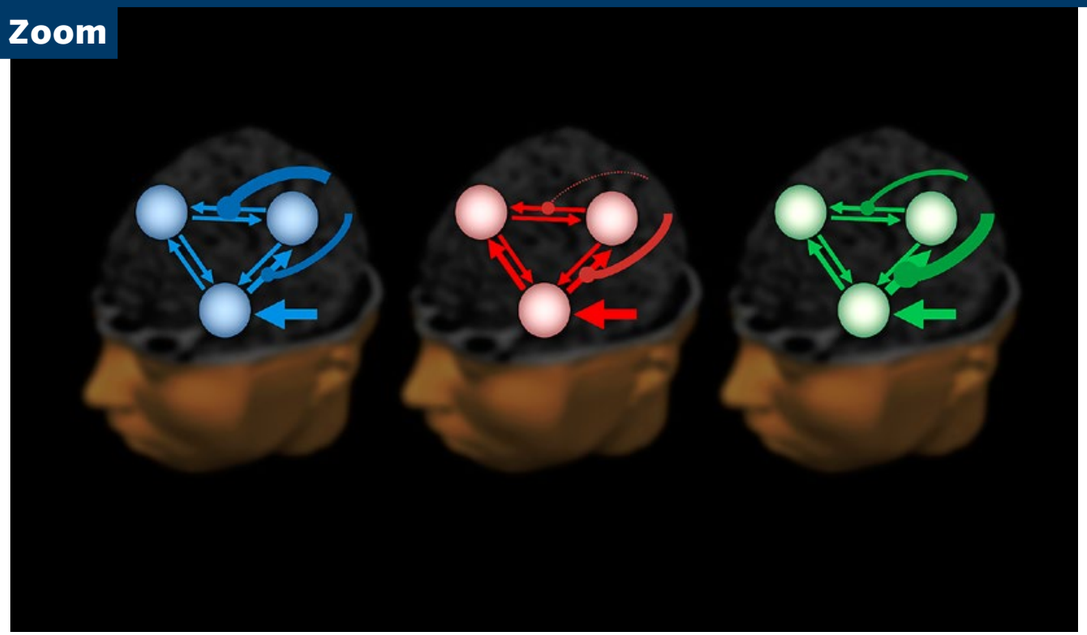
However, despite all our scientific considerations, there is one thing we should never forget, as Wehner sums up: mistakes, misconceptions and thus failure, too, are all part of life. In fact, it is even a privilege to be able to fail: "If I manage to achieve everything straight off, I haven't got any incentive to change anything and expand my horizons."

And no chance to "fail better" next time. As the Irish author and Nobel Prize winner Samuel Beckett once put it so nicely: Ever tried. Ever failed. No matter. Try again. Fail again. Fail better. ■

Psychology in Work and Society Group:
www.pda.ethz.ch →

Organization, Work and Technology Group:
www.oat.ethz.ch/news/index_EN →

Zoom



Using functional magnetic resonance imaging, a mathematical model can help researchers to draw conclusions about the degree to which schizophrenia patients are afflicted.

Translational Neuromodeling Unit

New paths for psychiatry

Maja Schaffner

Klaas Enno Stephan and his group develop mathematical models to examine psychiatric illnesses. Their long-term goal is to find tests for psychiatry permitting rapid, accurate diagnoses so as to give patients individual, targeted treatment.

"Today, patients with psychiatric disorders are more or less treated according to the 'trial and error' principle", says Klaas Enno Stephan, Professor at the Institute of Biomedical Engineering. The reason is that standardised questionnaires are in most cases the only tool available to identify psychiatric complaints. Diagnoses can be based on the symptoms but it is not possible to identify the mechanisms behind the condition. This is in contrast to physical disorders where, for instance, blood tests can help to clarify the underlying causes. It can thus take several months to find an effective drug treatment for psychiatric disorders. "This is very distressing for the patients who often have to accept what may be major side-effects without knowing whether a specific drug can really help", says Stephan.

This is where Stephan's research group comes in – the Translational Neuromodeling Unit. It develops novel tests intended to lead to rapid, accurate diagnoses which in future will enable psychiatric disorders to be treated appropriately from the very beginning.

The tests are based on mathematical models used to analyse images of the active brain. "The models are always simplifications of the actual hidden processes in the brain", explains Stephan. "However, they do render changes in brain activity visible and allow conclusions to be drawn about the causes of a psychiatric disorder."

Diagnosing schizophrenia

The scientists recently demonstrated that these models work for schizophrenia patients. They succeeded in distinguishing between test persons with and without schizophrenia, and also divided them into subgroups.

This "simple mathematical model" (thus Stephan) makes such differentiation possible by analysing brain activity by means of functional magnetic resonance imaging (fMRI) and presenting the results as an image. From these measurements the model calculates the strength of coupling, i.e. the intensity of communication among three selected brain regions. These coupling strengths permit conclusions about the type and severity of the disease afflicting schizophrenia patients.

In practice, the researchers tested their model by asking patients with schizophrenia and a control group of healthy test persons to look at images and remember them. During this working-memory task they recorded the participants' brain activity. This revealed major differences between the coupling strengths of the three brain regions of the control persons and patients.

Furthermore, with the help of their model the researchers were able to divide the schizophrenia patients into three groups with different patterns in coupling strengths. When these results were compared with their clinical symptoms, everyone was surprised to find that the three groups indeed represented varying degrees of severity of schizophrenia.

Further studies will be needed before the current model can be implemented in practice. "What we particularly lack are tests with patients who at the time of the study had not yet taken any medication. If researchers had access to such patients, they could observe over time how the disease develops, which medicines help and whether the model's predictions concerning the disease's trajectory actually prove to be true", says Stephan.

