ETH zürich
NO. 4/2020

GLOBE

A new mindset

Reshaping our response to the climate crisis

PAGE 12

rETHink: gearing up for the next 20 years
PAGE 34

Saving coral reefs with the help of 3D printing
PAGE 38

Alumnus Martin Bosshardt: The sky's the limit
PAGE 46

Researching the climate, living sustainably

Joël Mesot, President of ETH Zurich.

Even as our world struggles to contain the COVID-19 pandemic, we are simultaneously confronted with another global challenge in the form of climate change. Thanks to the Paris Agreement, we finally have consen-sus on the goal of restricting global warming well below 2 degrees Celsius above pre-industrial levels. And here in Switzerland, the revised CO_2 Act has given us the tools to push ahead with decarbonising every area of our lives in the years ahead.

Scientific facts are the key to tackling both the COVID-19 pandemic and climate change, even though the process of understanding such complex phenomena never truly comes to an end. Nonetheless, scientists have made great strides in learning about the mechanisms of global warming, and large parts of the economy now acknowledge the opportunities presented by the development of climate-neutral technologies.

This issue of *Globe* explores the question of how we can transform our understanding of climate change into meaningful action. Teaching, research and knowledge transfer are only one aspect of our university's efforts in this regard. Increasingly, the ETH campus itself is becoming a kind of living lab, a place to try out climate-friendly behaviours and test their suitability for everyday life – whether that means encouraging people to avoid air travel or promoting technologies such as the ETH Anergy Grid and battery-powered buses. Perhaps most striking of all is the commitment and creativity of our students, who constantly challenge and inspire us to think and act in more sustainable ways.

I hope you enjoy reading this issue!

Images (cover page): Daniel Winkler
Image (editorial): Markus Bertschi

GLOBE
NO. 4/2020

CONTENTS

NEW AND NOTED

5 News from ETH Zurich

6 Foundations for a giant centrifuge

8 Africa's coronavirus dilemma

FOCUS

12 Climate rethink
How ETH students are helping to combat the climate crisis.

14 Ready for the cleantech race
Technology and state support are the key to decarbonisation.

18 Time to act
A member of the climate strike movement and a climate researcher share their views.

23 Climate-friendly business ideas
How ETH spin-offs are bringing climate technologies to market.

27 Doing things differently
What might a sustainable economic system look like?

30 Campus policies drive societal change
Sustainability is part of daily life at ETH, and reducing air travel is just one example.

Producing fuel from sunlight and air – page 23

Diving into the realm of coral reefs – page 38

Lavinia Heisenberg hopes to improve the theory of relativity – page 50

COMMUNITY

32 Connections to ETH

34 ETH gets fit for the future
The rETHink project is picking up steam.

37 Transfer
Avatars lend a helping hand in all sorts of situations.

REPORT

38 Building reefs from 3D-printed bricks
An artist and a marine biologist team up to save coral reefs.

CONNECTED

44 Agenda

PROFILE

46 Engineers can change the world
Martin Bosshardt is passionate about engineering – and always pushing his limits.

5 QUESTIONS

50 Lavinia Heisenberg
"Every scientist dreams of expanding the boundaries of human knowledge."

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ClimatePartner° climate neutral

Print | ID: 53232-1502-1013

IMPRINT — Publisher: ETH Alumni / ETH Zurich, ISSN 2235-7289 **Editorial team:** Martina Märki (head), Roland Baumann, Corinne Johannssen, Michael Keller, Nicol Klenk, Karin Köchle, Felix Würsten **Contributors:** Stéphanie Hegelbach, Ori Schipper, Samuel Schlaefli **Advertising administration:** ETH Alumni Communications, globe@alumni.ethz.ch, +41 44 632 51 24 **Advertising management:** Fachmedien, Zürichsee Werbe AG, Stäfa, info@fachmedien.ch, +41 44 928 56 53 **Design:** Crafft AG, Zurich **Printing and proofreading:** Neidhart + Schön AG, Zurich **Translation:** trawo-Übersetzungen, Clare Bourne, Gena Olson, ETH Zurich **Circulation:** 39,100 (German), 7,000 (English); published quarterly **Subscriptions:** CHF 20 annually (four issues); included in full membership of the ETH Alumni Association **Orders and change of address:** globe@hk.ethz.ch and for alumni at www.alumni.ethz.ch/myalumni **Contact information:** www.ethz.ch/globe, globe@hk.ethz.ch, +41 44 632 42 52.

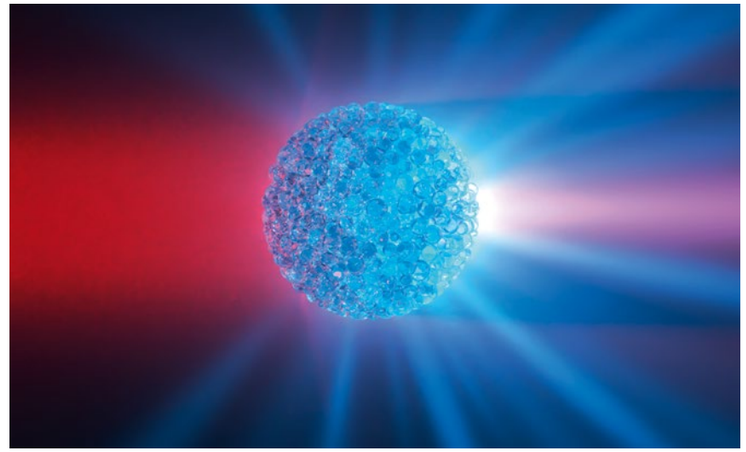
Images: Alessandro Della Bella; Leila Taz; Stefan Weiss

NEW AND NOTED

Nanotechnology

ORDERLY DISORDER

Researchers at ETH have produced an efficient material for frequency doubling of light using microspheres made of disordered nanocrystals. This new approach could be applied to lasers and other light technologies in the future. The study is the result of collaboration between ETH professor Rachel Grange from the Department of Physics and Lucio Isa, a professor in the Department of Materials.



Microspheres of nanocrystals double the frequency of incoming light, turning red into blue.

Materials science

FILTERING RADIOACTIVE ELEMENTS FROM WATER

Some time ago, a group of ETH researchers led by Raffaele Mezzenga developed a filter membrane made of whey proteins and activated carbon. The membrane efficiently removes certain substances from water, including heavy metals, some radioactive elements such as uranium, and precious metals such as gold and platinum. In a new study, they demonstrate that this new membrane is also very efficient at filtering out other radioactive elements from contaminated water.

The scientists used their membrane to purify hospital effluents contaminated with radioactive particles. Medical professionals use radionuclides to treat cancer and as a contrast agent in imaging procedures. Hospitals must securely store the effluents until the radioactivity has decayed to a safe level. Space is often a problem, and precautions must be taken to protect staff and the environment from radiation.

