ETH zürich

NO. 1/2020

GLOBE

PUSHING BOUNDARIES

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The **CYBATHLON** has been postponed due to the **coronavirus**. You can find more information at www.cybathlon.com.

Technology that moves us

Joël Mesot, President of ETH Zurich

Researchers and people with disabilities have been working for months now to prepare for the second Cybathlon. The Cybathlon is a unique championship in which people with disabilities complete everyday tasks using state-of-the-art technical assistance systems. Participants will tackle a virtual race with mind control, test their endurance in a bicycle race with muscle stimulation, take on tricky challenges with arm prostheses, and power through obstacle courses with leg prostheses, exoskeletons or wheelchairs. It is sure to be a moving experience for competitors and spectators alike!

The Cybathlon is the brainchild of Robert Riener, Professor of Sensory-Motor Systems, and the first competition was held in 2016. Riener's vision of inclusive, holistic rehabilitation has now taken shape as the Rehab Initiative. The heart of the initiative is a new centre of excellence where researchers from various disciplines can work together with patients, doctors, companies and disability organisations. The goal is to integrate the needs of people with disabilities more deeply in the research process.

So it is fitting that this issue of *Globe* gives a voice not only to ETH researchers but also to many people with disabilities. They give us a glimpse into their lives, their concerns and the barriers they face – as well as their successes and their enthusiasm for new technologies that help them achieve greater autonomy in their daily lives. I hope you enjoy reading this issue!

Cover image: Yves Bachmann / Editorial image: Markus Bertschi

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Also available as a free tablet version.

Images: F. Samrock; Simon Tanner; Daniel Winkler

NEW AND NOTED

Materials science

SHIMMERING CHOCOLATES

One day over coffee, a group of researchers from the fields of materials science, food science and physics got to thinking about how to colour chocolate without using additives. Their bright idea was to exploit the phenomenon of structural colouration. This is what happens when, for example, the finely textured surface of a butterfly's wing refracts and scatters light so as to make certain colours visible. With a patent already filed, a spin-off venture is now in the pipeline.

A pattern imprinted on the surface refracts light to produce shimmering colours.

Medicine

EXTENDING THE LIFE OF DONOR LIVERS

In a world first, an interdisciplinary research team working in Zurich has succeeded in extending the life of a donor liver from 24 hours to a whole week. Donor livers are preserved within a newly developed perfusion machine, which creates an environment that closely mimics the human body. A pump replaces the heart, an oxygenator the lungs, and a dialysis unit the kidneys. Diverse hormone and nutrient infusions emulate intestinal and pancreatic functions. The machine also continuously moves the liver to mimic the respiratory movements of the diaphragm. If required, the machine can be operated remotely.

The new perfusion system enables physicians to examine and treat donor livers outside of the human body. This will make it possible, for example, to undertake liver regeneration and oncological therapies, restoring donor livers that do not initially meet the criteria for transplantation and rendering them suitable for use.

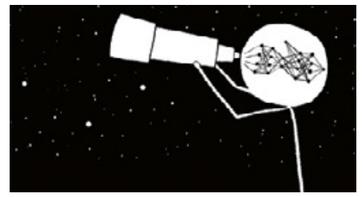
In the study, the machine was used to preserve ten donor livers, each of which had been rejected for transplantation on account of its poor quality. In a striking demonstration of the potential of this new technology, six of the ten livers displayed outstanding hepatic functionality at the end of the perfusion period.

Meanwhile, the demand for donor livers remains high. In Switzerland alone, the number of people waiting for a liver transplant outstrips the supply of donor organs by a factor of between two and three. The first transplant of a liver treated with this new method should take place sometime this year.

Quantum science

NEW APPROACH

To shed light on the field of quantum mechanics, physicists led by Renato Renner have chosen the unconventional approach of artificial intelligence. Using a simple task from the field of physics, the researchers were able to demonstrate that their idea works in principle. They tested whether the system could recognise, on the basis of observational data recorded on Earth, that the Earth orbits the Sun. The system passed the test with flying colours.



Heliocentric or geocentric?

Images: Giulia Marthaler; Tony Metger

NEW AND NOTED

Engineering Geology

BENEATH THE ICE

What kind of interactions occur between a valley glacier and its adjacent rock slopes? And what effect do climate change and glacier retreat have on the stability of these slopes? A research team led by Simon Löw, Professor of Engineering Geology, is currently investigating these questions at the Great Aletsch Glacier.

Glacial erosion over geological timescales erodes the valley floor, steepening the adjacent rock slopes. As a glacier retreats, it often leaves behind unstable slopes that are prone to collapse. Since the last ice age, daily and annual fluctuations in temperature and water pressure have also caused major stress changes in the slope, weakening the rocks and affecting the stability of the valley flanks. How the walls of a specific valley react to changing conditions depends on both their geological characteristics and the extent of the local stress changes. This ETH Zurich project is therefore also focusing on research into the long-term formation of rockfalls and landslides at the Aletsch Glacier tongue.

Engineering Geology at ETH:
→ www.engineeringgeology.ethz.ch

ETH researchers were able to access a cavity beneath the Aletsch Glacier measuring 4 by 2 metres.

Image: Simon Löw

ETH GLOBE 1/2020

Geothermal energy in Mongolia

Cleaner air with geothermal energy

The use of dirty coal as a heat source makes life tough in the Mongolian winter. ETH geophysicists are helping to develop geothermal energy as a clean alternative.

Many Europeans have an idyllic view of Mongolia as a land of wide, empty spaces and pristine nature. But the truth is more complicated, especially in winter. That's the time of year when life is anything but idyllic for the people who live here. Their settlements are shrouded in thick, sooty smoke that makes it difficult to breathe. The inhabitants face levels of pollution that are up to 80 times higher than guideline values specified by the World Health Organization (WHO) – an unacceptable situation given that the dirty air causes severe health problems among local residents.

It's only the second day of the heating season, which starts in early October, but the city of Tsetserleg is already shrouded in thick smoke.

Image: F. Samrock

Underground potential

One way out of this dilemma would be to stop heating houses with antiquated coal stoves that release unfiltered smoke, switching instead to renewable, clean energy sources. Mongolia offers many of the right conditions to achieve this, largely thanks to the hot magma hidden beneath the country's surface. Numerous hot springs – some reaching temperatures as high as 87 degrees Celsius – signal the presence of this natural resource. Mongolia already makes use of geothermal energy for various purposes, including heating greenhouses. However, any larger-scale use of this energy source would require far more water than currently reaches the surface. The problem is that the hot water only flows along certain subterranean strata – and without knowing where they are, any attempt to drill down into these valuable geothermal reservoirs is ultimately something of a gamble.

This is an experience familiar to many local people in Tsetserleg, the capital of Arkhangai Province in central Mongolia. The water brought to the surface by previous drilling projects has been barely hotter than 40 degrees Celsius. That might be acceptable for a hot bath, but it's not enough to heat a whole city, let alone generate electricity. Local authorities were therefore sceptical when ETH researchers suggested they should make a new attempt to exploit the region's geothermal energy resources on a large scale.

But Martin Saar, Professor of Geothermal Energy and Geofluids in the Department of Earth Sciences, and Friedemann Samrock, Senior Assistant in Saar's group, are confident the city could be heated with geothermal energy. "The conditions in Tsetserleg are ideal, with hot water underground, plus an existing district heating system to distribute the heat," says Saar. The system is currently powered by energy from coal firing, but it would be relatively easy to operate it using hot water from beneath the Earth's surface.

Fields and fluctuations

Saar and Samrock have good reason for feeling confident that they can find the right spots to access these reservoirs of hot groundwater. Their plan is to make use of magnetotellurics, a geophysical measurement method that can be used to infer exactly where subsurface water-bearing strata are located. This method is based on the fact that temporal variations in the Earth's magnetic field induce eddy currents in electrically conductive structures beneath the Earth's surface. Fluctuations in the Earth's magnetic field can be caused by phenomena such as solar wind and global lightning activity. The naturally occurring electrical field induced by these fluctuations produces a secondary magnetic field that – with the right measuring equipment – can be measured and analysed at the Earth's surface. "The measured data reveals the variations in electrical conductivity of subsurface materials. And since the conductivity of water-bearing strata is different to that of the dry rock around them, this analysis tells us where we can find hot water," says Samrock.

One of the advantages of Mongolia is that there is less electrical noise from human activity than in heavily populated countries such as Switzerland. This aided the speedy conclusion of the first measurement campaign last summer. The researchers were able to set up their measuring equipment to detect subsurface structures at a total of 184 different sites. "We're now in the process of analysing the data," says Samrock. "Next summer we intend to run a second measurement campaign to take a more in-depth look at the sites we feel are particularly promising."

The ETH geophysicists have another trump card to play when it comes to analysing the data, namely their collaboration with the Earth and Planetary Magnetism group, which has spent several years conducting research in Mongolia. The group has developed sophisticated numerical methods for analysing subsurface structures. "Our colleagues' computational programme has two key strengths. It takes into account the topography of the Earth's surface – unlike other programmes that simply assume it to be flat – and it correctly models the variations in resolution caused by the uneven distribution of the measuring stations," says Samrock.

Research for development

Yet this project is not only about geophysical research, but also about transferring knowledge. That's because it forms part of the Swiss Programme for Research on Global Issues for Development, which means it receives joint funding from the Swiss National Science Foundation and the Swiss Agency for Development and Cooperation SDC. It also includes the participation of the Mongolian Academy of Sciences. "One of our team members is an ETH doctoral student in my group, originally from Mongolia, who will continue working there once he graduates as an expert in this field," says Saar. "We will also be leaving our equipment in Mongolia once we complete our measurement campaigns so that local geophysicists can continue to search for hot groundwater in other areas, too." This could mark the prelude to huge improvements in Mongolia's winter air quality and, at the same time, help to reduce the country's CO_2 emissions. — Felix Würsten

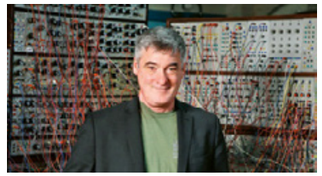
Find out more about the project:
→ https://GEG.ethz.ch/project-geothermal-mongolia

Images: Jimmy Day; courtesy of Renana and Roi Poranne

New ETH podcasts

The sounds of the ETH car park

Much of what MIT professor Joe Paradiso does today is rooted in his time as a postdoc fellow in the ETH Zurich Department of Physics in the 1980s. While he spent his days on research, his evenings were devoted to generating sound and building a synthesizer. In this podcast, he explains what prompted him to record audio in the ETH car park and why researchers need to get out of their comfort zones.



Two researchers, one family

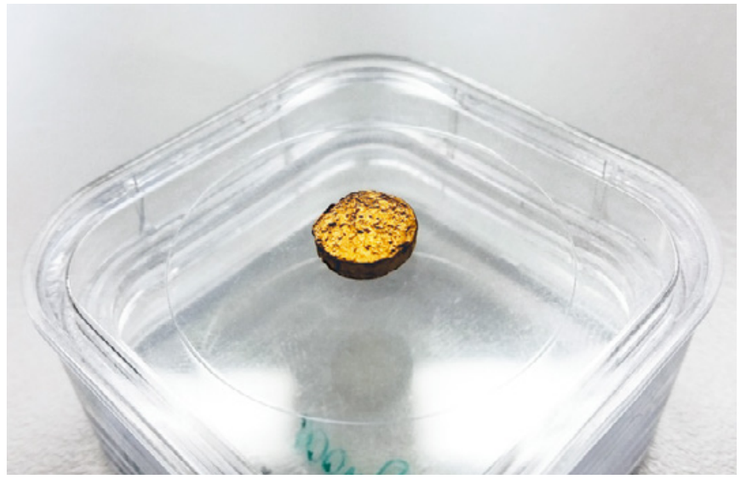
Chemist Renana Poranne and computer scientist Roi Poranne are both researchers who work at ETH Zurich. But in addition to being dedicated scientists, they're also the parents of two toddlers. In these podcasts, Roi and Renana talk about striking the right balance between scientific work and family life. They also have some words of wisdom to share with young researchers who are thinking about starting a family.