On the trail of neurotransmitters

Another mathematical model on which the researchers are working looks at neurotransmitters, i.e. the messenger substances in the brain like dopamine or acetylcholine. An imbalance in these messenger substances is one of the most frequent causes of psychiatric disease – too much or too little can have disastrous consequences. The problem is that today's methods mean it is impossible to determine clearly which of the messenger substances triggers a specific symptom in a patient. Understanding this would, however, be the key to targeted treatment.

The researchers' model visualises the activity in the brain regions which are of relevance for the formation of specific neurotransmitters. The scientists showed that this model works, too, by asking the test persons to solve learning tasks on the computer. They were asked to predict specific images. Using a model, the brain activity recorded using fMRI let them determine how and where these learning processes take place in the brain. They took a closer look at specific areas of the brain which are involved in the production of messenger substances.

Stephan's team is the first research group to succeed in accurately measuring activity in the basal frontal lobes of the brain where the messenger substance acetylcholine is formed. This had not been achieved up to now without mathematical modelling. In the midbrain, too, where dopamine is produced, the researchers were able to take reliable measurements using the model.

Both messenger substances have extremely important effects on the brain and, when disrupted, trigger severe illness. Acetylcholine plays a key role, for instance, in Alzheimer's disease. In Parkinson patients, dopamine-forming neurons die off. Dopamine is also involved in psychiatric diseases like schizophrenia, compulsive disorders or depression.

"Our models supply promising indicators for the work of these neurotransmitters", says Stephan. The researchers would like to continue testing their results in patient studies. If these are successful, they would fine-tune tests for practical use.

"By taking measurements at the start of treatment, we will hopefully be able to use these tests someday to predict how well someone will respond to a drug and the dose he should be given", explains Stephan. ■

First institution of its kind

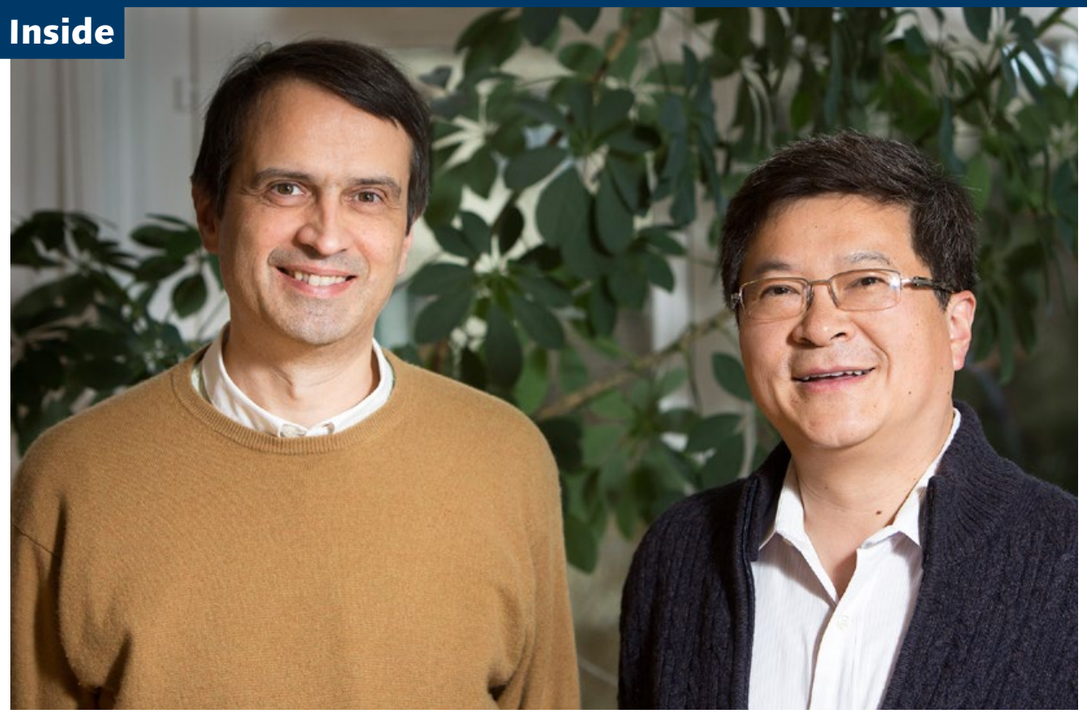
The Translational Neuromodeling Unit (TNU) is a joint institution of the University of Zurich and ETH Zurich and is attached to the Institute of Biomedical Engineering. Thanks to the cooperation between the two universities and a donation from the René and Susanne Braginsky Foundation, it was set up very quickly with minimum red tape in 2012.

At the TNU, which is headed by Klaas Enno Stephan, IT experts, electrical engineers and physicists work together with biologists, psychologists, doctors and medical staff. Stephan himself is a doctor and neuroinformatics scientist. The researchers have their own outpatient research unit at their disposal.

The distinguishing feature of TNU is that the scientists not only develop and test the models but they also want to fine-tune them themselves into tests that can be used in psychiatry. Up to now, this is a truly unique combination on the global stage.

www.translationalneuromodeling.org →

Inside



Giovanni Felder, Director of the ETH Zurich Institute for Theoretical Studies, with its first guest professor, Terry Hwa, who has been at ETH Zurich since January.

Institute for Theoretical Studies

Welcoming the world's elite

Corinne Hodel

The Institute for Theoretical Studies has welcomed the first top scientist to spend a research sabbatical at ETH Zurich. The American physicist Terry Hwa kicks off a highly promising series.

Last summer, the Institute for Theoretical Studies was founded at ETH Zurich with the aim of enabling top scientists from all over the world to take up research stints at ETH Zurich. "The first six months were all about looking for researchers", says Institute Director Giovanni Felder. Together with the scientific council, which is composed of representatives from ETH Zurich and external scientists, he has been keeping an eye out for renowned professors. And the committee has already found two: Terry Hwa, a physics professor from the University of California in San Diego, and Henryk Iwaniec, a mathematics professor from Rutgers University in New Jersey. The mathematician is coming to Zurich this summer, and the physicist is already here. Both will be spending a year at ETH Zurich.