In laboratory tests conducted with the medical radionuclides technetium-99m, iodine-123 and gallium-68, the membrane was able to remove the radionuclides from water in just one filtration step at over 99.8 percent efficiency. The researchers also tested their filter membrane with a sample of real effluents from a Swiss hospital, which contained radioactive iodine-131 and lutetium-177. Both elements were almost completely removed from the water.

This technology makes it possible to massively reduce the volume of waste and to store the radioactive elements as compact, dry solids. The filtered liquids can then be discharged safely into the sewage system.

Pharmaceutical sciences

RISE IN PARACETAMOL POISONING

In 2003, the Swiss government approved the sale of higher-dose paracetamol tablets containing 1 gram of the active ingredient. A study carried out by Andrea Burden and her group of ETH researchers shows that cases of paracetamol poisoning have since increased. Her team analysed sales figures from the Swiss pharmacists' association pharmaSuisse and data from the Tox Info Suisse poison information centre on calls related to paracetamol poisoning. Paracetamol is the most widely used painkiller in the world. For adults, the recommended maximum daily dosage is 4 grams. Paracetamol overdoses can cause severe poisoning and even death.

Image: Jolanda Müller

Geotechnical engineering

245 TONNES FOR RESEARCH

A special crane was required to lower this 245-tonne concrete cylinder into its new underground home on the ETH Hönggerberg campus. The installation of this huge cylindrical chamber is a major milestone in the creation of a new piece of geotechnical infrastructure. The chamber, which measures 10 metres in diameter, is the foundation for a centrifuge that is to be installed in December.

The centrifuge was originally used in Germany and is now being refurbished and modernised. It will be operational next year, allowing ETH researchers to conduct experiments under increased gravity and to simulate earthquakes, landslides and river scouring. These models will help scientists to optimise the design of bridges and high-rise buildings and to mitigate risks.

The world's first ever vibration-isolated geotechnical centrifuge, it will form part of the new ETH Geotechnical Centrifuge Centre. Its ability to accelerate 2 tonnes of payload to 250 g (g = Earth's gravitational acceleration) makes it one of the world's biggest centrifuges.

→ igt.ethz.ch

Image: Nicola Pitaro

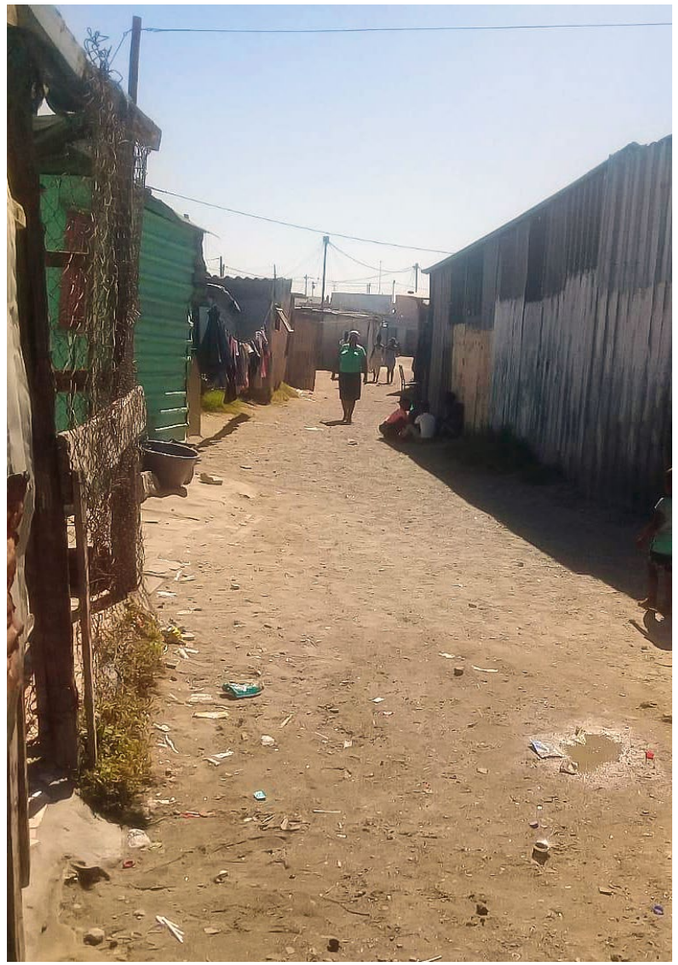
Lockdown

Poorest face dilemma in Africa's cities

A recent study in South Africa and Ghana shows that people support government steps to combat COVID-19 but lack the infrastructure and financial security required to maintain social distancing.

When South Africa imposed one of the world's strictest lockdowns on 27 March of this year, Antoinette van der Merwe was visiting her family in Pretoria. All outdoor activities were banned, aircraft were grounded, and only those working in essential industries such as food and energy were allowed to go to work. "I only left the house once during the first three weeks, to buy some essentials," says Van der Merwe, a doctoral student at the Development Economics Group at ETH NADEL. Once she saw the impossibility of returning to Zurich any time soon, she decided to make the best of the situation: as a development economist, she realised she had a unique opportunity to examine the impact of the COVID-19 pandemic and a strict lockdown on South Africa's poorest urban households.

Together with her colleague Kathrin Durizzo and supervisor Professor Isabel Günther, she designed a study to compare the situation in South Africa with that in Ghana. Durizzo is conducting research into Ghana's health system for her thesis. With the help of research partners at the universities of Pretoria and Ghana, the researchers obtained access to phone numbers of people living in Johannesburg and Accra, the two African cities with the highest rate of COVID-19 infection in April. Van der Merwe and Durizzo focused on districts of each city that are known to have a high proportion of poor households.



The PJS informal settlement in South Africa before Easter: a difficult place to adopt the kind of behaviours that reduce coronavirus transmission.

Image: Thabile Tsitsa, employee of the Development Economics Group in South Africa

Lack of infrastructure for maintaining social distancing

The study, which was based on 409 telephone interviews in Johannesburg and 1,034 in Accra, confirms the findings of research conducted in other countries: lockdowns aimed at curbing the COVID-19 pandemic have a particularly harsh impact on poverty-stricken families in the Global South. For many of those surveyed, the lockdown meant immediately losing their job while simultaneously facing higher prices for food. Sixty-seven percent of self-employed respondents in South Africa – and 86 percent in Ghana – were forced to close their business due to the lockdown without receiving any financial compensation. In order to survive, both they and day labourers that make their living in the informal economy need to be able to leave home and commute to work by public transport, often in overcrowded minibuses. Despite this, most people complied with the strict lockdown rules. However, some 30 percent of those surveyed said they continued to mix with large groups of people, 20 percent continued to receive visitors at home, and 30 percent left home more than once a week. This wasn't due to a lack of information. Most people were able to put together a relatively clear picture of the situation, generally based on what they saw on television. What's more, the majority of people considered the measures taken by the government to be reasonable, so there was certainly a willingness to stick to the rules. Nevertheless, economic necessity and a lack of infrastructure in poor urban settlements, where multiple households often share sanitary facilities, made it impossible for many people to consistently maintain social distancing.