Learn more at:
→ www.ethz.ch/podcast

Materials Science

AN 18-CARAT GOLD NUGGET MADE OF PLASTIC

Lovers of gold jewellery will be delighted by a new development that is set to make watches and other items much lighter without taking away any of their shine. ETH researchers led by Raffaele Mezzenga have created a new form of gold that weighs between five and ten times less than 18-carat gold. It uses a matrix of plastic in place of metallic alloy elements.



Looks remarkably similar to a real nugget: 18-carat gold with latex as the base material.

Zukunftsblog

Sustainability

TALKING ABOUT CHANGE

It's 2020 and Christoph Kueffer is now into his fifth year of (almost) not flying. Whereas not flying hasn't been difficult, talking about social change still is, he argues.

→ www.ethz.ch/zukunftsblog-kueffer-en

Christoph Küffer, *Privatdozent* at the Department of Environmental Systems Science

Digitalisation

ETHICAL GUIDELINES FOR AI

Working together with researchers from the Health Ethics and Policy Lab, Anna Jobin examined existing ethical guidelines for the use of artificial intelligence. Her conclusion: ethical AI involves far more than just technical issues.

→ www.ethz.ch/zukunftsblog-jobin-en

Anna Jobin, member of the Health Ethics and Policy Lab at the Department of Health Sciences and Technology

Health

CRISPR SHOWS ITS THERAPEUTIC SIDE

Last year's news of genetically engineered babies in China was met with round condemnation. With CRISPR therapies about to enter clinical practice in Europe, Jacob Corn explains why this isn't a case of double standards.

→ www.ethz.ch/zukunftsblog-corn-en

Jacob Corn, Professor of Genome Biology in the Department of Biology

Read the full version of these and other blog posts at: → www.ethz.ch/zukunftsblog

Images: Peter Rüegg; courtesy of Christoph Küffer, Anna Jobin; Giulia Marthaler

Climate research

GREEN VEGETATION, DRY RIVERS

It's a paradox: a new study proves that rather than withering during droughts, plants at higher elevations thrive splendidly. Observations made during the 2003 summer heatwave indicate that mountain forests and grasslands at higher altitudes release even more water into the air during droughts than in periods of growth with average temperatures and sufficient precipitation.

This is because warmth and abundant sunshine promote plant growth, and the vegetation responds by sucking water out of the ground and eventually releasing it into the air. Rivers, on the other hand, were much drier that hot summer, flowing with just half the usual amount of water.

The researchers used a model to simulate a temperature rise of three degrees in the Alpine region, a scenario that could come to pass by the end of this century. This kind of warming could further increase annual evaporation rates by six percent. This corresponds to three to four percent of annual precipitation per square metre in the Alps. Annual precipitation and its changes are by far the most important factors that determine runoff volume.

As a result, rivers and streams will come under even greater pressure in future. As summers grow warmer and drier, there will be a shift towards increased evaporation in rivers. In the long term, this will endanger the supply of water to the lower-lying regions in and around the Alps.

In hot summers, streams are fairly dry, but the vegetation at medium and high altitudes is lush and green.

Image: iStock/gkuna

Chemistry

THRIFTIER SCREENS

QLED screens are known for their intense colours, which are produced by quantum dot technology. It consists of spherical nanocrystals that are excited from behind with UV light. The colour of light each nanocrystal produces depends on its material composition. However, the light these spherical nanocrystals emit scatters in all directions inside the screen.

To increase this technology's energy efficiency, scientists have tried replacing the crystals with ultra-thin nanoplatelets. But they produce relatively weak light that is insufficient for screens. ETH researchers led by Chih-Jen Shih have now stacked extremely thin semiconductor wafers with an even thinner insulating layer of organic molecules separating them from one another. This means that the platelets emit light in only one direction, even when stacked.

The new technology requires less energy to produce the colours green, yellow and orange – and only half as much for blue. Scientists have yet to find a way of producing the colour red.

Learn more about this topic and read other research news from ETH Zurich at: → www.ethz.ch/news-en

Power up

There are limits to what medicine can do – but some people choose to transcend them. Wheelchair athlete HEINZ FREI, comedian GUY LANDOLT and Cybathlon pilot CLAUDIA BREIDBACH defy their disabilities on a daily basis. ETH Zurich recently launched an initiative to get people affected by disabilities even more involved in research.

TEXT Corinne Johannssen **IMAGE** Yves Bachmann

GUY LANDOLT had just begun a run of solo stand-up shows when, completely out of the blue, he was hit by two strokes within 24 hours. Among other things, the comedian lost the ability to speak. Following intensive training, he's now back on the stage.

CLAUDIA BREIDBACH was born without a left forearm. She now wears a powered prosthesis, which she will be using when she competes as a pilot in the powered prosthetic arm race at the next Cybathlon.

"I can accept my limits. But it's important to me that I'm given the opportunity to try."

JOKING ASIDE

"The great thing is that I was already a bit stupid before the stroke, so there was a limit to how much damage it could do," says **GUY LANDOLT**, prompting laughter from the audience. The Swiss comedian is on stage for his new one-man show *Schlagfertig*, a play on words in German that shows how he is using humour to strike back against fate. Three-and-a-half years have passed since he suffered two strokes within the space of 24 hours, leaving him paralysed, partially blind and unable to speak. "The funny thing is I never felt my situation was particularly bad," he says. He struggles to put into words how he felt after the stroke, describing it as a kind of trance, but there's one sensation he will never forget: "When I closed my eyes, there were no thoughts, nothing – just a huge emptiness in my brain."

That was more than three years ago, and Landolt now lives in a small two-room flat on the third floor of a Zurich apartment building – with no lift. Intensive courses of physiotherapy have restored his ability to walk, though he still can't run or grip things firmly with his hand. Apart from a slightly reduced field of vision, Landolt's sight has also returned to normal. "Nobody knows what else I might be able to achieve," he says. "No doctor wants to take the risk of being proved wrong!"

Learning things by heart – a vital skill for any comedian – is still something of a struggle. Before his stroke he performed one-man shows in Switzerland and Germany. He even lived in Berlin for a while to cater to his increasingly hectic schedule. In Switzerland, he played one of the three groundhogs in the musical *Ewigi Liebi* (Eternal Love) together with the other two members of his band Trio Eden. He had already signed the contract to reprise that role for the show's tenth anniversary – but before it could start, the stroke stopped him in his tracks, and a different actor had to step in.

But Guy Landolt doesn't let frustration get the better of him. He's too busy training his body to perform better, especially his voice. He spends one hour a day reading aloud, and it is clearly paying off. He can't articulate his words as clearly as he did before the stroke, but he's making huge progress – and his doctors are pleasantly surprised. Learning to speak again allows him to pursue his vocation and perform onstage as a comedian. "My voice nowadays reminds me of how I used to talk when I was drunk at 3 a.m. in a bar," he says, prompting more laughs from the crowd.

DO IT WITH FEELING

The gentle hum of a motor is audible as **CLAUDIA BREIDBACH** reaches for her cup. The fingers of her powered arm prosthesis grip the cup in a smooth, controlled movement.

By some whim of nature, Breidbach was born without a left forearm, yet she recalls a carefree childhood: "It was all I knew. It's not like I ever lost anything." Her parents supported her where they could, and even more importantly, they showed tremendous faith in her ability to cope by herself. "They accepted me exactly as I was," she says. But when she turned 11, Claudia Breidbach wanted to be like her friends – and that's when she embarked on a whole new chapter of her life with an arm prosthesis. The first model had no grip function. It helped her walk straight and ride a bike, but what Breidbach liked most was that her disability was no longer visible at first glance. Even so, she has always found it challenging to meet new people, especially judging whether they are more interested in her as a person or in her disability. "I've had negative experiences that have made me quite thin-skinned in social situations," she says.

Choosing a career also posed a challenge. Breidbach wanted to be a tailor, but that didn't work out. "I can accept my limits. But it's important to me that I'm given the opportunity to try," she explains. In the end, she opted to study architecture. She constantly had to prove herself and overcome obstacles, but her persistence paid off. She spent many years working as an architect ›

for the city of Koblenz. Now, however, she has transformed her true calling into a career with a job as a training manager at prosthesis maker Össur. Few things excite her more than introducing prosthetic arms to those who need them.

Breidbach wears an Össur prosthetic arm herself, which she will be using to participate in the next Cybathlon competition. A multi-articulating prosthesis with a separate motor for each finger, it allows Breidbach to select from 36 different grips. She controls the opening and closing of the hand through muscle contractions in the arm stump, which is connected to the prosthesis via electrodes, and she can perform other movements by making gestures. The prosthesis can also be controlled via an app that allows users to programme their own choice of grips. Her new prosthesis has changed her life. “People treat me differently,” she says. “I’m proud of this prosthesis, and people can see how much confidence that gives me.” It also makes her much more independent. “I absolutely love my prosthesis. I feel such a close bond to it, and it has improved my quality of life.”

Right now, Breidbach is primarily focused on training for the next Cybathlon. She took part in the powered arm prosthesis race four years ago, and she’s particularly excited about a new discipline that the organisers have added to the course. Known as the haptic box challenge, it requires Cybathlon pilots to feel objects of different shapes and materials with their prosthesis and identify them without any visual feedback. “I had never experienced the sensation of feeling something with my left hand,” says Breidbach. “I couldn’t sleep a wink after the first training sessions. It was a really emotional moment.”

She can hardly wait to demonstrate what she and her arm prosthesis can do at the upcoming Cybathlon. The gentle hum of the motor will be drowned out by the crowd cheering her on.

FINDING THE POSITIVES

You might think someone who has spent 40 years in a wheelchair might be bowed by adversity, but not HEINZ FREI. His optimism is undiminished, and his mental strength and extraordinary willpower have allowed him to achieve goals he hardly dared dream of. “If I’d spent too long wallowing in self-pity after the accident, then I wouldn’t be where I am today,” says Frei. Obviously life hasn’t always been a bed of roses, and it still hurts when he recalls all the emotions he has unloaded on loved ones in difficult periods, especially during the five months of rehabilitation at the former Swiss Paraplegic Centre in Basel. That was where he ended up after a terrible accident in the summer of 1978 when he was inspecting the course of the Seelisburg mountain run. Slipping on the wet grass, he plunged down a gorge. As he lay at the bottom, he realised he couldn’t feel his legs.

Frei was just 20 years old. “I had so many hopes and dreams, so much I wanted to do in life. It was a brutal blow.” He was plagued by questions as he chatted to the other young men in the hospital ward, but answers were tantalisingly hard to find. On one occasion, they found themselves wondering whether any of them could ever even consider having children. None of them knew, so the next morning one of the more courageous ones asked the doctor. “It wasn’t me, but I pricked up my ears.” Even the doctor was unsure and simply advised them to try. Today, with two children of his own, Frei is no longer in any doubt. “It’s been a real highlight for my sense of self-worth,” he says.