The first top-flight researcher

Terry Hwa has been in Switzerland with his family since January. His children go to school here, even though they can hardly understand a word of German. This research stint all worked out so spontaneously because, by coincidence, Hwa was already on the look-out for an exchange university. He is particularly over the moon at the opportunity to spend his one-year sabbatical at ETH Zurich. "Of all the European universities I've visited, ETH Zurich is the most international," says Hwa. Institute Director Giovanni Felder is also delighted that Terry Hwa will be his guest for a year: "He's a leading researcher with an innovative approach to theoretical biology." A research field that is becoming increasingly important – including at ETH Zurich.

The main focus of Hwa's research is the intestinal bacterium *E. coli*. Scientists know no other organism better – the ideal prerequisite for a researcher from theoretical biology to analyse these living beings and their environment with extreme precision. The intestinal bacteria are part of a highly complex and dynamic system involving countless partners. Cells, molecules and other actors interact with each other and are constantly in motion. Terry Hwa's goal is to describe this system mathematically and thus render the processes predictable. In other words, theory should describe practice and make it tangible.

Although Terry Hwa already knew numerous researchers from ETH Zurich, there has not been a collaboration that produced a scientific publication – something which the physicist wants to change. "A research sabbatical is just the ticket to put our heads together over a cup of tea and come up with an idea", says Hwa. "This creative exchange can't take place long-distance; direct contact is essential." The list of ETH scientists whom he wants to meet in person is long. He will often leave the house in Clausiusstrasse and hit the labs with the aim of initiating collaborations that will extend way beyond his stint at the Institute of Theoretical Studies.

Thinking outside the box

Hwa is also holding a lecture this semester for students from different disciplines, including physics, engineering and biochemistry. With his "Quantitative Biology" course he would like to bring the students closer to biology. "For me, it's important to highlight how central is the interdisciplinary approach and how the individual subjects can benefit from each other", says Hwa.

That perfectly suits his host institute, which already sets great store by a dialogue between subjects. In future, Institute Director Giovanni Felder would like to move further in this direction and work with even more disciplines.

For instance, he has a collaboration with biologists or chemists in mind. Today, the exchange primarily takes place among leading researchers from mathematics, computer science and physics. New, potential research facilities for the Institute are discussed in the interdisciplinary series of talks entitled ITS Science Colloquium.

A chance for young people

However, the Institute does not merely want to boost the exchange of ideas between big names in research; it is also committed to promoting the next generation of researchers. For instance, talented young scientists who have just completed their doctorate successfully are offered the opportunity to spend three years as postdocs at the Institute of Theoretical Studies by means of an exchange programme. They work there independently, but supported by a professor of ETH Zurich.

One feature is the fact that they specifically have funds to invite researchers from all over the world to visit Zurich. "International exchange between scientists is a key success factor across all generations", Felder is convinced.

Unlike "senior fellows" invited to ETH Zurich, "junior fellows" need to be nominated by a professor. Consequently, Felder has written to colleagues and pointed out the opportunities his Institute can offer. "We've received so many top-class applications that it wasn't easy to decide", he says. Although there aren't any candidates here as yet, the first three have already been chosen. A mathematician and a computer scientist, who are currently finishing off their dissertations at the University of Michigan and Jerusalem University respectively, are due to start in the autumn. And another mathematician, currently doing a doctorate in the theory of relativity at Stanford University, will be joining them next year. They will all be conducting research at ETH Zurich for three years as postdocs.

And Terry Hwa is constantly on the look-out for talented young researchers for his lab in San Diego, too. Perhaps he will be going home at the end of the year with an ETH student in his suitcase. ■

The new institute at ETH Zurich

ETH Zurich's Institute of Theoretical Studies (ETH-ITS) invites top scientists from all over the world for research sabbaticals. It was founded last year thanks to two extremely generous donations of CHF 25 million. The donors, Martin Haefner (representing the Walter Haefner Foundation) and Max Rössler, both studied mathematics at ETH Zurich and are still involved with the university to this day.

Since the very beginning, ETH Zurich has always had great theoreticians in its ranks. Scientists such as Albert Einstein, Wolfgang Pauli, Hermann Weyl and Niklaus Wirth have shaped the theoretical foundations of their fields and contributed towards key innovations. The new institute should build on this tradition and strengthen ETH Zurich's scientific basis.

www.eth-its.ethz.ch →

MOOCs

ETH Zurich launches its first MOOC

Roland Baumann

ETH Zurich's online courses are primarily designed to enhance classroom teaching. However, this does not exclude their contents from being made publicly accessible, as the first MOOC reveals.

In 2011 Stanford University launched the first three lectures that were publicly accessible worldwide. Ever since, these so-called Massive Online Courses (MOOCs) have been shaking up the academic world. Hundreds of these courses have emerged in the last two years. The platform Coursera, founded by Stanford, alone offers around 600 courses from over 100 different universities and organisations.

ETH Zurich launched its first MOOC on 14 February, on the topic of autonomous mobile robots. It was offered by the professor of autonomous systems Roland Siegwart together with his colleagues, and received an extremely positive response without much advertising. A fortnight before the launch, over 10,000 people had signed up for the course on the edX platform where it was offered.

Pilot project underway

Why offer the first ETH Zurich MOOC now, all of a sudden? ETH Zurich has been enabling its lecturers to use web-based teaching formats for around fifteen years. This service has proved extremely popular, if the 250 teaching units that have been produced over the years are anything to go by. They range from individual elements such as videos and quizzes to small modules and even entire online courses. "Here at ETH Zurich, we have been keeping an eye on the development of MOOCs from the outset and launched a pilot project in 2012 addressing the sensitive issue of data protection, for instance", says Koni Osterwalder, Head of the Educational Development and Technology unit. "Based on our analysis, however, we set our priorities somewhat differently."