Some aspects of the study revealed distinct differences between the two countries. In Ghana, respondents said their biggest concerns were higher food prices and a lack of income, while South African respondents, especially women, also tended to express their fear of falling ill. This may be due to the fact that many poor households in South Africa continued to receive state benefits during lockdown. The situation hit children particularly hard: with schools closed, 37 percent of parents in South Africa said their school-age children had done no reading or any other kind of learning the day before the survey. And since most children in the households surveyed in South Africa, and almost half the children in those surveyed in Ghana, received meals at school, the decision to close schools had a financial impact on families as well as increasing the time spent on childcare.

Fears inspired by lockdown remain

The study also showed that the lockdown in South Africa, which was considerably stricter than the one imposed in Ghana, did not necessarily cause people to adhere more closely to social distancing guidelines. Most respondents said they were far more afraid of losing their job and being pushed further into poverty than they were of catching COVID-19, says Van der Merwe: "Should case numbers start going up again, our findings suggest that South African authorities should also consider different ways of responding to the pandemic that enable people to follow the regulations." She cites examples such as investing more in public transport and running additional information campaigns.

Van der Merwe and Durizzo are currently working on a follow-up study. Over July and August, they contacted some 80 percent of the original respondents to ask how their situation had changed since the lockdown was eased. "The results showed that people in Ghana are less worried than people in South Africa," says Durizzo. "The situation returned to normal more quickly in Ghana, in part because the lockdown wasn't as extreme for people there as it was in South Africa."
— Samuel Schlaefli

Images: courtesy of Adina Rom and Churchill Agutu

New ETH podcasts

Fight against poverty

The ETH for Development (ETH4D) initiative aims to tackle poverty by improving specific aspects of people's lives, such as access to off-grid electricity. In this ETH podcast, ETH4D Executive Director Adina Rom and doctoral student Churchill Agutu discuss how research and practice can make a difference in the fight against poverty.

When will the vaccine be ready?

People all over the world are eagerly awaiting a COVID-19 vaccine. Some ask why it's taking so long; others wonder what role the flu vaccine should play in our response to the pandemic. In this podcast, we put these questions to two immunologists, Professor Emma Slack from ETH and Johannes Trück, a paediatrician from Zurich Children's Hospital.

Cybathlon: a unifying force

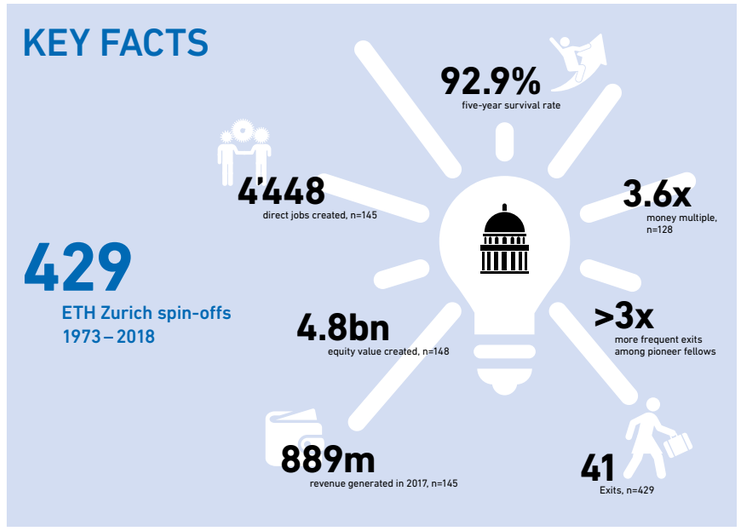
In this ETH podcast, Joachim Schoss recalls the motorcycle accident 18 years ago that cost him his arm, his shoulder and part of his leg. Today, he is President of MyHandicap and serves as a Cybathlon ambassador. ETH robotics professor Robert Riener explains how he came up with the idea of a competition for people with physical disabilities – and how the Cybathlon helps advance the frontiers of science.

Find out more at:
→ www.ethz.ch/podcast

Knowledge transfer

ETH SPIN-OFFS STRENGTHEN THE ECONOMY

As well as generating significantly more jobs on average than other Swiss start-ups, ETH spin-offs are also more frequently the object of an acquisition. According to a comprehensive study carried out by the University of St Gallen, this owes a great deal to the institutional support provided by ETH Zurich. The study looked at four categories: HR-related factors, the impact on economy and innovation, financing and operational factors.



A success story: key figures from the comprehensive study.

Zukunftsblog

Sustainability

A HOLISTIC APPROACH TO PESTICIDE USE

No simple measures or bans can solve the complex problems posed by crop protection. We need to take a more holistic approach to pesticide policies, says Robert Finger.

→ www.ethz.ch/zukunftsblog-finger-en

Robert Finger is Professor of Agricultural Economics and Policy in the Department of Management, Technology and Economics.

Digitalisation

CASH IS DEAD

Roger Wattenhofer is confident that, sooner or later, the digital currency CBDC will completely replace cash. He outlines some of the many advantages of this new electronic payment method.

→ www.ethz.ch/zukunftsblog-wattenhofer-en

Roger Wattenhofer is Professor of Distributed Computing in the Department of Information Technology and Electrical Engineering.

Health

PUTTING USERS CENTRE STAGE

Even once the COVID crisis is over, health systems will still face big challenges. Digital technologies could be part of the solution. Nicole Wenderoth explains how we can develop technologies that really work.

→ www.ethz.ch/zukunftsblog-wenderoth-en

Nicole Wenderoth is Professor for Neural Control of Movement in the Department of Health Sciences and Technology.

Read the full version of these and other blogposts at:
→ www.ethz.ch/zukunftsblog-en

Images: ETH Zurich; Giulia Marthaler (2); Valerio Zerbi

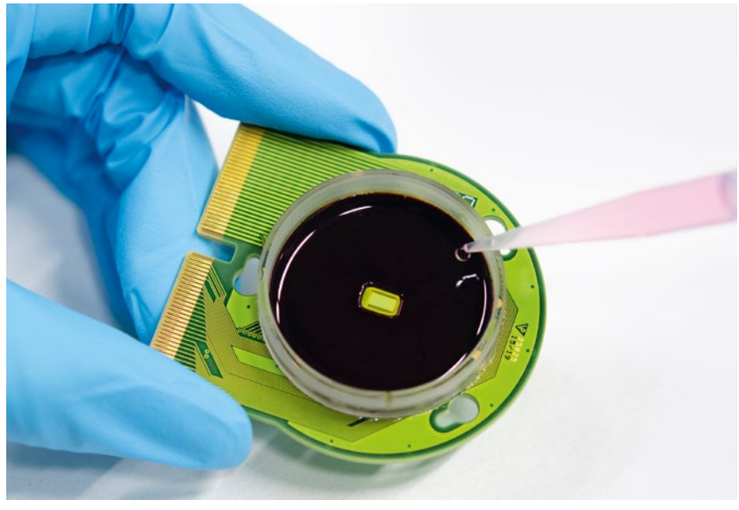
Microelectronics

THOUSANDS OF NERVE CELLS AT ONCE

For over 15 years, ETH professor Andreas Hierlemann and his team have been developing microelectrode-array chips that can be used to precisely stimulate nerve cells in cell cultures and to measure electrical cell activity. Now, researchers from Hierlemann's group in the Department of Biosystems Science and Engineering at ETH Zurich in Basel have joined forces with ETH spin-off MaxWell Biosystems to develop a new generation of microelectrode-array chips, which enable comprehensive recordings of significantly more electrodes than earlier systems.