To this day, it’s not his inability to walk that bothers Frei the most. Rather, it’s having to constantly stay vigilant about the range of hazards faced by people with paraplegia: for instance, burning himself if he forgets to check the shower temperature, getting frostbite during wheelchair skiing or dealing with bladder problems and pain. Yet Frei’s discipline has largely spared him from the demoralising side effects of his disability. “It helps put my condition in perspective,” he says. Perhaps even more importantly, it has provided the basis for his extraordinary sporting career. Heinz Frei is one of the most successful Swiss athletes of all time. He has taken part in every Paralympics since Los Angeles in 1984, winning a total of 15 gold medals. He also has 14 world championship titles and over one hundred marathon victories to his name. “I know how lucky I am, and I’m both humbled and grateful,” explains Frei. His body still does what his mind tells it to do. “So I always give my body a pat on the shoulder to say thank you!” Fortunately, technology continues to develop at an equally impressive pace, with wheelchairs getting both lighter and more manoeuvrable. That spurs Frei on, and the 62-year-old is even toying with the idea of taking part in Tokyo 2020, which would be his tenth Paralympics. ○

HEINZ FREI is one of the most successful Swiss athletes of all time. He has been in a wheelchair since an accident over 40 years ago. Having originally trained as a surveyor, he now works at the Swiss Paraplegic Centre in Nottwil and serves as a Cybathlon Ambassador.

ASSISTANCE SYSTEMS WITHIN EASY REACH

A hand exoskeleton designed for everyday wear has to be light and straightforward to use.

1 HEADING HOME WITH A REHAB ROBOT

TEXT Martina Märki

Hands are our most important tools. Many stroke survivors struggle with a serious loss of motor function in their affected hand. Despite undergoing intensive physiotherapy and occupational therapy in the first few weeks, two out of three patients subsequently find that this hand remains impaired. This constraint takes a heavy toll on their independence in day-to-day life. Roger Gassert, Professor of Rehabilitation Engineering at ETH Zurich, aims to change that.

"The use of robotic devices for therapy is fairly widespread in hospitals and rehabilitation centres," says Gassert. However, he sees room for improvement, particularly when patients return home from a clinic environment. "The transition to everyday life is tricky," notes Gassert, adding that the moment patients are on their own, they tend to favour their healthy hand, using it more often to relieve their impaired hand. The consequences are dire. The hand remains untrained, and the skills acquired so painstakingly in rehab are lost. The impairment worsens, as do the adverse effects of paresis.

USE IT OR LOSE IT A training regimen to exercise the hand's functions could counteract this problem and provide additional benefits such as moving and strengthening the arm. "Gripping isn't just about muscle strength. It also involves sensory perception and dynamic interaction with the environment, which are cognitively demanding," says Gassert. But how do you motivate people to keep training and using their impaired hand at home?

Gassert and his team are pursuing two avenues. For one, they aim to continue developing a robot designed for hand therapy in hospitals so that patients can also use it independently at home. The other option – a hand exoskeleton to help patients grasp objects – is for cases where the first approach has little chance of succeeding. Both robots are already undergoing trials with partner clinics. But what works in the sheltered setting of a rehab facility may not be suitable for day-to-day use at home.

The ReHapticKnob is a robot-assisted therapy device with two finger modules. The patient interacts with these interfaces, shifting their relative positions with a pinching motion or rotating both. Various sensors track the hand's motor and sensory functions with great accuracy. This device can render a wide range of virtual objects with different characteristics for the patient to feel. Using virtual reality, patients can monitor how their fingers are accomplishing the task of grasping an object. The robot allows patients to execute special exercises based on neurocognitive therapy, which were developed and implemented in collaboration with the Hildebrand Clinic in Brissago. It automatically adjusts the degree of difficulty according to an assessment of how the therapy is progressing.

The robot has been used successfully for therapy in a clinical setting, as one study has shown. It remains to be seen if this approach works at home. "You can't just hand this kind of device over to patients and say, 'your turn,'" says Gassert, pointing out the many challenges they would face. This is why researchers are starting with a follow-up study to determine how patients fare once they are familiar with the devices and are free to use them independently at the clinic but outside of regular therapy hours.

REDUCED TO THE MAX Gassert is well aware that technologies for home use have to be convenient, easy to operate, robust and as low-maintenance ›

as possible. Reduce to the max: that's the mantra. Tenoexo, a hand exoskeleton, has already been extensively streamlined. This assistive device is designed to help people grasp real objects in their day-to-day activities. "Today's devices are very complex and heavy. They may be able to do a lot, but they're hard to carry and put on without help," says Gassert. In marked contrast, the exoskeleton from Gassert's laboratory is streamlined for utmost simplicity. The researchers found that four grasp types suffice to hold 80 percent of all objects, which is why at the moment the exoskeleton can only close all its fingers at the same time. Equipped with elastic elements, they adapt to whatever object they grasp. The motor is housed in a small backpack. All in all, the exoskeleton weighs less than 150 grams. The wearer gives the command to move by simply pressing a button. Gassert's team decided to do without sensors and control channels that connect the nerves or brain to a brain-computer interface (BCI). "That's obviously exciting, but it's still too unreliable for use in daily life," says Gassert, dismissing the BCI option with a wave of his hand.

He is vigorously pursuing his vision of introducing robot-supported rehabilitation and assistance into people's everyday lives. Far from limiting his collaboration to clinics and partners from Switzerland and neighbouring countries, Gassert will also be able to develop his vision further in the new Future Health Technologies research module at the Singapore-ETH Centre. The environment in Singapore looks ideal from his perspective, with skilled research partners, a tech-savvy society and a close-knit healthcare system that accompanies patients as they return to their lives at home. "We hope this will give us easier access to patients in their homes," says Gassert. ○

Roger Gassert at the Rehabilitation Engineering Laboratory:
relab.ethz.ch/laboratory/team/roger-gassert.html

2

BRAIN GAME

TEXT Samuel Schlaefli

Samuel Kunz is hard at work on his training regimen. At the next Cybathlon, he will be up against 11 other athletes, competing in a virtual car race in which he controls the vehicle using only his thoughts. Each week, Paulina Kratka – a Bachelor's student from the Neural Control of Movement Lab – visits him in Frauenfeld to help him train. She starts by placing a cap on his head studded with 64 electrodes and filling each electrode cavity with an electrolyte gel to ensure good contact between the electrodes and his scalp. Then she plugs the cable from the cap into a signal amplifier. This is connected to a laptop on which the game runs.

Samuel Kunz is the pilot of the ETH Zurich Brain Computer Interface (BCI) team. He has had tetraplegia since a swimming accident in the Limmat river in the summer of 2014. Despite his disability, he completed his degree in mechanical engineering at ZHAW and now works as a design engineer. "I'm a total technophile," he says. "When my therapist told me about the Cybathlon, I was immediately keen to take part."

STEERED BY EEG For the next Cybathlon, Nicole Wenderoth, an ETH Professor at the Neural Control of Movement Lab, is working closely with Professor Cuntai Guan from Nanyang Technological University (NTU) in Singapore. Guan's group specialises in electroencephalography (EEG) and neural signal processing. In neuroscience, EEG is used to measure the electrical activity of the brain. With the right algorithms, it can also be used to play computer games.

"We use EEG to record all the signals from the cerebral cortex," explains Rea Lehner, Senior

By measuring brain signals, it's possible to play a computer game with nothing more than your thoughts.

Researcher in Future Health Technologies and manager of the ETH BCI team. "So we start out with a complete mess of different brain signals." She says that the biggest challenge is to filter out the signals the pilot uses to control their avatar in the computer game and identify them using machine learning. In the case of Lehner's BCI team, the signals of most interest come from the motor cortex in the rear portion of the frontal lobe. Published research has shown that these signals are suitable for establishing a brain-computer interface (BCI) due to their distinct activity.

The Cybathlon team, which is supported by Rehaklinik Zihlschlacht and the company Brain Products, spent almost two years optimising the signal processing algorithm. This is what converts the electrical signals from Samuel Kunz's motor cortex into movements on the screen – and it has to be as consistent and accurate as possible. Four commands are required to play the game. To steer his vehicle left, Kunz thinks about moving his left hand. When the racetrack curves to the right, he thinks about his right hand. To drive straight ahead, he has to relax as much as possible – and when the game racetrack is plunged into darkness, he has to switch on the headlights by thinking about moving both hands at the same time. Different patterns are activated in the cortex region depending on his thoughts. These are recorded via EEG and converted into control signals using algorithms. "The training is exhausting," says Kunz. "Trying to move my body in my thoughts is a bit like being trapped in a dense, sticky substance like honey," he adds, though he emphasises that things have improved markedly since he first started, when he felt like he was encased in concrete. Gradually regaining a mental feel for his own body has taken a great deal of rehabilitation and training.

In December 2019, Rea Lehner relocated from Zurich to the Singapore-ETH Centre. She wanted to be in the same place as her research partners so they could work together even more closely in the months leading up to the Cybathlon. While the Singapore team wrestles with the algorithm, training is in full swing in Zurich. Every session has a program running in the background that analyses the algorithm's performance. "The number of training sessions we run with a specific algorithm is key, because the algorithm adapts to the pilot, and the pilot gets used to the algorithm," says Lehner. Deciding when the time has come to stop developing the algorithm is a tricky business, she adds.

INTEREST FROM TECH COMPANIES Unlike other technologies showcased at the Cybathlon, the brain-computer interface is still a long way from its first practical application, one example of which might be controlling a wheelchair by thought alone. The problem is that preparing and using an electrode cap is a cumbersome task, and signal conversion is highly complex. Right now, it is easier to rely on signals from muscles that are still active, such as the eyelids. Signals produced in this way are considerably stronger than so-called thought signals. ›

Nevertheless, there is already huge interest in BCIs from businesses, with Google and Facebook already investing millions in the field. Voice recognition was a major leap forward for smartphones and tablets, but mind control is the next big thing. Tesla founder Elon Musk is also developing BCIs through his company Neuralink, where a team of over 90 researchers is working on projects such as tiny implantable electrodes. Making this tech safe for human use is still some way off, however, and Lehner has some concerns about this invasive form of BCIs: "Implanting electrodes directly in the brain obviously gives you much clearer signals than a cap," she says. "But in terms of patient benefits, I think those kinds of interventions are only justified in exceptional cases." The potential complications can be severe, and scientists have yet to carry out long-term studies on large cohorts. Lehner hopes rapid progress in the development of non-invasive BCI technologies will ensure invasive technologies are reserved for exceptional cases.

VICTORY NAP At the Cybathlon, Kunz will compete against 11 international BCI teams. To complete the 500-metre race, he will have to execute each of the four commands four times, without knowing in advance in which order he will need to do so. The current favourite is the team led by former EPFL Professor José Millán, which won the 2016 Cybathlon. The biggest challenge we pilots face, says Kunz, is to avoid moving our face muscles, as this causes serious signal interference. His best result to date came after a post-lunch nap. "But I'm not sure I'll be able to take that kind of nap right before the race, where there are thousands of people in the crowd," says Kunz. ○

Find out more about the BCI project:
ncm.hest.ethz.ch/research/bci-cybathlon.html

Podcast featuring Samuel Kunz and Rea Lehner:
www.ethz.ch/podcast

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THE ARTIFICIAL LEG THAT CAN FEEL

TEXT Fabio Bergamin

"I can feel my foot again for the first time after so long!" says Djurica Resanovic. Doctors were forced to amputate one of his legs above the knee seven years before the trial. Since then, he has worn a prosthetic leg. Like many others with amputations, however, he finds it hard to rely on his prosthesis when walking. People with intact legs can feel their knee move and their foot touch the floor, but prosthetic wearers do not receive any sensory feedback to the brain from their standard prostheses.