Link-up with classroom teaching

TORQUE is the magic word at ETH Zurich. It stands for "tiny, open-with-restrictions courses focused on quality and effectiveness." Unlike MOOCs, TORQUEs always have a close relationship to a course at ETH Zurich, thus contributing towards superior, up-to-date classroom teaching. "Their role can be likened to an interactive course book", explains Osterwalder. As a result, TORQUEs offer brand new possibilities for classroom teaching: if students learn the material by themselves at home, the brief time spent in the lecture can be used for questions and discussions. In other words, the lesson is used for consolidation. Experts refer to it as the "flipped classroom."

As TORQUEs always link up with a course, they are offered on ETH Zurich's own Moodle platform. "Albeit with the drawback that they are not accessible worldwide", concedes Osterwalder. "On the other hand, the lecturers can test the quality of the formats one-on-one in the classroom – and revise them if need be."

Two-track strategy

For Osterwalder, the important thing is that TORQUEs and MOOCs are not mutually exclusive. Quite the contrary: lecturers can develop a MOOC from a TORQUE. And a MOOC can also be used in classroom teaching. Roland Siegwart's course is the best example of this, as it was produced just in time for the start of the spring semester. "At ETH Zurich, it's always the individual lecturers who decide what formats to use in their courses," explains Osterwalder. "We merely make suggestions and help with the realisation."

So far, the pilot project has yielded three completely different TORQUEs and the first MOOC. More courses are currently in the pipeline. Osterwalder expects around half a dozen TORQUEs and two or three MOOCs to be up and running by the end of the pilot phase in early 2015. "Then we'll evaluate the project, assess where there is a need among other lecturers and see where the journey takes us."

ETH Zurich publishes its MOOCs on the non-profit platform edX, which was initiated by MIT and Harvard University:
www.edx.org/school/ethx →

Connected

Special exhibition

The secret diary of Max Frisch

Excerpts from a diary by Max Frisch, which had to be kept under wraps until twenty years after his death, have now been published in book form. In it, the author (standing, with his wife and the author Uwe Johnson) describes his first year in Berlin and takes a critical look at himself. However, he also provides a highly insightful description of the plight of intellectuals subject to the dictates of the ideology of the GDR. The Max Frisch Archive at ETHBibliothek is currently holding an exhibition on the book, focusing on the author's relationship with the German capital. Moreover, original pages from the diary can also be viewed for the first time in Switzerland. The exhibition runs until 29 August 2014.

Venture competition

A basis for innovative business ideas

At the first awards ceremony for this year's Venture competition, Roche CEO Severin Schwan (right) spoke about the right breeding ground for pioneering ideas. A record number of business ideas were submitted, as Venture initiator Thomas Knecht (centre) and President of ETH Zurich Ralph Eichler (left) noted. And even more encouragingly, three of the ten prize-winners were ETH-Zurich spin-offs.

Watt d'Or

Energy award for hybrid engine

ETH Zurich Rector Lino Guzzella (centre, together with researcher Christopher Onder) and his research group were awarded the energy prize Watt d'Or 2014 by the Swiss Federal Office of Energy for developing a natural gas/diesel hybrid engine. It emits up to half as much CO_2 as conventional engines with the same output.

Heinz Hopf Prize

Heinz Hopf Prize

The Heinz Hopf Prize 2013 has gone to the two mathematicians Helmut Hofer from the Institute for Advanced Study in Princeton and Yakov Eliashberg from Stanford University (from left). The award, which carries CHF 30,000 in prize money from ETH Zurich's Department of Mathematics, was presented by Roland Siegwart, ETH Zurich's Vice-President of Research and Corporate Relations (second from right). The Chairman of the Prize Committee is emeritus professor of mathematics Gisbert Wüstholz (right of the picture).

Strong partners

Cooperation with Microsoft

ETH Zurich and ETH Lausanne have entered into a new research cooperation with Microsoft Research, which will fund computer science projects at the two universities to the tune of five million CHF spread over five years. Researchers from the technology company work closely with scientists from the two universities. The new research cooperation is a continuation of a funded project launched in 2008. It recently got underway with a kick-off meeting (see photo) at Microsoft Research in Cambridge (GB), where the scientists supported in the first round of funding showcased their projects. Seven projects were selected: four from ETH Zurich and three from ETH Lausanne.

ETH-Alumna Katja Fink

Four in one fell swoop

Felix Würsten

The immunologist Katja Fink has set herself a demanding task. Together with her team in Singapore, she is endeavouring to develop an effective dengue fever vaccine. To do this, she has to keep four different pathogens in check.

The World Health Organisation (WHO) estimates that 50 to 100 million people around the globe contract dengue fever every year. This disease, which normally manifests with flu-like symptoms, is seen as extremely insidious. For around 500,000 patients it follows a severe course; for 22,000 people, mainly children and youngsters, it proves fatal. Even today there is still no specific treatment for the disease, which occurs above all in the tropics and sub-tropics and is transmitted by mosquitoes, nor is there an effective vaccine.

This is what Katja Fink would like to change. She works as a Principal Investigator at the Singapore Immunology Network, a state research institute with around 200 employees which is attached to the Agency for Science, Technology and Research. A few months ago she was able to announce an initial success in her search for an effective vaccine, and this also attracted considerable attention in the local media. She has discovered an approach which makes it impossible for the virus to evade the human immune system.

Katja Fink has been working on dengue fever for many years now. "As a researcher I would like to look at other diseases, too, but this topic is so diverse that I now concentrate fully on this area." She is probably not going to change direction any time soon either. "If we had a dengue vaccine in five years' time, I would be very proud" she says, indicating a timeline.

And what happens if the path she's embarked on leads to a dead-end? "Then we would switch to plan B", she says with conviction. "I have many ideas about what else we could do."