Similar to previous chip generations, the novel chips consist of around 20,000 microelectrodes that cover an area measuring 2 by 4 millimetres. In order to pick up the comparatively weak nerve impulses, the signals from these electrodes need to be amplified. However, amplification electronics take up space, which is why the earlier chip was only able to concurrently amplify and read out signals from 1000 of the 20,000 electrodes.

In the new chip, smaller amplifiers mean that the signals of all 20,000 electrodes can be amplified and measured at the same time. This process yields a clear picture of the signal activity over the whole area being measured. Using the new chip, the researchers can create electrical images of both the cells and the extension of their axons – and they can also establish the speed at which a nerve impulse is transferred to the farthest reaches of the axons. Such detailed measurements help researchers examine the effects of drugs in cell cultures. This can help to reduce the number of animal experiments.



Chip for measuring nerve impulses at the base of a cell-culture dish.

Image: Xinyue Yuan

Work psychology

INTERRUPTIONS CAUSE STRESS

At the Mobiliar Lab for Analytics at ETH Zurich, an interdisciplinary team is working on a digital early-warning system that uses machine learning to detect stress in the workplace in real time. The researchers began by identifying a suitable method for measuring the effects of interruptions and other common causes of workplace stress.

To conduct their experiment, the researchers asked the participants to perform typical office tasks as employees of a fictional insurance company. The participants were divided into three groups, each of which was exposed to different levels of stress. At six points during the experiment, the researchers measured the concentration of the stress hormone cortisol and took other readings of the participants' physical responses.

Analysis of the data showed that the stress group exposed to additional stressors in the form of chat messages from their fictional superiors released almost twice the level of cortisol as those in the stress group who were not interrupted by chat messages. This confirms that workplace interruptions do indeed influence the biological stress response. Previous studies had focused primarily on their effects on productivity and performance.

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

How to tackle the climate challenge

In this issue's Focus section, ETH researchers explain why climate change demands action at the technical, political, economic and societal level. Meanwhile, young ETH students are already taking matters into their own hands. Below are just a few examples of how they are helping to tackle the climate challenge.

PHOTOGRAPHY Daniel Winkler

Penguins have fascinated Janine Wetter ever since she was a child. They were the subject of her first research trip in 2014.

Ice cold

Janine Wetter loves the cold, however extreme it gets. She has always dreamt of becoming a polar researcher – and so far she seems to be heading in the right direction. As a student in the Department of Environmental Systems Science and the recipient of an Excellence Scholarship, she seized the opportunity in the summer of 2018 to spend a few weeks with the Swiss Arctic Project travelling to Spitsbergen on the research ship MV San Gottardo. Her job was to report via social media on climate change and its consequences, but she ended up staying in Spitsbergen for an exchange semester. "I'm a polar addict! Luckily, my studies at ETH give me regular opportunities to really get to grips with this topic," says Janine.

She has long been interested in climate change and its impact in the polar regions. Her Matura thesis took herto the Antarctic, where she made a film about birds threatened by climate change. Back in Switzerland, she now gives presentations about her experiences to help amplify messages about climate change.

Images: Charles Michel, Janine Wetter, Swiss Arctic Project

Get ready for the cleantech race!

Meeting the goals of the Paris Agreement means embracing a sustainable transition to renewables. Yet analyses suggest that decarbonisation can only be achieved with targeted government support for the right technologies.

Text Samuel Schlaefli

Tobias Schmidt vividly recalls attending the 2009 UN Climate Change Conference in Copenhagen as a doctoral student. At the time, he says, he naively believed that the primary goal of the politicians at the conference was to save the world from the looming climate crisis. His enthusiasm soon turned to disappointment when he saw that the only result of the negotiations was a non-binding political statement based on a minimal consensus. "At some point the penny dropped," says Schmidt, now Assistant Professor of Energy Politics at ETH Zurich. "I realised that climate politics had become much more about industrial competitiveness than the climate."

Feeding renewable energy sources into the power grid raises new challenges.

Image: Heiko Kueverling, Colourbox

Looking back, Schmidt believes the diplomatic fiasco in Copenhagen was primarily driven by the fear of economic losses. Earlier that year, management consultants McKinsey & Company had published the second of its much-cited marginal abatement cost curves. This predicted what the cost of avoiding 1 tonne of CO_2 equivalent would be in 2030 on the basis of various technologies. "Some of the forecasts were far more pessimistic than what actually ended up happening," says Schmidt. For example, the authors assumed that e-mobility would remain a niche market until at least 2030. Since then, however, over 8.5 million electric vehicles have been sold – a trend that continues to rise sharply. Similarly, their projected cost for photovoltaic (PV) modules in 2030 was undercut years ago. In the 1990s, the cost of a PV system that would avoid the production of 1 tonne of CO_2 ran to several thousand Swiss francs. Today, PV generation often generates revenue for the power it produces, so in some cases the costs of avoiding carbon emissions are already negative. "They massively underestimated the innovations in clean technology," says Schmidt. This had significant consequences: "None of the politicians at the 2009 conference would commit to expanding this supposedly expensive tech, because they were afraid of their country losing its competitive edge."

How technology drives policy

Six years later, at the Paris Climate Change Conference, Schmidt witnessed exactly the opposite. In the meantime, various countries had introduced funding programmes for research and development in renewable energy technologies. For example, the feed-in tariffs under Germany's Renewable Energy Sources Act had fuelled an expansion of solar power and wind generation. And China was investing billions in its own photovoltaics industry. "Many of the politicians at the Paris conference realised that low-carbon technologies were becoming increasingly competitive and would potentially create new industries employing thousands of people," says Schmidt. In a highly acclaimed comment piece published in *Nature Energy*, he argued this was one of the key reasons that ultimately led 195 countries to agree to limit the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels. In other words, technological innovation can also fuel political ambition.

To corroborate this thesis, Schmidt's group analysed the political debate on the energy transition in the German Parliament. The researchers used the methods of discourse network analysis to study over 800 pages of text from debates on energy policy held between 1983 and 2013. The results showed how the political parties' positions on Germany's energy transition had changed over that period. Securing the supply of energy, increasing cost-effectiveness and reducing the environmental burden were all key arguments in parliamentary discourse – but so too was the wish to establish a robust and competitive industry supplying new energy technologies. Schmidt believes this important finding could help bridge political divides: "The more governments appreciate that a low-carbon energy policy creates new economic opportunities, the more willing they are to raise their climate ambitions to help domestic companies gain a competitive edge."