A research consortium led by ETH Professor Stanisa Raspopovic and Lausanne-based start-up SensArs has now developed a neurofeedback system to rectify this problem. Information is collected by pressure sensors under the sole of the foot and motion sensors in a sophisticated high-end prosthetic knee joint. Specially developed algorithms translate this information into electrical impulses – the language of the nervous system – in real time. Tiny electrodes implanted in the sciatic nerve then forward this information to residual nerves in the patient's leg. Nature does the rest: the nerve signals reach the brain, allowing the wearer to sense their prosthesis and better control their gait.

This is the first time scientists have developed a prosthesis that people with amputations above the knee can feel. "It makes walking much easier. What's more, it helps people with leg amputations navigate obstacles without falling and climb stairs much faster – two tasks that these patients previously found difficult or impossible," says ETH Professor Raspopovic. If a prosthesis is not connected to the brain, the amputees do not perceive it as part of their body. This loss of sensory perception makes it difficult for people to trust their prosthetic limb. Instead, they rely too much on their healthy leg, which reduces their mobility.

As part of a clinical trial carried out in collaboration with the University of Belgrade*, the researchers demonstrated the benefits of walking with sensory feedback. The three volunteers completed a series of tests both with and without neurofeedback, and results clearly showed that they found it much less tiring to walk when using neurofeedback – evidenced by their significantly lower oxygen consumption. Measurements of brain activity also revealed that the neurofeedback mechanism reduced participants' mental fatigue. Resanovic was one of the volunteers who took part in the trial, and his enthusiasm is palpable. "Walking used to be an act of intense concentration for me, but not any more," he explains. "I can look straight ahead without having to constantly check where I'm stepping." The participants reported significantly increased confidence in their prosthetic leg thanks to neurofeedback. Measurements of brain activity also showed they were actually perceiving the neuroprosthesis as an extension of their own body – a blending of machine and body that made their artificial leg feel like a real limb.

Thanks to sensors on the knee and sole of the foot, this prosthesis almost feels like it's part of the body.

NEUROSTIMULATION TO FIGHT PAIN The new interface to the nervous system can also be used to stimulate nerves independently of the prosthesis. Savo Panic also took part in the clinical trial. Prior to volunteering, he had experienced severe phantom limb pain that often woke him up at night. "Everything used to hurt, from my toes, foot and heel to my ankle and calf," he explains. "But now that's all gone."

Panic was one of two volunteers to complete a month-long neurostimulation therapy programme as part of the trial. Scientists succeeded in significantly reducing the pain experienced by the other volunteer. In Panic's case, the pain disapeared entirely. "I haven't felt any phantom pain since I began using neurostimulation," he explains.

Although researchers are buoyed by these positive results, they insist that a longer study – one in which a larger number of volunteers can test the system in their day-to-day lives – is required to draw more robust conclusions. This time-limited clinical trial used a cable to transmit the signals through the skin from the prosthesis to the electrodes in the patient's thigh. This meant that participants had to undergo regular medical check-ups. To eliminate this need, the scientists are now working with the start-up SensArs to develop a neurostimulation device that can be fully implanted in patients like a pacemaker and that can receive information wirelessly from external sensors. ○

ETH Zurich Neuroengineering Lab:
www.neuroeng.ethz.ch

*In addition to ETH Zurich, the universities of Belgrade and Freiburg, and the companies SensArs and Össur, the project also included the participation of researchers from EPFL, the Sant'Anna School of Advanced Studies in Pisa, the University of Montpellier and the company mBrainTrain.

BREAKING BARRIERS, RAISING AWARENESS

People with no mobility restrictions rarely think about the everyday obstacles faced by people with physical limitations or different needs. A new project aims to remove barriers at ETH.

TEXT Norbert Staub

Julian Heeb on the ramp to ETH Zurich's main building.

"We want to break down barriers – or rather stop them going up in the first place," says Horst Weltner, an expert in facility management who heads up the Barrier-Free at ETH Zurich project, which was launched in 2018. Spearheaded and managed by ETH Vice President Ulrich Weidmann, the project follows the "design for all" principle. "This project will demonstrate how creating barrier-free environments benefits everyone," says Weidmann. "The problem isn't people with disabilities, but rather infrastructure that creates unnecessary barriers and is therefore not fit for purpose." He argues that the entire ETH infrastructure – including buildings, IT systems and the bus between Zentrum and Hönggerberg – should be accessible to all ETH members and guests but acknowledges this is not yet the case. "A seemingly innocuous step can literally stop people with a physical disability in their tracks. Many obstacles result from careless planning and construction," says Weltner. "Wheelchair users shouldn't have to take a lengthy detour just to get to the same place as non-wheelchair users." One such barrier was recently eliminated in the ETH main building when a ramp was installed at the main entrance, making the building accessible to wheelchair users and non-wheelchair users alike.

CULTURE SHAPES ARCHITECTURE Toilet design has recently become a much-discussed yardstick of how inclusive an organisation is. The need for gender-neutral toilets became clear based on greater consideration of trans and non-binary people. "One estimate suggests there are up to 300 trans people at ETH, so we need to put solutions in place quickly," says Weltner. "Wherever feasible, we are now converting toilets and showers into gender-neutral facilities."

"This project has been a real eye-opener," says Weltner's colleague Romila Storjohann. "I recently tried out a wheelchair just for half an hour or so. Even that was enough to give me a sense of how daunting even the smallest obstacles can be." A lot of the changes that are needed obviously involve infrastructure, she says, but there are deeper issues at play. "It's important to start with the culture. We can only break down barriers and prejudices if diversity is a natural part of how people think and plan," she argues.

PARTICIPATION IS KEY That's a conclusion that Marie Glaser readily agrees with. As director of the ETH Centre for Research on Architecture, Society and the Built Environment and an expert in cultural studies, she has spent many years working on equal opportunities in housing and the built environment. How comfortable people feel in their own home is determined not only by accessible architecture, she says, "but also, crucially, by their ability to participate in social life. Put those opportunities in place, and the necessary structural modifications are often less complex than you might think."

As an example, she quotes the Zurich housing cooperatives' centenary project, which is supported by the city of Zurich. The "More than housing" site development will provide cooperative housing for 1,400 people on the northern edge of Zurich. It draws on models of village life by offering numerous communal spaces including a bistro, coworking spaces, an indoor playground, a workshop and even a guesthouse. Instead of everyone having their own freezer, there is a central cold store – and instead of a supermarket, a collective provisions store. "Inclusion came naturally in this project because diversity was taken into account at every stage of the planning process," says Marie Glaser. In fact, the principle of universal design plays a key role in recent discourse on design and architecture. "It's not about thinking in terms of groups, and certainly not marginal groups," she explains. "It's about developing solutions that are compelling and appealing precisely because they cater to everyone's needs and abilities right from the start."

AN APP PAVES THE WAY Julian Heeb – who studied electrical engineering at ETH Zurich and completed his Master's degree in 2007 – also believes in transforming problems into solutions. He now works as a software engineer and project manager at the IT company Supercomputing Systems and uses an electric wheelchair. He doesn't recall any serious problems with accessibility during his degree course, though this was largely thanks to his fellow students. They kept him company on the many detours he had to take and helped him with doors and lifts. On one occasion, however, he had travelled to Zurich from his home in St. Gallen for an event run by a professional association only to discover that the venue was in the basement of a restaurant. Access was impossible. Unable to take part, he simply had to leave – but he refused to sit back and do nothing. "The engineer in me wanted to find a solution to prevent those kinds of frustrating experiences," says Heeb. The result was Ginto, an app that collects and compiles information on the accessibility of public buildings. The app not only caters to people with special physical needs, but also to other groups such as parents with pushchairs. One of the secrets to Ginto's success is its reliance on crowdsourcing. Users answer a list of questions to provide Ginto with the data it needs on issues such as the presence of steps, ramps or lifts and the width of doorways. It then compares this data with the user's profile to offer tailor-made information. "What we perceive as barriers can differ markedly from one person to the next," says Heeb. "So we leave it up to the individual user to decide whether a building is accessible or not." ○

The Cybathlon is an opportunity for people with physical disabilities to put the latest assistive technologies to the test. ETH Zurich aims to step up rehabilitation research and education with the Rehab Initiative. But how are the needs of people with disabilities best met? To discuss the issues, we hosted a roundtable with a physician, a person with a disability and a researcher.

TEXT Corinne Johannssen and Martina Märki

MICHAEL LEUNIG, Head of Hip Surgery and CMO at the Schulthess Klinik in Zurich. This clinic supports ETH’s Rehab Initiative.

THEA MAUCHLE, President of the Behindertenkonferenz Kanton Zürich BKZ (disability association of the canton of Zurich). An accident 30 years ago left her reliant on a wheelchair.

ROBERT RIENER, Professor for Sensory-Motor Systems at ETH. He set the Cybathlon and the Rehab Initiative in motion.

Ms Mauchle, how was your trip to ETH today?
THEA MAUCHLE I came by “bike” – that is, my wheelchair tractor. Unfortunately, not every tram and stop is wheelchair-accessible, so I have to plan my route carefully before I leave. The same goes for the location of ramps and big lifts here in ETH’s main building. I always leave myself plenty of time to get places.

So a good wheelchair alone is not enough?
ROBERT RIENER It takes a lot more than that. It takes barrier-free buildings; it takes good signage. Technology can help, of course – for example, an app for buildings that shows the best route for wheelchairs. Or a wheelchair that can climb stairs like the one developed by the ETH spin-off Scewo. The combination of barrier-free access and technology can offer many solutions.

Professor Leunig, what’s your take on this situation as a physician?
MICHAEL LEUNIG There are many aspects I simply don’t experience directly in my day-to-day work at an acute hospital like Schulthess Klinik. Thanks to the development of minimally invasive techniques, we’ve now reached a point where patients often go home a few days after surgery.

But the Schulthess Foundation is very much involved in ETH’s Rehab Initiative.
LEUNIG The goal of the initiative is to improve the quality of life for people with disabilities, and the Schulthess Foundation is very committed to this. Although we focus on acute care in our clinic, we’re well aware that the rehabilitation phase that follows is extremely important. For example, we want to find out how to prevent sarcopenia, the loss of muscle strength in old age. Defining the term rehab as broadly as possible makes sense in view of our ageing society.
RIENER In the Rehab Initiative, we’ve adopted a very broad definition of rehabilitation that includes the entire process from the end of the acute phase through various stages of rehabilitation and on to everyday support for people with disabilities. We take rehabilitation to ›

also mean integration in everyday life and inclusion in society.

The Schulthess Foundation is funding a professorship in data science. Why?
LEUNIG If we collect data about the limits of patients' capabilities, we can invest in measures that are much more targeted. We've been following this approach in orthopaedics for some time and are now applying it to smaller studies in physiotherapy. We need data science to extend these capabilities to large data sets.
RIENER The Schulthess Klinik already has a large data set based on tracking patient histories in everyday life over years following clinical treatment of their hips, knees or back. This knowledge can serve to optimise treatment and in the best case even avert diseases – in other words, we can improve prevention. And technology can be adapted to better meet the actual needs of people with disabilities.