It's not easy to develop an effective vaccine against dengue fever. This is because dengue fever in fact encompasses four different viruses, each of which operates in line with slightly different natural laws. The challenge is to develop a vaccine which offers equally good protection against all four virus types. "As a rule a potential vaccine is only effective against one or two pathogens but not against all four, because the human body develops an immune response at varying speeds to the variousviruses", explains Katja Fink. This highlights another difficulty: until recently the researcher did not have a good mouse model for her work. The reason is that mice are by nature immune to dengue fever. If you want laboratory animals that are not immune, then first you have to switch off their natural immune response. However, if at some later stage you want to test a corresponding vaccine, then this can prove to be a real stumbling block. For the vaccine to be effective, the immune system would have to be reactivated.We now have a mouse model at our disposal which is suitable for our research", she explains.

> "If we had a dengue vaccine in five years' time, I would be very proud."
>
> Katja Fink

It was by chance, back in the mid-1990s, that Katja Fink happened upon her original field of study, biochemistry.

If the current approach should fail, Katja Fink already has a Plan B that she could also pursue.

"In high school I didn't even know there was such a subject." It was only when she went to find out about possible courses of study that she learned about it and registered to study it at the University of Zurich. In retrospect it was the perfect choice, as she really enjoyed her studies from the outset. After graduating, she moved to ETH Zurich to join Hans Hengartner, who headed up the Institute of Experimental Immunology together with Rolf Zinkernagel. There she examined how B cells in the immune system react to infection with the varicella-zoster virus. "Hengartner's group was based in the pathology unit of the University Hospital Zurich", remembers Fink. "This led to close cooperation with the doctors, which I found to be very enriching." In Singapore, she is now endeavouring to convince her colleagues that cooperation with doctors would be worthwhile – though with little success so far, as she admits.

The fact that she found her way to Singapore after obtaining her PhD and a short postdoc at the University Hospital was again down to chance. "I wanted to go abroad – but not to the USA", she explains. Initially she had set her sights on a research position in Australia. But then she read an article about the Novartis Institute for Tropical Diseases in Singapore. During a visit there she quickly realised that she really liked the Institute. And so she accepted a post-doctoral position in the dengue department.

The relocation to this small Asian country was a big change. In particular, the behaviour at her new place of work took some getting used to. In contrast, she quickly became acclimatised to everyday life in Singapore. "Singapore is relatively western. And as a native of Switzerland, I really like the fact that the public services and institutions are well organised and clean", comments Fink. She only really misses the mountains, and places where you could find real peace and quiet. "Singapore is extremely densely populated. And since I moved here the country has experienced enormous growth. Only in a very few places today can you get away from all the man-made noise."

She finds tranquillity, for instance, during her training runs in the forest. A passionate ultra-trail runner, she participates from time to time in mountain races in Asia and Europe. She first had to find suitable training opportunities in Singapore. "There are a number of skyscrapers which are suitable", she says, smiling. "And there is a 169-metre hill which is technically rather challenging." Only recently she saw for herself that mountain races can be staged in a flat country like Singapore, too. During a race the runners had to tackle the hill several times over. At the end they had climbed more than 6,000 metres in total.

She could see herself living even longer in Singapore. "Today, I no longer feel so much like the exotic foreigner that I did in the beginning." And as Vice-President of the ETH Alumni Chapter Singapore, she has an excellent network with other former students of the university. "We regularly stage events, sometimes together with Alumni organisations from other Swiss universities", she reports.

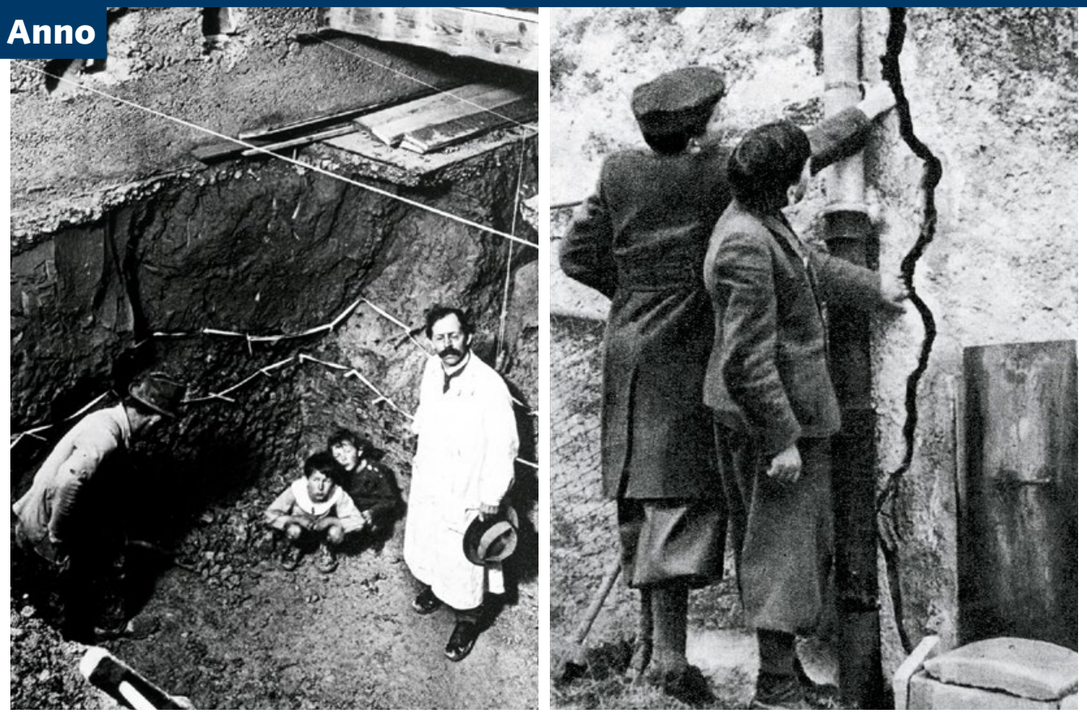
> "I found the close cooperation with doctors to be very enriching."
> Katja Fink