According to Schmidt, China – currently the country with the highest annual CO_2 emissions – offers a good example of the feedback mechanisms between policymaking and technology that his group has explored in several articles. Recent years have seen the Chinese government progressively toughen up its climate goals. At the same time, it has used cheap loans to fuel the creation of the world's largest photovoltaics industry. Beijing has also announced medium-term plans to switch road traffic over entirely to electric vehicles, and it has boosted battery-cell production by providing targeted support for a range of systems. In September, China stunned the world by announcing that it intends to become carbon neutral by 2060. Far from being driven solely by a sudden environmental epiphany, Schmidt argues, these ambitious goals also reflect China's determination to become the leading industrial power in the cleantech sector: "In the short term, politicians are much more interested in jobs and competitiveness than in achieving climate goals." Beijing is taking a clever approach to funding technology by pursuing what Schmidt calls a "technology-smart policy". This nuanced strategy uses different instruments to support different technologies, depending on their complexity, innovation curve and price development. This stands in contrast to the more scattergun approach taken by many countries in Europe.

Challenges of energy storage

Switzerland has so far chosen to drive forward the energy transition through feed-in remuneration at cost (KEV) and one-off investment grants for renewable energy projects. It has also introduced programmes to renovate buildings and promote research and innovation. Despite these steps, green energy (excluding hydropower) only makes up some 4 percent of Switzerland's current energy mix. The Swiss government insists this will rise significantly over the next few years to compensate for the shutdown of nuclear power plants and to meet the additional demand for electricity prompted ›

"Most parties have now come to the same conclusion: it's time to get ready for the cleantech race!"

Tobias Schmidt

Longer range for electric vehicles

“Electric drives are helping to shape the future of mobility,” says Martin Tanner, an electrical engineering student. He recently led a focus project to develop a new electric motorcycle, together with a team of nine other students, most of them from the Department of Mechanical and Process Engineering.

“The purpose of our electric motorcycle is to make mobility more climate-friendly,” he says. The team came up with some smart ideas to achieve this. To extend the motorcycle’s range, they developed a sophisticated drive concept with two wheel-hub motors. Together with a system designed to recover energy through regenerative braking, this allows the motorcycle to cover greater distances with a smaller battery. The students also opted for passive oil cooling to ensure the battery cells remain within the optimum temperature range, even when driving down the motorway in summer. Other key features include real-time systems and sensors that combine with dedicated software to optimise the motorcycle’s riding performance.

Martin Tanner with three of his talented colleagues from the ethec project: Anna Schnyder (top left), Marco Failla (top right) and Steven Peter (bottom right).

Stylish and green: the electric motorcycle offers motorbike enthusiasts a climate-friendly alternative.

by an increase in electric vehicles. Experts argue that the greatest potential for expanding renewables lies in PV systems. Yet feeding large amounts of solar energy into the power grid raises new challenges. With the support of the Swiss Federal Office of Energy, ETH researchers are using the Nexus-e simulation platform to model how the grid will need to be designed in the future and which economic and policy-related factors will impact implementation. “The biggest challenge is having to constantly maintain the balance between electricity generation and consumption,” says Gabriela Hug, Nexus-e project manager and professor at the Power Systems Laboratory. “PV output depends on weather conditions, so we’re likely to need technologies that can provide affordable solutions for long-term energy storage.”

Solar panels produce more electricity in summer than in winter, so without seasonal storage – and after the phasing-out of nuclear power – the grid would have to import significantly more electricity in the winter, when household consumption is at its highest. Options for seasonal storage include hydroelectric power stations with artificial reservoirs, of which Switzerland already has several. More of these could be installed in places where valley glaciers are retreating due to global warming. Another option is power-to-X (P2X) technologies, which transform electricity into more easily storable energy carriers such as hydrogen and synthetic fuels such as methane. Yet many of these technologies are relatively immature and expensive. Alternatively, electricity consumers could even take on a load-balancing role themselves by tailoring the use of electric vehicles and washing machines to the requirements of grid stability. This is becoming feasible thanks to rapid developments in information and communication technology and the increasing accessibility of user data. Yet electric vehicles and washing machines can only store surplus energy for a brief period, and certainly not from summer to winter. Hug argues that the only way to ensure grid stability with a high proportion of renewable energy is by ensuring that Switzerland is properly integrated in the European electricity network. Control technology is another challenge here: when power is produced with the synchronous generators used in nuclear, hydroelectric and coal-fired power plants, this leaves more time to modulate short-term imbalances between supply and consumption. By contrast, PV systems cause more rapid changes in frequency, which increases the risk of power outages. This is another area where Hug’s research group is currently seeking solutions.

Shifts in the political spectrum

Despite the technical challenges and the threats posed by a coronavirus-led economic recession, Tobias Schmidt is cautiously optimistic about the global energy transition: “The Paris Agreement five years ago triggered a race to develop green energy technologies – and not even Donald Trump’s decision to withdraw the US from the climate agreement can change that.” He is also increasingly seeing shifts in the political spectrum, including in Switzerland. “In 2018, the FDP was still trying to water down the CO_2 Act in the National Council,” explains Schmidt. Yet this autumn, the Act was passed by the whole of the Swiss Parliament with the sole exception of the SVP parliamentary group. “I think that shows how most parties have now come to the same conclusion,” says Schmidt. “It’s time to get ready for the cleantech race!” ○

Professor Gabriela Hug
Gabriela Hug is a professor at the Institute for Power Systems & High Voltage Technology. Her area of specialisation is the integration of renewable energy sources within the existing power grid. She regularly discusses this issue with policymakers and businesses.
psl.ee.ethz.ch

Professor Tobias Schmidt
Tobias Schmidt is Assistant Professor of Energy Politics at the Department of Humanities, Social and Political Sciences. He originally studied electrical engineering, followed by a doctorate at D-MTEC. His current work also includes advising policymakers and UN organisations on the best strategies for the energy transition.
epg.ethz.ch

Images: Sintratec AG; Giulia Marthaler (2)

“The key thing is to make a start.”

Civil society and governments struggle to take action when it comes to climate change. So what’s the solution? We asked climate researcher Reto Knutti and climate strike advocate Marie-Claire Graf for their perspectives.

INTERVIEW Corinne Johannssen and Martina Märki IMAGE Daniel Winkler

Mr Knutti, you’re a scientist, but right now you often get asked to express your views in social and political contexts, too. How would you define your role?
RETO KNUTTI: I could simply keep my head down and focus on research and teaching, but I think people expect more from my position. ETH is funded by taxpayers, so if ETH discovers something that is relevant to taxpayers, we have a responsibility to make it public – especially if it could put people at risk.