What do you think of this approach, Ms Mauchle?
MAUCHLE Above all, I think that more needs to be done to enable barrier-free access. During rehab, I learned how to live the most self-determined, independent life possible with a wheelchair. Then I came out of rehab to discover that was impossible. I was shocked. I got the impression that the public was hostile to disabled people, and that politicised me.

Has anything changed in the last 30 years?
MAUCHLE A lot has improved in medicine, but not so much in society. People still expect the individual to adapt and overcome obstacles. However, there is a paradigm shift underway in the discussions about equal rights for disabled people. The perspective is shifting from the individual medical angle towards a societal outlook: How can we create an environment that enables a person with a disability or disease to take part in social life? This may require some technical assistance. But I don't want stair-climbing wheelchairs to give architects the idea that they can stop thinking about those "ugly" ramps.

> "Technology can also be very burdensome."
>
> THEA MAUCHLE

LEUNIG But can't we also hope to see fewer and fewer barriers as new technologies emerge? Or individuals being able to surmount these barriers relatively easily?
MAUCHLE I'm not a technophobe. I just find that technology doesn't always help me; it can actually be very burdensome. You have to obtain it, maintain it, store it. A lot of it may be exciting, technically speaking, but not necessarily practical in everyday life.

Professor Leunig, what impact have technical advances had on your field?
LEUNIG So much has changed. In the past, the focus was mainly on improving implants. Now we're seeing huge strides in surgical techniques. Our short-term rehab is all about building muscle. Perhaps there'll soon be neurostimulation techniques not only for acute treatments but also for helping patients with chronic conditions.

What's your experience of the transition from invention to practice?
MAUCHLE Much has improved on the organic front – such as nerve tracts, bladder, intestines – and in terms of drugs and therapies. On the other hand, when I had my accident 30 years ago, the media were reporting about paralysed rats that were able to walk again. At the time, I actually thought, "Great, I'll be walking again in ten years!" Unfortunately, we still haven't reached that point.

FUNDING THE REHAB INITIATIVE
ETH researchers are working with disability organisations, hospitals, government and businesses to establish end-to-end rehabilitation. Donations from the Stavros Niarchos Foundation and numerous private individuals gave the project a major boost in 2019 and supplemented the funding provided by the Wilhelm Schulthess Foundation. ETH is seeking further funding partners.
www.ethz-foundation.ch/en/reha-initiative

LEUNIG The challenge today with implants is that the regulations have grown so prohibitive – in part because of various scandals – that it's becoming increasingly difficult to get innovations into clinical practice.
RIENER Development costs are enormous in the field of medicine. But there can be no progress without new developments. The new prosthesis we're testing in the lab will eventually replace today's most expensive prosthesis or make it more affordable. The same applies to new implants.

Professor Riener, what prompted the Rehab Initiative's launch?
RIENER The Cybathlon was a big catalyst. We got a lot of positive feedback from disability organisations and from people with and without disabilities. This encouraged us to delve deeper into this topic in terms of research, teaching and technology transfer at ETH. The same goes for the public discourse about disabilities. Soon we'll have a professorship for barrier-free architecture. And we're thinking about a professorship in social sciences to address the topic of inclusion.
LEUNIG What is fascinating about the Cybathlon is seeing things that may not be ready for mass production today, but that point the way towards the future. And what I find so compelling is that the people trying out and testing the equipment are the ones who are actually affected. Another very positive point is that it raises awareness of disability issues.

Do you think that awareness helps?
MAUCHLE I believe there's a deep-seated psychological defence against the topic of disability and therefore also against people with disabilities. Nobody wants a disability. No one wishes for a disabled child. A disability is not going to be greeted with euphoria even when super-robots become a reality. This defensive attitude prevents many things that could be done from being done. When I see restaurants with steps at the entrance, I often think they just don't want the sight of disabled people to spoil the atmosphere.
RIENER That's why it's so important for people to come to terms with "otherness". This is the idea behind the Cybathlon – experience, organise and discuss things together to foster much greater acceptance and turn otherness into normality.

How do you promote these encounters?
RIENER We run a programme of visits to schools, and there are panel discussions. The Cybathlon@School programme takes us into schools because we believe that these encounters should start as early as possible. And this isn't just about demonstrating new technologies – the children are taught by someone in a wheelchair or a person with an artificial limb.
MAUCHLE Children are least likely to have problems with such encounters. They have no qualms about asking me questions when they see me on the street. But some parents respond in a very anxious, uneasy way.
RIENER Adults are often awkward about it. I had very strong inhibitions the first time I interacted with a paraplegic patient at the clinic for my doctoral thesis. Things would have been different if I had been accustomed to dealing with people with disabilities at an early age.

Ms Mauchle, as a person with a disability, how do you rate the ETH Rehab Initiative?
MAUCHLE I view it with good-natured scepticism. It's tremendously important for us to be truly involved – as disability organisations, as the people directly affected by disabilities, and as technology users. ○

> "Defining the term rehab broadly makes sense in view of our ageing society."
>
> MICHAEL LEUNIG

The award-winning Anergy Grid on the Hönggerberg campus.

ETH's underground storage system

ENERGY PRIZE

ETH has won the Watt d'Or Energy Prize, bestowed by the Swiss Federal Office of Energy, for its dynamic underground storage system on Hönggerberg campus. With more than 30 buildings, teaching and research facilities are equipped with the latest technologies. They consume nearly 77 gigawatt hours of energy a year, with heating accounting for 22 gigawatt hours. The Anergy Grid and its underground storage system heat and cool buildings in an energy-efficient way. It also helps curb CO_2 emissions. The reduction target for 2020 is 50 percent of 2006 or 5,000 tonnes of CO_2 a year.

Singapore

REIMAGINING HEALTHCARE

ETH Zurich intends to step up its research activities in Singapore. Aiming to extend its current Future Resilient Systems programme by five years, it is also poised to launch a new Future Health Technologies programme in March 2020. The latter is a collaboration with Singapore's National Research Foundation (NRF).

As the population ages around the world, countries are confronted with new challenges. "Singapore saw the signs early on, so we can learn a lot there," says Nicole Wenderoth, professor for Neural Control of Movement at ETH Zurich. Wenderoth is the designated director of the new Future Health Technologies programme, which ETH Zurich plans to launch under the umbrella of the Singapore-ETH Centre with local partners from universities, clinics and industry. This programme centres on the big question of how to pursue innovative healthcare projects outside of hospitals and clinics. It will focus on new approaches to prevention and patient care after a hospital stay. The programme is to kick off with three projects that aim to address pressing real-world issues. They will explore ways of preventing femoral neck fractures in older people, combating obesity, and developing more efficient therapies for stroke patients.

National research priorities

NEW PROGRAMMES LED BY ETH STAFF

ETH Zurich staff have been designated to lead or co-lead three of the new Swiss National Centres of Competence in Research. The UControl NCCR deals with the basics of automation and digitisation. It is led by John Lygeros, professor at the Automatic Control Laboratory, and by Gabriela Hug, professor at the Power Systems Laboratory. The Suchcat (Sustainable Chemical Processes through Catalysis) NCCR is led by ETH chemistry professor Javier Pérez-Ramirez. Professor of microbiology Julia Vorholt is co-lead of the Microbiomes NCCR.

Image: ETH Zurich

Major changes on campus

Building for the future

More and more people are studying and working at ETH. There's construction work ahead to ensure the university premises can cope with the increasing demand.

The new Polyterrasse will have a more spacious, open feel. A view of the future Polyterrasse with the café level clearly visible below.

Image: MM Krucker Ghisleni

Anyone who has visited an ETH Zurich campus recently will have noticed the amount of construction work going on. On the Hönggerberg campus, ETH Zurich is renovating the HIF building, which opened in 1976 and houses the Department of Civil, Environmental and Geomatic Engineering. The building is also being expanded to include a multi-purpose hall and additional laboratory facilities. The new laboratories will bring together all nine environmental engineering professorships in the same space for the first time. Promoting collaboration is also one of the key principles behind the new GLC development and laboratory building. Currently under construction on the Zurich Zentrum campus, it will be used for work in the fields of health sciences and medical technology. The building includes laboratories for both new and existing professorships as well as research facilities that will enable collaboration with the University of Zurich and the hospitals. It will also provide new seminar rooms and workspaces for students. On the Schällemätteli Life Sciences Campus in Basel, ETH is building the BSS laboratory and research building for systems biology and synthetic biology. In total, the three construction projects will provide 35,250 square metres of additional space for teaching, research and knowledge transfer – the equivalent of nearly 138 tennis courts! It's a significant amount of space, but it's still just a drop in the ocean.

Growth constraints

ETH Zurich has approximately 490,000 square metres of usable space at its disposal in around 200 buildings – eight times the area of the Louvre in Paris. But space is still at a premium. In the city of Zurich, for example, building plots are growing scarce while the residential population continues to increase. Room for expansion at ETH Zurich is slowly running out too, particularly on the Zentrum campus, where there is hardly any free space left for new buildings.

This situation stems from the significant increase in the number of ETH students and staff over the past ten years and the fact that construction has not kept pace with this growth. "We expect this trend to continue in the years ahead, though growth is not something that ETH Zurich is specifically aiming to achieve. Our primary objective, as ever, is to lead the field in high-class, innovative teaching and research," says Ulrich Weidmann, ETH Vice President for Infrastructure. "That's what will continue to attract researchers and students in the future, so ETH will continue to grow." Exploring and building on new trends in teaching and research is a major undertaking – and one that requires additional tailor-made spaces.

Increasing density on Hönggerberg

The Hönggerberg campus is central to ETH's plans to develop its premises. While development options are limited on the Zentrum campus due to the historical layout of the district and city, ETH still has land available for new buildings on the Hönggerberg campus. Between now and 2040, the university intends to increase the total volume of its buildings by 50 percent. But before ETH can go ahead with these construction projects, the Zurich Municipal Council must approve special new building regulations.

The vision for Hönggerberg is to make it an attractive campus with an urban feel, combining the teaching and research buildings with public spaces, gardens and a busy boulevard featuring cafés and shops. Four new high-rise buildings along the boulevard (Wolfgang-Pauli-Strasse) will free up space for a new park and the expansion of the Flora Ruchat-Roncati garden. ETH Zurich is pursuing a strategy of infill development, which will leave the surrounding landscape and nearby recreation area intact.

Opening up the Polyterrasse

As well as the construction work, ETH is also starting to refurbish buildings constructed in the 1970s. These include the HIL building on the Hönggerberg campus – which houses the Department of Architecture and the Department of Civil, Environmental and Geomatic Engineering – and the main building on the Zentrum campus, as well as the multi-purpose canteen building below the Polyterrasse. This latter building combines sports and restaurant facilities, which are used by some 4,000 students, staff and faculty each day. This number has increased substantially in recent years, overwhelming the sports facilities and highlighting deficiencies in the number and distribution of the available spaces, which are inadequate for a modern sports centre.

The refurbished building will include an event space which will replace the Alumni Pavilion adjacent to the Polybahn. This will create a clear and direct connection between the Polybahn and the café level. The plans also envisage opening up the approach to the Polyterrasse, which continues to be a popular place to pass the time and admire the marvellous views. The steps that currently lead up to the main building will be moved to the edge of the terrace to create a larger and more coherent space. A spiral staircase crowned by a crystalline glass structure will forge a new connection between the Polyterrasse and the ETH Link bus stop, making this transit point more accessible for both pedestrians and vehicles. The refurbishments will also include improvements to building services, fire safety, earthquake protection and barrier-free access.