Last year, for instance, the Swiss Alumni met Federal Councillor Johann Schneider-Ammann, who was paying a visit to the Singapore ETH Centre. Just how long Katja Fink will actually stay in Singapore also depends on how her work develops. "I hope that our approach to a dengue vaccine will prove successful in the forthcoming tests", she explains. Co-operation with the departments which handle the marketing of scientific findings was also an interesting experience for her. "I learned a great deal about just what it takes to turn a promising laboratory approach into a medicinal product which can be used in clinics." ■

About the person

Katja Fink studied biochemistry at the University of Zurich and then did her PhD at ETH Zurich, at the Institute of Experimental Immunology. Today, she works as the Principal Investigator at the Singapore Immunology Network and is also an Adjunct Assistant Professor at the Nanyang Technological University in Singapore. In her work she mainly focuses on the insidious tropical disease dengue fever.

Anno



Alfred de Quervain, the first director of the SED, in the foundation pit for the twenty-ton universal seismograph he developed (left). The last major earthquake in Switzerland occurred in 1946 near Sierre (Canton of Valais), causing considerable damage to buildings.

1914

Earthquake detectives

Felix Würsten

When a federal law was passed a century ago, monitoring earthquakes became a government responsibility and has been performed by the Swiss Seismological Service (SED) ever since. Over the years, the SED has established a dense, efficient monitoring network.

In 1878, the world's first permanent official organisation for observing earthquakes was launched – not in a typical "earthquake" country like Italy or Japan, but in comparatively tranquil Switzerland. At its annual meeting, the Swiss Association of Natural Sciences founded the Earthquake Commission, which collected and archived reports on current and historical earthquakes on a voluntary basis and set its sights on establishing earthquake monitoring stations throughout Switzerland.

However, it was some time before those stations could be realised. It wasn't until 1908 that Parliament approved a grant of CHF 12,000 to set up an earthquake surveillance station in Degenried near Zurich, which eventually opened three years later. A small, inconspicuous building in the woods provided a home for two bulky pieces of equipment: a Mainka horizontal seismograph and a Wiechert vertical seismograph. That same year, the station recorded its first incident: an earthquake in Thurgau.

The Earthquake Commission had primarily relied on reports from the general public up to that point, and soon found itself stretched to its limits with its new monitoring station. As a result, the committee was dissolved and replaced with the Swiss Seismological Service, a new department affiliated with the Central Meteorological Institute (the forerunner of today's MeteoSchweiz). When the federal act came into force on 1 April 1914, the SED became an official institution once and for all, with salaried scientists in the public service to carry out its responsibilities. Geophysicist and meteorologist Alfred de Quervain, who had recently returned from his famous Greenland expedition, became the first director of the new service.

The SED's core task has remained the same since its foundation a century ago: the seismic monitoring of Switzerland and its neighbouring countries. To this end, the monitoring network has steadily been expanded over the years. One important step came in the 1920s when the SED equipped the three monitoring stations in Zurich, Chur and Neuchâtel with universal seismographs, forming the first integrated seismic network.

Its actual expansion into a modern, nationwide network began in the 1970s. Nowadays, the SED records underground tremors at over 100 locations. The technological progress that has been made is not only reflected in the number of monitoring stations, but also their design. Whereas the universal seismographs weighed over twenty tons, today's monitoring devices weigh only a few kilograms. They are also considerably more accurate and can detect signals that are tens of thousands of times more subtle than the universal seismographs. This enables them to register the slightest of movements – including tremors caused by a supersonic boom.

The home of Switzerland's very first earthquake monitoring station in Degenried near Zurich.

Detecting incidents right away

The SED underwent an important change in 1957: under a federal act, it was incorporated into ETH Zurich's Institute of Geophysics. From then on, the Seismological Service would not only run monitoring stations and observe seismological activity, but also increasingly conduct research projects itself and join international organisations. When the SED's focus was realigned in the 1970s, its earthquake monitoring system was rapidly expanded. In particular, an automatic evaluation system was established that was able to localise earthquakes within thirty seconds. This meant that the appropriate authorities could be alerted quickly if an incident occurred.

Today, the SED is a separate unit controlled directly by the Vice-President of Research and Corporate Relations and employs around 60 people. Besides many projects in Switzerland, the SED is also active abroad, running a temporary seismological network in Bhutan and a number of monitoring stations in Greenland, for instance. In Switzerland alone, the SED registers around two earthquakes per day – in other words, between 500 and 800 per year. However, only about ten of these are strong enough to be felt by the public. The quakes are not evenly distributed, either, more earthquakes being registered in Valais, the Basel area, the St. Gallen Rhine Valley, the central Grisons, the Engadine and Central Switzerland than in other regions. Strong quakes measuring around six on the Richter scale occur every sixty to 100 years in Switzerland, the most famous of which hit Basel in 1356, destroying much of the city. The last serious incident took place near Sierre in the Canton of Valais in 1946, also causing major damage.

The SED also uses the data recorded for other tasks – such as determining the properties of the subsurface or monitoring geothermal projects. And it is involved in the implementation of the UN's Nuclear-Test-Ban Treaty. A station near Davos, opened in 2003, belongs to the global monitoring network that ensures compliance with the Treaty.

100 years after its foundation, the SED continues to optimise its monitoring network. For instance, there is a need for research into early warning systems. As electromagnetic waves spread faster than seismic ones, areas that are some distance from the epicentre can in principle already be alerted seconds before the strongest tremors hit – provided that the quake is recognized quickly enough. ■

The SED turns 100

The SED is to showcase itself in a variety of ways in its centenary year: September 21, for instance, with an open day and starting September 6 with a centenary exhibition to present its diverse activities to the public. For anyone looking to delve into the world of seismological research in Switzerland before then, however, the monthly snapshots uploaded onto the SED homepage offer unusual and inspiring insights into the topic.