Where does science end and politics begin?
KNUTTI: It’s always a balancing act. Presenting figures in isolation is pointless, because numbers mean nothing without context. But the moment you contextualise them, they cease to be purely scientific. The idea of totally separating pure science from social or political realities simply doesn’t work in practice. The important thing is to clarify the assumptions and value judgements you’re making when you interpret the figures.

Ms Graf, you’re deeply involved in the climate strike movement. How would you define your role in the climate debate?
MARIE-CLAIRE GRAF: From one perspective, I see myself as a student acquiring new knowledge. But we also have an additional responsibility, especially if we know the facts and can see that people are not acting in accordance with them. That’s why many young people – including me – saw the need for a movement that would really fight for the implementation of agreed climate goals. I also feel it’s my job to “connect the dots”. That means converting my academic knowledge into political demands and channelling those demands into a pressure group. And it also means embracing multiple strategies: we need strikes, we need civil disobedience to challenge entrenched structures – but we also need diplomacy.

As a scientist, what’s your response to the climate strike movement and its demands?
KNUTTI: Climate scientists like me have made our position perfectly clear. Several thousand signatures support what the younger generation is ›

Marie-Claire Graf
is an active member of the climate strike movement and part of the Swiss delegation to the UN Climate Change conference.

Reto Knutti
is Professor of Climate Physics at ETH Zurich and the author of various IPCC reports. He plays an active role in communicating climate science to the general public.

“We need a movement that fights for the implementation of agreed climate goals.”

Marie-Claire Graf

saying and confirm their concerns are well founded. That doesn’t mean we specifically back the use of strikes and civil disobedience, but we don’t condemn them, either. We can all decide for ourselves whether this is the right approach. Personally, I won’t be chaining myself up in front of the Swiss Federal Palace because I have a different role.

Does the climate strike movement feel it gets enough public support from climate scientists?
GRAF: Universities could do more in terms of communication. But I also appreciate that they can’t risk damaging their credibility and their role as research bodies. The communication of scientific facts is a hugely important part of encouraging politicians to take action.

Did that influence your choice of what to study?
GRAF: I initially signed up to study environmental sciences at ETH. We certainly learnt plenty of facts on that course, but I felt they were keeping the crisis behind the numbers at arm’s length. So I decided to switch to political science, because I wanted to learn how to put solutions in place to accelerate the transformation we so urgently need. That’s something we should be incorporating much more in other degree programmes as well, because, ultimately, we need a society in which everyone gets involved.

The decision to act always has a political dimension. Are democratic structures suitable for tackling a problem like climate change?
KNUTTI: We need to initiate a process that we will have to shape together for decades to come. It must be endorsed by society – and for that you certainly need a democratic process.
GRAF: Democracy is hugely important for these issues. Remember that, in many cases, citizens’ assemblies have actually proposed much more ambitious measures than governments. Scientific studies show that if people know what kind of crisis we’re in, then they’re willing to act.
KNUTTI: Several prominent studies have also shown that factors such as intelligence and education do not necessarily correlate with concerns about climate change. Just because people are more informed, that doesn’t mean they’re more concerned about climate change per se. It seems to be more about personal priorities, political beliefs, and values and ideologies. But studies in the US have also shown that there is a fairly big group of uninformed people sandwiched between those who are concerned about climate change and those who don’t want to accept it. And that’s where facts could make a big difference.

Right now, coronavirus is occupying all our attention. Can this crisis teach us something about how to deal with climate change?
KNUTTI: There are some obvious parallels. Both things started out as quite abstract and poorly understood. They seemed quite distant, and perhaps the threat wasn’t immediately obvious. Yet, in both cases, quick action pays dividends. Those who take the facts seriously end up doing better – and those who wait get a nasty shock. And there’s something else the two problems have in common: in both cases, you don’t see the results of your actions immediately, but the situation can blow up in your face if you act too late! However, there’s also an important difference in the timescales. Climate change won’t kill us from one day to the next – and that makes it easier to ignore.
GRAF: Another thing that helped with coronavirus was the decision to officially classify the situation as a crisis from a very early stage, initially by the WHO, and then by many governments. That freed up funds and paved the way for new political measures. In the case of climate change, we still haven’t really had an official acknowledgement that we’re in a crisis. That’s why one of the key demands of the climate strike is for governments to recognise climate change as a crisis by declaring a climate emergency.
KNUTTI: If we interpret “emergency” as meaning we have an urgent problem that we need to tackle now, then I would sign up to that as a political statement. But I don’t see the justification for declaring a state of emergency in the legal sense. That’s because climate change is neither a situation that we couldn’t have foreseen, nor a situation that we can solve within a short time frame. We can solve climate change with our established political processes, but we need to take more effective action much more rapidly.
GRAF: We’re not calling for the legal declaration of a state of emergency. We simply want this to be acknowledged as a crisis, so we can respond to it as a crisis.

Has corona detracted from the climate debate?
KNUTTI: In the short term, yes. But climate change hasn’t completely disappeared from the political agenda – for example, in autumn the revision of the CO_2 law was approved by the Swiss Parliament. The coronavirus crisis has also taught us that we can do things people previously thought were impossible. It just requires the political will to get them done.
GRAF: Coronavirus has drastically disrupted our plans. That’s because we chose to respond to it in a responsible manner, based on science and solidarity. It’s certainly made things much harder. As well as affecting the climate strikes, it has also pulled the plug on other key events. Last December, I was part of the Swiss delegation to the 25th United Nations Climate Change conference. Key negotiations were due to continue this year, but they’ve all been postponed, even though we always talked about 2020 as “the year to act”. We’ve also lost a lot of momentum internationally.
KNUTTI: You might also see an argument emerging now that we should help the economy first and that we can’t focus on environmental protection at the same time. But scientific studies have shown us that the economy and environmental protection are not mutually exclusive. It’s another example of a situation where, in the long term, it’s cheaper to solve the problem rather than waiting.

How is the business community responding?
KNUTTI: We’ve seen a big increase in calls for action from businesses over recent years. Banks and financial service providers – even the big, well-established names – have clearly stated that we need to get to grips with climate change. Those companies are starting to realise that they might be affected by increasing risks, changing consumer behaviour and needs, liability issues and much more. They also see a chance for innovation.
GRAF: Banks have seen that they have to respond, in part because many young people say they don’t want an account with a bank that isn’t sustainable. But the banks’ reaction is often superficial. What we need is a complete shift from a destructive business model based on the exploitation of natural resources to a business model that is inherently sustainable and based on solidarity. And that’s still a long way off. The problem from a scientific perspective is that there is only a window of about 10 years in which there is a moderate probability of reaching the 1.5-degree goal.
KNUTTI: It’s true that we haven’t made nearly as much progress with the principles of a circular economy as we should have. But one really positive development is that some parts of the business world are no longer arguing with the research. Instead, they’re now acknowledging that the net-zero target is the right way to go and are willing to move in that direction. Many of them are even pushing for the state to set clear guidelines.