A range of interim solutions will be provided for vehicular access, sports and restaurant facilities during the construction project. The University of Zurich will provide temporary access to sports facilities in Irchelpark, and the approximately 2,500 meals eaten in the canteen each day will be served from a temporary canteen on Karl-Schmid-Strasse. — Florian Meyer

Find out more:
→ ethz.ch/en/campus/development/construction-projects.html

Image: Eline Keller-Soerensen

Philanthropy

CHANGING THE FUTURE TOGETHER

By Donald Tillman

I recently received an email from 17-year-old student Shirin Ferdows saying that she would like to make a donation to support breast cancer research at ETH Zurich. Soon afterwards, we met up with Shirin to find out more. Together with her schoolmate Ana Sofia Reyna, she had organised a Pink Day at the International School of Geneva to raise awareness of breast cancer. With members of her own family having been affected by this disease, it is a cause that is close to her heart.

The two students raised a total of 2,000 Swiss francs. This money will now go towards supporting the research of ETH professor Orçun Göksel. His work has improved breast cancer screening and helped cut the number of incidents of this condition. This spring, Shirin and her schoolmates will get to meet Professor Göksel on a visit to ETH. I am truly impressed to see a young person like Shirin responding so positively to a difficult situation and actively contributing to efforts to find new technologies to improve screening and treatment. Well done, Shirin!

→ www.ethz-foundation.ch/en

Taking stock of spin-offs

A VERY SUCCESSFUL YEAR

It was a very good year for ETH Zurich spin-offs. The number of start-ups was again up from the previous year, with ETH Zurich researchers founding 30 new companies in 2019. The considerable investments made in ETH Zurich spin-offs also attest to their appeal. GetYourGuide, for example, was the first ETH start-up to achieve a valuation of over 1 billion dollars before going public. The overall volume of investment in ETH spin-offs also developed positively last year. It achieved an unprecedented level with around 630 million Swiss francs invested in ETH spin-offs.

As in previous years, many of these new companies have their roots in information and communication technology. The area of advanced materials has seen particularly strong growth, with six of the new spin-offs focusing on sustainable and eco-friendly materials.

ETH Zurich Vice President Detlef Günther is delighted with the number of start-ups. He asserts that for ETH Zurich, it is crucial that promising technology and ideas arising from basic research are translated into companies with growth potential, leading to the creation of new jobs. Surviving in the market over the long-term is a challenge and poses a high risk to the company founders. However, as Günther says, "Prospects for starting a company at ETH Zurich are excellent."

ETH Zurich President Joël Mesot (left) and Hubert Keiber, Chairman of the Board of Trustees of the Werner Siemens Foundation, are pleased with the long-standing partnership between their two institutions.

ETH Foundation

BUILDING DIGITAL TRUST

Now that we engage in so many more activities online, it is becoming vital for us to be able to navigate the digital world safely and securely. ETH professors David Basin, Peter Müller and Adrian Perrig and their project partner Matthew Smith, a professor at the University of Bonn, are looking to develop a fundamentally new security architecture that enables trusted data communication. The researchers are seeking to transfer the same properties that instil trust in the real world to the digital world, thereby creating a trusted environment in which to carry out digital transactions. This project is building on – and is sure to boost – ETH Zurich's strengths in data and cybersecurity. The Werner Siemens Foundation has donated 9.83 million Swiss francs in support of this ambitious project.

This generous grant to the Center for Digital Trust now brings ETH Zurich's long-standing partnership with the Werner Siemens Foundation into its fifth chapter. In 2004, the foundation supported the construction of a flexible auditorium, the Werner Siemens-Auditorium, in the HIT building on the Hönggerberg Campus. In 2013, the foundation provided initial funding for the creation of a professorship in geothermal energy. 2017 saw the foundation enable the creation of the Center for Single Atom Electronics and Photonics. In 2018, the Werner Siemens Foundation lent significant support to the creation of the Bedretto Underground Laboratory, which houses research activities on earthquake dynamics and safe geothermal energy extraction.

Image: Alessandro Della Bella

Transfer

Skin-friendly electrodes

Electrodes developed by the ETH spin-off IDUN Technologies monitor body parameters anywhere – even underwater – and deliver high-quality readings.

IDUN Technologies produces soft and dry biopotential electrodes for measuring body data. Comprising a skin-friendly composite of silicon rubber and conductive silver particles, these electrodes are elastic like skin. Their adhesive properties stem from their special surface patterning. The electrodes can serve to monitor the electrical activity of the heart, the brain and muscles, delivering results of the same quality as clinical gel-based electrodes.

The advantage of dry electrodes is that they are comfortable even when worn for longer periods and do not irritate the skin. They also perform reliably even in difficult conditions, such as underwater. Readings may be taken anywhere, even outside the hospital in ordinary day-to-day settings. IDUN Technologies also produces tailor-made electrodes that readily integrate into diverse appliances and wearables.

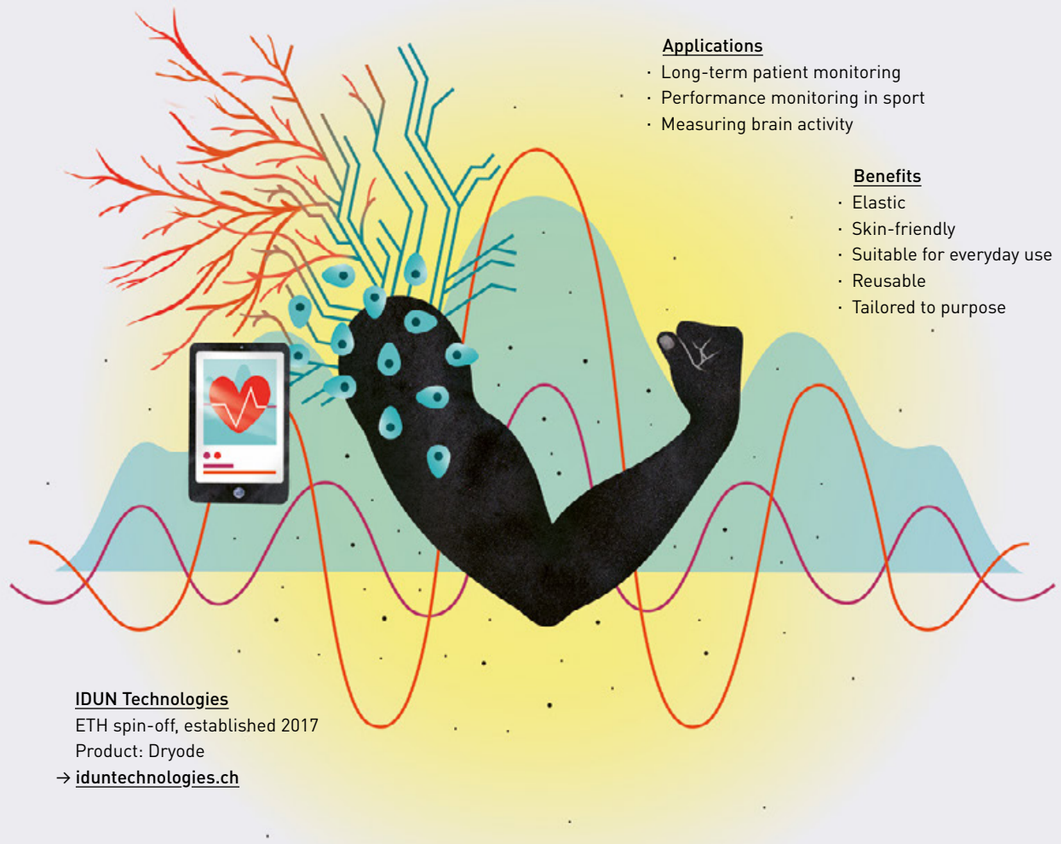


Illustration: Carolin Eitel

Hot topics, cool ideas

The Energy Science Center harnessed Energy Day 2019 at ETH for a bold experiment, collaborating with myblueplanet to organise an energy conference for young people. Some 100 baccalaureate school students from Winterthur signed up for the event.

TEXT Martina Märki IMAGES Simon Tanner /Alessandro Della Bella

ETH Rector Sarah Springman welcomes the students.

Néhémie and Marco (second and third from left) sketch out ideas with the rest of their team.

It's 8.30 a.m. in the almost empty ETH Audimax – the calm before the storm. Clad in blue T-shirts, members of the climate protection movement myblueplanet have gathered around the speaker's podium for a final briefing with Christian Schaffner, Executive Director of the Energy Science Center (ESC) at ETH Zurich, and ESC staff member Annina Gantenbein. Any minute now, they will be opening the doors to over 100 students from the Büelrain cantonal school who are here to participate in the Youth Energy Conference.

This is the first time this event has taken place, yet the mood in the room is surprisingly relaxed – especially considering the challenges that lie ahead. The participants in the Youth Energy Conference will be spending the morning working in groups, examining real-world challenges faced by energy companies and developing their own solutions. Belimo, Swiss Post and the electric utilities EKZ and EWZ have each come up with a specific challenge that affects their business. During the assignment, the groups of students will be able to call on the assistance of experts from ETH and the companies themselves as well as ETH students. The best proposals will be presented at the Energy Day public symposium in the afternoon.

Expert partners

"Myblueplanet is a great partner to have on board because they have so much experience in organising energy-related school projects, and the Büelrain cantonal school in Winterthur has demonstrated real commitment to this issue," says Christian Schaffner. Myblueplanet has been running school projects on climate protection for a number of years, and in 2019 they started offering schools the opportunity to apply for the title of "Climate School". Angela Serratore, who heads the Climate School programme, explains what this involves: "The Climate School label means that the institution has not only worked through our educational programme but also implemented specific climate protection measures in-house." Büelrain is the first cantonal school in Switzerland to apply for this certification.

"We've been discussing for some time at the Energy Science Center how we could use Energy Day to appeal more to a younger crowd, so the Climate School project was a real inspiration," says Schaffner. Büelrain cantonal school immediately signed up for the event, full of enthusiasm despite the event's demanding schedule: "This conference is the perfect opportunity for our students to come into contact with real-world energy issues. We're always trying to incorporate these kinds of opportunities in our lessons. In economics, for example, we set students the task of applying dynamic assessment calculation methods to calculate our own photovoltaic system's profitability," says headmaster Martin Bietenhader.

By now the students have crowded into the auditorium, throwing their thick jackets and rucksacks over the backs of their chairs and mostly taking refuge in the upper rows of seating, ›

"We wanted to find ways of appealing to a younger crowd."

Christian Schaffner

Giulia and Claude enjoying the pitch.

Group work with EWZ expert Renato Sydler.

perhaps unsure what to expect. But ETH Rector Sarah Springman, eager to greet the young people herself, quickly breaks down any inhibitions. “Come a bit nearer so I can see your energy up close!” she says, breaking the ice with an easy smile. “Learn something, do something special, save the planet with science facts,” are her final words of advice to the youngsters as she wraps up her welcome speech.

The first step is to introduce the students to the main topic of the energy conference, so the event kicks off with a brief overview of the challenges involved in tackling climate change and reaching net-zero carbon emissions. After that, it’s time for the students to choose one of the four industry challenges and set to work. The goal is to work in small groups to come up with solutions. Each group is assisted by one expert from industry and one ETH expert as well as myblueplanet facilitators and ETH students.