Information on the SED centenary:
www.seismo.ethz.ch/sed/100/index_EN →

ETH alumnus Roland Hänni has taken not one, but two students into his home, as he thinks it is a shame not to make use of empty living space.

Student accommodation

Mutually rewarding

Felix Würsten

Today, it's difficult for students to find reasonably priced accommodation in Zurich. So the Housing Office of University and ETH Zurich is delighted when private living space is opened up to students. The example of ETH alumnus Roland Hänni shows that this can be rewarding for the landlord, too. He and his wife have taken not one, but two students into their home.

The figures themselves are very encouraging. More than 2,700 young men and women matriculated to study for a Bachelor degree at ETH Zurich in autumn 2013. They all contribute to a further increase in the total number of students. More than 18,000 are now studying for a Bachelor, Master or PhD at ETH Zurich – a new record for the university. And there are no signs of an end to this growth. In its plans, the Executive Board of ETH Zurich is counting on this trend continuing over the next few years.

The downside to growth

There is a similar picture at the University of Zurich. Around 26,600 students are matriculated there, 3,500 more than a decade ago. The dynamic development of Zurich as a university city is also reflected in building activities at the two universities. Both ETH and the University have erected new research and teaching buildings in recent years, particularly at the two sites of Hönggerberg and Irchel. The additional students don't just need auditoria, but also laboratories and workstations.

This positive development for both universities has a downside, however, because there is also an increased need for reasonably priced accommodation – and this in an environment characterised by a very tight housing market. Cheap accommodation has become a scarce commodity in the Zurich region, and this is what makes it so difficult for students to find somewhere suitable to live. "The demand is very high, particularly at the beginning of the autumn semester when many new students move to Zurich", explains Pascal Felber from the Housing Office of University and ETH Zurich.

To cater better for this demand, new student residences have been constructed over the last few years. For instance, this spring the Studentische Wohngenossenschaft Zürich (Student housing cooperative) is to open two new buildings: a residence with 103 rooms on Bahnhaldenstrasse in Zurich Oerlikon, and the Aspholz development in Zurich-Affoltern with over 330 rooms, erected by the Stiftung für Studentisches Wohnen (Foundation for student living). And last but not least there will soon be new housing for students near the ETH Hönggerberg. Together with private investors, ETH Zurich is to put up five residences for a total of 1,000 students.

Appeal to alumni

Urgently needed additional accommodation is being created with these new student residences. However, the demand is far from being met. "We are still in desperate need of private rooms or flats for students", explains Pascal Felber. Together with the ETH Alumni Office, the Housing Office therefore made an appeal last spring to former students of ETH Zurich. "With our letter we wanted to encourage alumni to make their empty rooms available as student accommodation", says Felber. Around two dozen alumni responded to the Housing Office using the reply coupon. Other alumni placed an advertisement directly on the Office's online platform.

Mutual exchange

One of the alumni who posted an ad is Roland Hänni. This independent project manager graduated from ETH in mechanical engineering in 1985 and is today an active member of the alumni group AMIV. He is very familiar with the difficulties that students face in trying to find cheap accommodation in Zurich – not just from his own experience, but because his elder son is also studying at ETH Zurich. When the second of his two daughters moved out last year, Roland Hänni and his wife realised the time had come to make the empty room available to other students. "I think it's a real shame when accommodation is left empty", is how he explains his thinking. "Particularly as we live close to Hönggerberg, in an ideal location for students."

Moritz Buchholz from Hanau (Germany) was one of the students who responded to the ad placed on the Housing Office platform. Hänni chose him because of his hobbies. Like Hänni's younger son, Moritz too is an enthusiastic musician, and this results in a stimulating exchange for both parties. By chance, Hänni found out that Heiko Schönherr from Zuchwil in Canton Solothurn was also urgently looking for accommodation in Zurich. The Hännis have now made their small guestroom available to him during the week. For Heiko, too, this is an interesting exchange because Hänni's older son is a fellow student of his. "Before we lived with our two daughters and two sons under one roof. Now, we live with four young men", says Roland Hänni, smiling. "So, in fact, my wife and I still live in a kind of extended family."

"Frequently, we get feedback that leasing rooms to students is worthwhile for both sides", observes Pascal Felber. "Many landlords see it as rewarding to have direct contact with the young generation." This is exactly what Hänni has experienced. "The contact with students is very enriching for us." So for him it's clear: "I can highly recommend other alumni to make empty living space available to students." ■

Accommodation available?

Do you live in greater Zurich and have a room you could sub-let to a student? Or do you even have a flat to let? On the online platform of the Housing Office of University and ETH Zurich you can place your ad for a small fee of CHF 20. The advantage is that you have a clearly defined target group, because only students and employees of the two universities have access to search the ads. The platform also has information for you, the landlord, about what you should bear in mind when advertising accommodation.

www.wohnen.ethz.ch/index_EN →

Alumni life

Agenda

Alumni business events

Philip Mosimann
Bucher Management AG
25 March 2014

Suzanne Thoma
CEO BKW Gruppe
2 October 2014

Susanne Ruoff
CEO Post
23 October 2014

Networking aperitif from 6 p.m., event begins at 6:45 p.m., ETH Zurich, main building, Dozentenfoyer

Register at:
www.alumni.ethz.ch →

Career events

Leadership, delegation, motivation
Course with Gerhard W. Grieb
15 April 2014, 8:30 a.m.–5:00 p.m.
ETH Zurich, Alumni Pavilion

Social media workshop
Recognising opportunities and risks
Careers seminar with Anne Forster
8 May 2014, 8:30 a.m.–5:00 p.m.
ETH Zurich, Alumni Pavilion

Information on all careers events:
https://www1.ethz.ch/career/event →

Alumni trips

Hanover and Wolfsburg
15–18 May 2014

Scotland
7–14 August 2014

Info at: www.alumni.ethz.ch/events →

This year's Alumni trip heads to Scotland from 7 to 14 August. The eight-day tour includes Edinburgh, Glasgow and Oban, with many high points (and not just for technophiles, either). Information available at www.alumni.ethz.ch/events.