Are you optimistic that we can hit the target?
KNUTTI: The 2-degree goal is technically feasible and economically affordable. I’m more sceptical about the 1.5-degree goal, because it would require us to reduce emissions at a rate that is hard to square with today’s system and the level of knowledge we currently have. But I would argue we need to reframe the question. What we should really be asking is: how do we start? Because the key thing here is to actually make a start. Obviously we’ll make mistakes along the way, but we can learn from those and improve as we go. Waiting until we have a master plan for the next 30 years before we start would be completely nonsensical, in my opinion.
GRAF: I’m very optimistic. Much of what’s holding us up is simply a lack of political will. But the coronavirus has shown us how quickly we can act once we realise the situation is critical.
KNUTTI: It’s important that we don’t just focus on the problem but also develop a vision of where we want to be. By starting the climate strike movement, young people have found a positive way to address this topic and get people behind it. If we can manage to develop this vision together, then I’m optimistic. ○

Putting climate-positive business ideas into practice

More and more ETH Zurich researchers are taking the plunge into entrepreneurship. By launching spin-offs, they hope to turn their lab findings into solutions that can help stem the rise in atmospheric carbon dioxide.

TEXT Ori Schipper

The data for Julian Rogger's thesis came from various equipment at the Früebüel research station in the canton of Zug, including this eddy covariance measurement station for carbon dioxide.

Climate-friendly agriculture

Julian Rogger, who received an Excellence Scholarship in 2018, recently completed his Master's thesis in agricultural sciences. He investigated carbon dioxide fluxes in agriculture and the impact of climate change, drawing on over 15 years of measurements by the Grassland Sciences group. Keen to help combat climate change and promote climate-friendly agricultural practices, Julian is also an active member of the Swiss climate strike movement. Together with fellow activists, he is helping to develop a climate action plan that lays out a concrete vision of a society with net-zero greenhouse gas emissions: "I've been contributing my know-how to the agriculture working group." It's a time-consuming process, says Julian, but worth every minute: "It's important to put the things I learn at ETH to practical and political use."

There is no shortage of evidence for what the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) describes as an "unequivocal warming of the climate system". At no point in the past 800,000 years has the concentration of greenhouse gases in the atmosphere been as high as it is today. Since 1750, human activity has caused 555 billion tonnes of carbon dioxide to be released into the atmosphere, raising the concentration of carbon dioxide by 40 percent above pre-industrial levels. Between 1880 and 2012, the average temperature of the Earth's surface rose by 0.85 degrees Celsius. And with global snow and ice cover steadily shrinking, sea levels are rising by an average of 3 millimetres a year.

Scientists are united in their belief that humanity must do everything in its power to slow the rise in the concentration of greenhouse gases in the atmosphere, or even reverse it. There has been a noticeable increase in efforts by ETH Zurich researchers to come up with potential solutions for climate change. And increasing numbers of them are also venturing beyond the walls of academia and striving to put climate-positive business ideas into practice. Of the 242 spin-offs established at ETH Zurich since 2010, 34 are pursuing ways to combat global warming. In this article, we take a closer look at two examples: one from the energy sector, the other from the construction industry.

Carbon-neutral fuels made from sunlight and air

Since its founding in 2016, Synhelion has been working on something that sounds almost too good to be true: a solar technology that can reverse the combustion process. The company's mission is to produce synthetic liquid fuels exclusively from sunlight and air. Known as solar fuels, these release only as much CO_2 during combustion as was previously extracted from the air in order to produce them, thereby giving them the potential to make the transport industry practically carbon-neutral. Taken as a whole, air, sea and road transport currently release some eight billion tonnes of carbon dioxide into the atmosphere, making it responsible for a quarter of anthropogenic CO_2 emissions.

"We believe that liquid solar fuels have an important role to play in the energy transition," says Gianluca Ambrosetti, CEO of Synhelion. He rightly points out that no other energy carrier comes close to matching the energy density and long-term storage capabilities of liquid fuels. "What's more, our solar fuels are a drop-in technology, which means they don't require any additional infrastruc- ›

Images: Markus Staudinger; Keystone/Alexandra Wey

ture," says Ambrosetti. "They can be processed in existing refineries and distributed via the network of filling stations that is already in place."

Highly concentrated solar radiation

Synhelion's ingenious solar technology is based on three innovations originally developed by a group of researchers led by Aldo Steinfeld, Professor of Renewable Energy Carriers at ETH Zurich. Synhelion is now seeking to take these innovations to the next level. The first is the solar receiver, a black chamber containing a greenhouse gas. Solar radiation – concentrated several thousand times by mirrors – shines through the quartz glass window that fronts this chamber and heats up the gas to well over 1,000 degrees Celsius. The second innovation is the ceramic foam technology used in the thermochemical reactor. When heated to a sufficient temperature by the hot gas, this reactor is able to split water and carbon dioxide to produce syngas, a mixture of hydrogen and carbon monoxide. Conventional methods can then be used to convert this syngas into liquid fuels such as methanol, gasoline and kerosene. The third innovation is a thermal energy-storage system that can be used to drive the reactor processes at night and on overcast days.

A year has passed since Steinfeld and his team set up a mini-refinery, which produces around one decilitre of methanol a day, on the roof of the Machine Laboratory building at ETH Zurich. "This pilot plant proves that we can make sustainable fuel from sunlight and air under real-life conditions," says Steinfeld. The next goal, says Ambrosetti, is to scale up the processes, increase the efficiency and drive down costs.

Ambrosetti acknowledges that people may have doubts about scalability: "I think it will be at least five more years before we can start using this technology on an industrial scale." That's why Synhelion is developing an interim solution, known as solar upgrading, to shorten the time to market. "By adding methane to the mixture of water vapour and carbon dioxide gas, the temperature required for thermochemical conversion into syngas can be reduced to as little as 800 degrees Celsius," says Ambrosetti. "This simplifies the whole process, which means it should only take us two more years to get to the point where we can produce affordable solar fuels that release half the net CO_2 emissions of fossil fuels."

Turning carbon dioxide into stone

Neustark – an ETH spin-off founded in 2019 – is pursuing a business model based on an entirely different concept. The company is developing a technology that turns carbon dioxide into stone by binding it with concrete aggregate, thereby transforming it into high-grade limestone. The benefits include both an upgraded aggregate and long-term carbon storage. "The construction industry has so far made little progress in reducing emissions – and that's because so much research just gets filed away and never used," says Johannes Tiefenthaler, one of the spin-off's two founders. "I would like to see the effort that I'm putting into my doctorate make a tangible difference somewhere."