Initial doubts, feverish work

The process of dividing over a hundred students into four groups runs remarkably smoothly, and soon the students are grabbing their jackets and rucksacks and following the expert assigned to them into the room reserved for their particular challenge. Marco and Néhémie are in the same class and are keen to work on a challenge together. They have signed up for the group assigned to EWZ, the Zurich municipal electric utility. “Energy is something we know quite a lot about,” they say, explaining that Marco’s father is an electrician and Néhémie’s father also tackles energy-related issues at work. The students working on the EWZ challenge break into teams to discuss possible future energy solutions that could be locally implemented in urban districts. Each team has one hour to come up with ideas before pitching their suggestions to the rest of the challenge group. The best ideas from each industry challenge will then be presented to the 400-plus Energy Day participants in the Audimax the same afternoon.

The teams have gathered around tables and opened their laptops, and ideas are already flowing freely. Yet the mood in Marco and Néhémie’s team is still rather hesitant. Are the organisers looking for more of a focus on technical solutions, or should the team be discussing issues of economic viability as Néhémie has suggested? “We’re not really sure where to start,” says Marco with a note of frustration. “I admit this isn’t an easy task,” says EWZ representative Renato Sydler, the industry expert assigned to their challenge group. He emphasises that the most important thing is to discuss the topic to raise awareness: “The actual results are less of a priority for me.” Eventually Sydler steers the discussion towards a specific technical problem: “You already know about roof-mounted photovoltaic panels that convert the sun’s rays into electricity. That’s fairly self-explanatory nowadays. But how might we be able to store that energy to balance production and consumption?” Suddenly Marco’s face lights up. A few clicks later, he is busy showing his team a website on his mobile phone, explaining that a power-to-gas system might be the solution they need. “Norway already has these kinds of systems running on hydro and solar power,” he says. “We learned about them in geography.” However, his teammate Néhémie cautions that the systems are “super expensive”. Katharina, one of the ETH students assisting the teams, adds: “And technically they’re still very challenging.” Marco grabs a pen and starts to sketch a diagram on the flipchart. “But it’s pretty cool how Norway is actually using them to pull carbon dioxide out of the air!” he says.

The first hour passes in the blink of an eye, and soon it’s time for Marco and Néhémie’s team to make their pitch. Each of the teams presents their proposals to the challenge group plenum, revealing a surprising diversity of ideas and approaches. Marco and Néhémie explain their concept of energy conversion and storage, while a second team suggests funding a system of not-for-profit batteries with a CO_2 tax. The third team presents a new business model for promoting solar panels in the district. The last team explains their concept for a sports centre in which the various sports activities could be used to produce energy. The key to their idea is that the gym members would not only see how much energy they have generated but also what that energy could be used for. The team thinks this would make people more aware of the value of energy. This final idea turns out to be the most popular in the subsequent discussion and also gains the backing of the experts. “Based on current developments in areas such as e-mobility and the increasing popularity of heat pumps, there’s a high likelihood that we will end up consuming more energy in the future even as our devices and machines become more and more energy-efficient,” says Sydler. “That’s why energy awareness is so important. The only way to reach the goal of net-zero carbon emissions is by extending the change process to how people act as well as the technologies they use.”

During the lunch break, Marco and Néhémie get chatting to Giulia and Claude, who have been working on a challenge set by the electric utility of the canton of Zurich, EKZ. Their task was to find ways of promoting energy efficiency within the company, and Giulia has clearly enjoyed the experience: “It was really interesting to hear ›

> “The only way to reach the goal of net-zero carbon emissions is by extending the change process to how people act.”
>
> Renato Sydler

the EKZ expert describing what it takes to persuade companies to become more energy efficient," she says. She and her family see climate change as a big issue and do their best to live an environmentally friendly life. Claude, whose main interests are photography and art, is a bit more reserved. At this point, he is still unaware that he will soon be experiencing his own memorable moment at the Youth Energy Conference.

Exciting lab tour

Next stop for the students is a tour of the ETH High Voltage Laboratory. The array of machinery is impressive enough, but then the lab guide points to a keyboard and asks for a volunteer to sit down and play. Claude skilfully runs his fingers over the keys, and the sound of an organ echoes through the High Voltage Laboratory to the accompaniment of sparks, flashes and hissing sounds. The keyboard is hooked up to a musical Tesla coil that generates a high-frequency alternating current of almost half a million volts, casting metre-long arcs of electricity generated at a desired frequency and allowing the keyboard player to play a melody of their choice. This remarkable fusion of technologies was put together by ETH students. It combines the famous Tesla coil invented by Nikola Tesla (1856–1943) with modern power semiconductors. Claude finishes his performance with a dynamic flourish, and his fellow students applaud enthusiastically.

The time has come for the students to join the other guests at the official Energy Day symposium, so everyone hurries back to the Audimax in the ETH main building. The teams of students who will be presenting the results of the challenge groups are obviously nervous, while most of their companions are clearly relaxed and pleased to rest their feet as they find their seats in the auditorium. All they need to do for the rest of the day is listen – a demanding task, however, with five ETH professors ready to take them on a breakneck journey through the challenges posed by climate-neutral energy systems.

Official presentations

Soon it's the students' turn to take to the stage. The four proposed solutions for the four different challenges are presented with varying degrees of proficiency but in refreshingly undogmatic style. Two groups in particular receive spontaneous applause, with the first of them appearing almost professional as they present a solution for the future of sustainable regional public transport for Swiss Post. The group proposes a hybrid bus system that would involve replacing normal buses on less popular routes with smaller electric buses and improving capacity utilisation by combining services such as public transport and parcel deliveries.

The presentation by the students from the Belimo group is a more informal affair. Belimo – a market leader in actuator solutions for controlling HVAC systems – set them the task of finding the best ways to heat and cool buildings in the future. Their suggestions include wearing pullovers in colder flats, creating an app to regulate heating and ventilation, and shifting unused heat from school buildings to nearby homes at the weekend. At the end of the event, the audience and the experts were united in their praise for the young people's commitment and creativity. "We hope that today has served to fuel their interest in energy issues," says Christian Schaffner. "And perhaps one or two of you will end up focusing on these kinds of topics in your *Matura* thesis or your degree studies." It's an option, but not one that Claude, Giulia, Marco and Néhémie will be ready to decide on for some time yet. They do agree, however, that the Energy Day experience at ETH Zurich has been interesting, though right now they are keen to take a break. "We've earned it," they say in unison. ○

Insights into research at the High Voltage Laboratory.

Top: *Christian Schaffner, Executive Director of the Energy Science Center.*
Bottom: *High school students present their best ideas at the Energy Day.*

"Perhaps one or two of you will focus on these kinds of topics in your *Matura* thesis."

Christian Schaffner

CONNECTED

1 *ETH in Davos*

RETHINKING CREATIVITY

This year marks the fourth time that ETH Zurich has had a presence at the World Economic Forum (WEF) in Davos. True to this year's slogan "Rethinking Creativity", the ETH exhibition focused on interfaces between art and science – both of which are driven by human creativity. ETH Zurich President Joël Mesot (left) mingled with visitors and got creative on a piano keyboard made of fabric.

2 *Falling Walls Lab*

MAKING COMPLEX DATA SEXY

Mariëlle van Kooten's (right) ingenious idea won the ETH doctoral student second place in the international Falling Walls Lab in Berlin. Jury member Claudie Haigneré (left) presented the award to the systems biologist for her app, which turns complex medical data into simple images. This makes it easier for the untrained eye to navigate the data jungle.

3 *ALEA Award*

A FESTIVE END TO THE YEAR

Gabriela Hug from the Department of Information Technology and Electrical Engineering garnered the 2019 edition of ETH Zurich's Art of Leadership Award. The ALEA Award honoured the professor for her outstanding leadership, her promotion of advanced and innovative working conditions, and her support for staff in balancing their work, private life and community engagements. The award was presented to Gabriela Hug at a ceremony that took place at the Executive Board's Christmas Apéro.

4 *National Latsis Prize*

ACCOLADE FOR MIGRATION RESEARCHER

ETH political scientist Dominik Hangartner (centre) has been awarded the National Latsis Prize by the Swiss National Science Foundation (SNSF). SNSF President Matthias Egger (left) and presenter Ioannis Papadopoulos (right) bestowed this prize in recognition of the outstanding quality of Hangartner's research into migration and his work's applicability to public policy. The National Latsis Prize is one of Switzerland's most prestigious science awards.

5 *Cyber Defence Campus*

CONFRONTING CYBER DANGERS

Defence Minister Viola Amherd and ETH President Joël Mesot have opened a laboratory for the national Cyber Defence Campus at ETH Zurich. This is the final element in a project connecting three locations and bringing together the Swiss federal government, universities and the private sector in a joint effort to tackle the growing threats that are emerging from cyberspace.

1 *ETH at the WEF*

On a journey of discovery in the ETH Zurich Pavilion

4 *National Latsis Prize*

2 *Falling Walls Lab*

3 *ALEA Award*

5 *Cyber Defence Campus*

Images: Andreas Eggenberger (2); Florian Gaertner / photothek.net; Alessandro Della Bella (2); SNF/Severin Novacki

Events can be canceled due to the **coronavirus**. Please inform yourself at: **ethz.ch/coronavirus** or on the website of the organizer.

Agenda

DISCOVER

Seed City

An oasis of biodiversity, the Seed City community garden at ETH Hönggerberg has been inviting nature-lovers to teach, learn, work and relax on its some 1,200 m² of grounds since its inception in 2010.

ETH Zurich, Hönggerberg Campus
→ www.seedcity.ch/community

19 May 2020, 6:15 – 7:15 p.m.

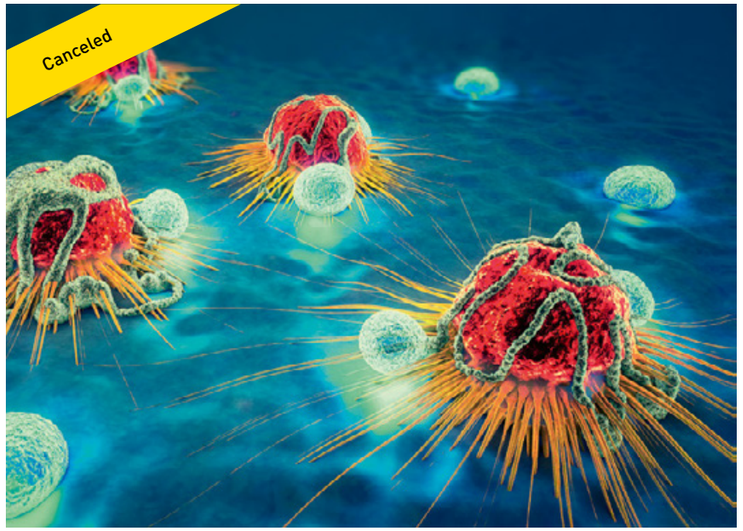
Exotic journeys: around the world with eight historical prints

The ETH Library's historical prints illustrate how travellers in the olden days conveyed their impressions of faraway lands and exotic regions. Visitors can explore its rare books to immerse themselves in the adventurous lives and times of earlier centuries.

ETH Zentrum campus, Library

Find out about this and other guided tours at:
→ www.tours.ethz.ch

Canceled



Bacterial pathogens in the human body.

Treffpunkt Science City

EXPLORING HUMAN HEALTH

15 March – 5 April 2020 Will new therapies be able to defeat cancer? Might the family doctor soon be a robot? How important is the gut to our health? Research is yielding solutions for detecting symptoms early on and treating common diseases effectively. A public science programme for people of all ages, ETH Zurich's Treffpunkt Science City focuses on health and medicine this spring. The programmes for children and teenagers have been extended due to popular demand and feature exciting experiments with researchers.