Alumni events

Studying civil engineering at ETH Zurich
Panel discussion with Anton Affentranger (Implenia), Dominik Courtin (Basler & Hofmann) Cristina Zanini (Borlini & Zanini) and Prof. Ulrich Weidmann, Prof. Mario Fontana and Prof. Sarah Springman (all D-BAUG, ETH Zurich)
10 April 2014, 5:30 p.m.ETH Zurich, main building, Audimax

Alumni Symphony Orchestra

Spring concert

Gustav Mahler (1860–1911)
Symphony No. 4 in G major

Richard Strauss (1864–1949)
The Rosenkavalier, Suite

Soprano: Sophie Klussmann
Conductor: Johannes Schlaefli

10 April 2014, 7:30 p.m.
Rudolf Steiner School, Wetzikon

3 April 2014, 11:00 a.m.
Zurich Tonhalle, great hall

www.alumniorchester.ch →

Ausstellungen

Erik Steinbrecher
Books & Prints
Until 13 April 2014
Collection of Drawings and Prints, ETH Zurich, main building, E53
www.gs.ethz.ch/english.html →

The Walk
Naples–Karlsruhe–Zurich
Until 11 April 2014
gta exhibitions
ETH Hönggerberg, HIL Building
www.ausstellungen.gta.arch.ethz.ch →

Treffpunkt Science City

The theme of the spring edition of the popular series Treffpunkt Science City is mobility. Under the banner of "totally mobile in space, time and thought", scientists from ETH Zurich examine the possibilities and limitations of our mobility today in lectures, discussions, demonstrations, lab visits, exhibitions and tours.

16 March–13 April 2014
www.treffpunkt.ethz.ch →

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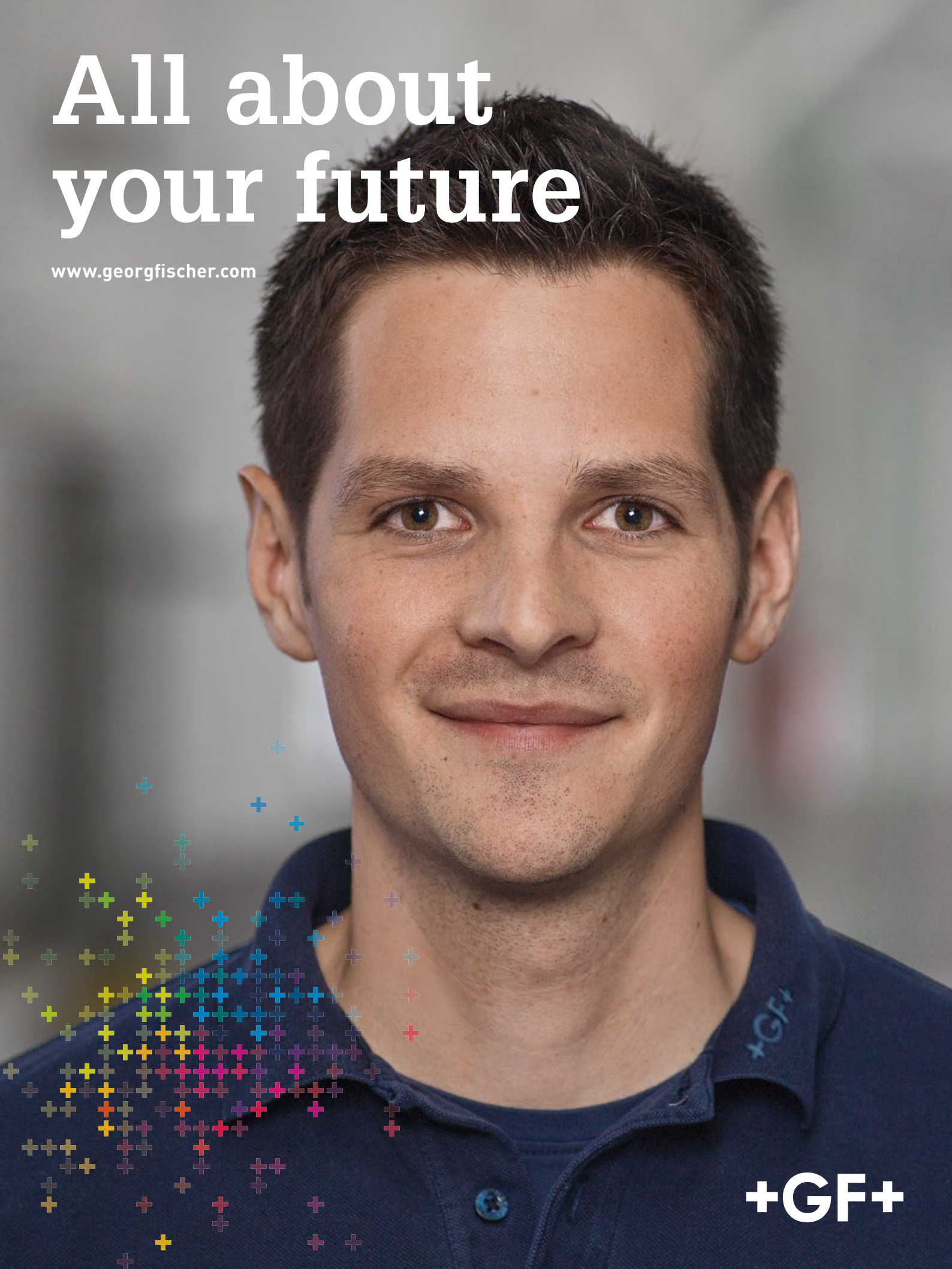

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