Programme:
→ www.ethz.ch/treffpunkt-en

Canceled

BrainFair 2020

THE VULNERABLE BRAIN

16 – 21 March 2020 BrainFair is a series of events devoted to the topic of brain injuries. This year's discussions will take place in six forums and several brief presentations. Visitors can experience what life is like with a brain injury at various stations of an obstacle course staffed with people who have suffered such trauma.

University Hospital and University of Zurich

Programme:
→www.brainfair.uzh.ch/de/Programm

Images: ETH Library; iStock/Christoph Burgstedt

EXHIBITIONS

1 April – 28 June 2020

Looking back

Commemorating the 90th birthday of Franz Gertsch, the ETH Zurich Graphische Sammlung will be showing early pieces from the renowned Swiss artist's extensive body of work.

ETH Zurich, Zentrum campus
→ gs.ethz.ch/en

Through 30 April 2020,
Mon – Fri, 10 a.m. – 5 p.m.

Switzerland without an army?

This exhibition in the Max Frisch Archive tells the story of Max Frisch's commitment to the Group for a Switzerland without an Army (GSoA) and explores the significance of the military in his life and work.

ETH Zurich, Max Frisch Archive at the ETH Library
→ mfa.ethz.ch/en

MUSIC

20 May 2020, 7.30 p.m.

Yuri Revich

The music that Yuri Revich elicits from his violin is simply divine. Revich will present a solo programme at the final concert of the 25th anniversary season of Musical Discovery. It will include virtuoso performances of compositions by Ravel, Debussy, Dvorak, Paganini and Sarasate.

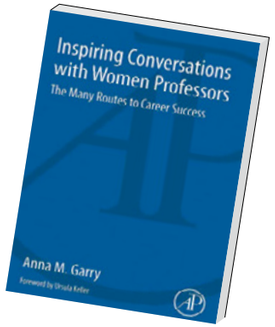
University of Zurich, Rämistrasse 71, Auditorium
→ www.musicaldiscovery.ch/konzerte/8

KIDS

Globi's astronaut school

On this discovery trail for school classes and children's events, kids can learn interesting and exciting facts about space travel from the students and aerospace experts staffing its seven stations. The tour highlight is a rocket launch!

Sign up for this and other tours at:
→ www.ethz.ch/private-tours



A good read

INSPIRING CONVERSATIONS WITH WOMEN PROFESSORS

The career steps taken by professors provide a good example for students and researchers to follow as they map out their professional paths. Valuable insights into diverse and continuing academic careers can help them find their way.

Inspiring Conversations with Women Professors, a book by Anna M. Garry, provides concise insights into the varied career paths of female professors in mathematics, computer science, the natural sciences and engineering. The 23 featured professors, 16 of whom hold professorships at ETH Zurich, have different family backgrounds and hail from 11 countries. Their childhoods, educations, and career trajectories in different countries shaped the life stories of these successful female researchers, who spoke candidly about their career and family decisions in these interviews. This makes for interesting and entertaining reading.

Author: Anna M. Garry
Published by: Academic Press, Elsevier Inc., 2019
ISBN: 978-0-12-812346-1

Images: Max Frisch Archive, Zurich; musicaldiscovery; © Globi Verlag, Imprint Orell Füssli; Academic Press, Elsevier

A born architect

Guido Doppler's life has been rich in experiences and achievements. Now 86, the ETH alumnus, architect and animal lover continues to pursue his passions.

TEXT Claudia Hoffmann and Isabelle Vloemans IMAGE Daniel Winkler

The first thing Guido Doppler does each morning is head to the stables to muck out and feed the horses. Outdoor yoga is also part of his daily routine – and probably one reason he looks younger than his 86 years. The retired architect lives with his wife on a farm near Hütten in the canton of Zurich. Doppler replaced the original farmhouse with a new one, a combination of a home and stables that blends unobtrusively into the landscape. Light floods the house, revealing a meticulous eye for detail. Paintings by contemporary artists adorn the walls, and each object pays tribute to its owner's aesthetic taste. His dogs have their beds next to the fireplace in the open-plan kitchen and living room. "I love animals," says Doppler, whose wife Daniela works as a vet. When Doppler retired, the couple moved to the countryside to keep horses.

Doppler has architecture in his blood: in the late 19th century, his grandfather moved from France to Basel and set up his own architecture firm. Doppler's father and uncle both eventually joined the firm. The war made its presence felt during Doppler's school years in the border city of Basel. "I still remember how hungry I felt but also how tightly our family held together," he recalls.

The hardships lessened considerably when he moved to Zurich to study at the Polytechnikum, as ETH Zurich was called at the time. It was the 1950s, when the degree programme in Architecture was still run from the ETH main building on Rämistrasse. "The first time I walked into the hall, I was absolutely blown away," says Doppler. He was immediately drawn into the university atmosphere. "We built up a fantastic sense of camaraderie," says Doppler. "But there was also a great relationship between the lecturers and the students."

A full life

He and a friend moved into a rather run-down house in Niederdorf, renting a maisonette with a roof terrace for just 40 Swiss francs a month. Their home became a hub of social activity, attracting both fellow students and professors to informal debates and parties. One professor even took to dropping by every Sunday evening for a drink.

But when it came to the course itself, the aspiring architect was far from satisfied. "I learnt a lot at university but not necessarily about architecture," he says. One reason was the dearth of professorships in architecture: there were only three at the time. On behalf of his fellow students, Doppler sent a letter to the president of the School Council asking them to employ more professors and expand the course content. Both demands were met, and Doppler finished his degree in 1957.

He started work at his father's architecture firm in Basel but recalls that things soon became tense: "We had totally different ideas about architecture, and staying at my father's firm would have been taking the easy option anyway!" So when one of his friends suggested moving to Paris, Doppler jumped at the chance. He soon found a job at an architecture firm run by Andre Gomis. "That's where I learned what it means to put your heart and soul into getting a challenging project over the line," he says. One of his designs won a competition to build a residential district of 2,500 flats in Gonesse, a commune in the north-eastern suburbs of Paris. ›

GUIDO DOPPLER

Born in Basel in 1933, Guido Doppler studied architecture at ETH Zurich before forging a career in Paris and Basel. In 1969, he became a partner in the Burkhardt & Partner architecture firm, helping set up their Zurich office. After retiring early, he worked for the Zurich zoo on a voluntary basis. Doppler lives with his wife on a farm near Hütten in the canton of Zurich. They have three horses, two dogs and three cats. Doppler has two adult children from his first marriage.

"I have always loved this university."

Major career step
Four years later, his boss suggested that he move to the overseas department of Guadeloupe to work on a project. This idea was met with resistance by Doppler's wife, whom he had married during his time in Paris. So they decided to return to Switzerland, where Doppler joined an architecture firm in Basel. "It was such a huge contrast to Paris," he says. Unlike his previous job, which had given him so much freedom and flexibility, this new position was saddled with strict rules and fixed working hours that he found overwhelming. "I was very unhappy," he recalls. Eventually, however, he got the chance to work on several major projects for the chemical producer Sandoz, which would turn out to have far-reaching consequences. In 1969, on the back of his work for Sandoz, Doppler was offered a partnership at Burkhardt & Partner in Basel, now one of Switzerland's biggest architecture firms. Doppler agreed, and Martin Burkhardt, one of the firm's founders, ended up becoming a close friend, even though they didn't always see eye to eye at work. "Sometimes he threw his weight around – but then so did I," Doppler says with a smile. His main focus was on managing the company and helping to plan major projects. The firm's biggest customers came from the chemical industry and banking sector, with projects including Sandoz's head offices in Brazil and France and a computer centre for UBS in Bussigny near Lausanne.

Fresh start in Zurich
When the 1970s energy crisis hit and the economy slumped, the firm's dependence on the chemical industry came to haunt them. The company was forced to let some staff go and borrow money from banks. "It was a bad time," says Doppler. "I felt responsible and did everything I could to get the firm back on its feet and prevent anything similar happening in the future." The partners decided to diversify the business and expand their reach to customers from other industries. Doppler took on the challenge of setting up a branch office in Zurich, and his persistence soon paid off. He landed a major project for the University of Zurich's Irchel Campus, and more contracts soon followed.

It was in Zurich that Doppler, now separated from his first wife, met Daniela. She lived next door but moved in with him in 1983. An active couple, they were each devoted to their own separate hobbies. His love of flying, which he describes as "an indescribable sense of freedom", was matched by her passion for riding. They decided to take up each other's passions. "And that's how I learned riding when I was 55 years old," says Doppler. Years of lessons with a horse trainer taught him to treat the animals as equals. Doppler was particularly intrigued by "difficult" horses that buck or even throw off their riders but that ultimately end up cooperating. "For me it's about building up a relationship with the animal," he explains.

Plenty to do
Doppler took early retirement from Burkhardt & Partner when he was 58 – but he's not one to sit still for long. He continues to volunteer on various projects that allow him to combine his passion for animals with his love of architecture. As president of Zurich zoo's building commission, he helped plan and construct the Masoala Rainforest Hall, which opened in 2003. He also designed a national park building for a nature reserve set up to resettle wild horses in Mongolia. In recent years, Doppler's attention has once again turned to his old university. He supports the Excellence Scholarship & Opportunity Programme through the ETH Foundation, which enables outstanding students from all over the world to pursue a Master's degree at ETH Zurich. "I admire ETH's emphasis on quality and its determination to attract the best students from around the world," says Doppler. He regularly attends scientific talks and other events at ETH, and although he never shies away from asking difficult questions, his affection for the place is clear: "I've always loved this university." ○

5 QUESTIONS

Laurent Vanbever researches computer networks. For his exceptional teaching, he was awarded the Golden Owl for the second time on ETH Day 2019.

What is good teaching in your opinion?
To me, good teaching is about helping students get acquainted with a particular topic, in my case, computer networks. It's a demanding task that involves illustrating the importance of the topic, designing high-quality teaching materials, and exchanging ideas with students in order to adapt the process along the way.

How important is the practical aspect of teaching?
Learning by doing is still the best way. Which is why nearly all of our lectures involve practical work, even at the Bachelor's level. One project involves a class of more than 100 students setting up and operating their own internet infrastructure. It's eye-opening for them to realise that making the internet work is truly a team effort.

Laurent Vanbever is Assistant Professor of Networked Systems at the Department of Information Technology and Electrical Engineering.
→ nsg.ee.ethz.ch

Your research deals with networked systems. What is it about the field that fascinates you?
Ever since I was a kid, I've been fascinated by the idea of communicating across the globe almost instantaneously. When I started to learn about internet infrastructure in secondary school, it immediately grabbed me. I spent most of my pocket money on second-hand networking gear. What appeals to me as a researcher is that networking is so multi-disciplinary and opens up so many opportunities. A lot of the tech we use every day – like the web, e-mail, or video streaming – originated in the networking community.

You're also active in the field of IT security. How can we better protect ourselves against cyber attacks?
We're currently exploring the interesting concept of self-securing networks, which automatically detect and protect end-users from cyber attacks. We're building these networks using state-of-the-art network hardware that can analyse entire terabits every second.

"Learning by doing is still the best way."

What does the future of the internet look like for you?
Of course, we need to increase internet bandwidth, decrease end-to-end delay, and connect more people. But for me, the focus in the future will be on resiliency. The internet is still a fragile infrastructure today, not so much because of hardware failures, but because of human mistakes. That's why our research is largely geared to ensuring fault-free network infrastructures.
— Interview by Karin Köchle

Image: Stefan Weiss