As part of his Master's degree, Tiefenthaler was already investigating various ways of converting carbon dioxide into limestone by reacting it with minerals. There are enough minerals on Earth to bind hundreds of billions of tonnes of carbon dioxide. However, as Tiefenthaler explains, many of them – such as magnesium silicate – are not particularly reactive, so they must first be heated to 700 degrees Celsius. In contrast, demolition rubble broken into concrete aggregate has proven to be highly reactive due to the huge total surface area of the numerous particles, each just a few millimetres in size. As a result, the concrete aggregate forms very stable chemical compounds with carbon dioxide, without the need for any pre-treatment.

Synhelion: This mini-refinery on the roof of an ETH building produces around one decilitre of methanol a day from sunlight and air.

Image: Alessandro Della Bella

"What I love about this solution is that it's ready to go now, not just in five or ten years," says economist Valentin Gutknecht, Neustark's second founder. The main challenge right now, he says, is juggling all the different issues involved. "As well as ensuring the properties of the concrete are exactly right, we also have to navigate the convoluted web of CO_2 certification."

Negative CO_2 emissions offer economic benefits

While Tiefenthaler works at the Department of Mechanical and Process Engineering to deliver the next generation of technology for the mineralisation of carbon dioxide, Gutknecht and an ever-growing team of employees are busy focusing on the operational side of the business. As part of a project funded by the Federal Office for the Environment and the Swiss Climate Foundation, Neustark has set up a pilot plant at the Kästli concrete works in Rubigen near Bern. Part of this pilot plant is a bright orange, skip-like container, in which liquid CO_2 is added to rubble from demolished concrete structures. After soaking in the bath of carbon dioxide for around two hours, the pieces of concrete rubble may still look the same, but they weigh significantly more because the tiny pores in the rough surface of the concrete have absorbed approximately 10 kilograms of CO_2 per cubic metre.

The carbon dioxide forms a chemical bond with the calcium oxide in the concrete rubble. This produces limestone crystals, which significantly enhance the qualities of the concrete aggregate: by using this recycled, upgraded aggregate to make fresh concrete, the same strength and rigidity can be achieved with less cement. Concrete production worldwide releases over 2 billion tonnes of carbon dioxide into the air each year. This represents around 7 percent of anthropogenic CO_2 emissions. By cutting the amount of cement required in construction, Neustark's technology can help reduce the industry's carbon footprint by eliminating some of the emissions that would otherwise occur during the production of cement.

But Gutknecht and Tiefenthaler are quick to point out another important advantage: thanks to their ingenious method of capturing carbon dioxide from the air, soaking it into the pores of the concrete aggregate and binding it permanently into limestone, they can even reverse CO_2 emissions. "There are very few technical concepts that deliver genuine negative emissions," says Tiefenthaler. Use of these concepts has so far been limited due to a lack of effective incentive schemes and business models. "This is where our method is unique, because it shows how binding carbon dioxide can create added value. The enhanced qualities of the concrete aggregate prove that negative emissions don't have to raise costs, but can actually provide economic benefits," says Gutknecht. ○

Learn more about these spin-offs at:
synhelion.com
neustark.com

To Australia by land and sea

A few years ago, Giulia Fontana and Lorenz Keysser made a big decision: "It's time to protect the climate – so no more flying!" Not long after, the two students, both of whom study environmental sciences at ETH, received an invitation to a friend's wedding in Australia. So off they went on an epic journey to Australia and back by rail and cargo ship, travelling all the way around the world without taking a single flight. They even wrote a book to share their experiences. "We managed to reduce the CO_2 emissions of the trip by over 10 tonnes and had some unforgettable experiences!" says Lorenz. The two students faced plenty of obstacles on their way. "Time, money and nationality issues are three of the biggest challenges – and that makes this kind of journey impossible for many people," says Giulia. This is an issue that features prominently in their book: "Individual changes in behaviour are certainly important, but we must always consider them in combination with changes to policies and systems. That's what we need to be fighting for!"

Doing things differently

Without a profound socio-ecological change, we will never achieve climate neutrality, say three economists. A brief sketch of what a sustainable economy might look like.

TEXT Michael Keller

Geared for growth, our economic system relies on the fact that damage to the environment costs next to nothing. This encourages the exploitation of nature – even though natural resources are finite. "It's just not sustainable," says Irmi Seidl, an economist who heads the Economics and Social Sciences research unit at the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL). Seidl's research explores how we can design an economy that serves people's needs while preserving the natural foundations of life.

"That's not what our current system does. Without an ecological rethink, economic crises and social disruption can only increase," she says. For decades, influential sectors of the economy have opposed effective environmental policies, arguing these would inhibit growth.

But such policies are urgently needed. Seidl insists that technology and voluntary action alone are not enough to combat climate change, the destruction of nature and species extinction. She doesn't believe in "green" growth. "Carrying on as before with some greening won't work," she argues. Seidl says that so far a growing economy has always been accompanied by rising consumption of energy and resources – and there is no sign of an absolute decoupling.

Towards a sustainable economy

As an economist, Seidl insists the answer lies in fundamental socio-ecological change: "If we want to make responsible use of the resources that support our lives and livelihoods, we need to attach a significant value to natural capital and move away from the traditional pursuit of growth."

Seidl argues there are levers to achieve this. "The key is to change the structural incentives that lead to environmental damage," she says. Her first recommendation is that the cost of energy and natural resources should reflect their ecological scarcity, and a price be put on the negative impacts on the climate and environment. "Environmental exploitation should be much more expensive," says Seidl. The second is to abolish – or redesign – subsidies that end up harming the environment. Like in many other countries, the Swiss tax system includes numerous incentives designed to promote sectors such as energy, agriculture, transport, and settlement development. These include direct or indirect support for pesticide use, commuting, land consumption, urban sprawl and construction.

Seidl also argues that we need to make central pillars of our society less dependent on growth. Two examples she cites are tax revenues and social welfare services. Both are heavily financed by contributions paid on employment, at the same time as corporate taxes are falling. This makes labour noticeably more expensive, which is why companies are replacing labour with technology. More growth is then required to create paid employment, achieved – among other things – by measures to attract new companies and workforce, zoning of land, and construction of roads and housing.

Seidl asserts that this spiral of growth must be stopped. This requires not least a new understanding of work, she says, because at present we pursue growth primarily to ensure the availability of paid employment. "We therefore need to reduce the elevated status attached to paid employment," she concludes. That would mean we would spend less time working to earn money and would produce and consume less. In return, we would benefit from an intact environment, better health and more time to spend on voluntary and charitable work and caring for others.

Getting the economy on a greener and more climate-friendly track will ultimately require us to completely ›

Images: Giulia Fontana and Lorenz Keysser

restructure various sectors, says Seidl, including energy and transport, housing and urban development, and construction and agriculture. “Ecological transformation isn’t easy,” says Seidl. “But it’s doable if we tackle it in a socially just way and recognise it as a task that involves the whole of society.” Research has a key role to play in this context. Transformation requires sustainable materials, production technologies and infrastructure solutions, all of which researchers will need to develop. “Most of the innovations for this come from universities, not from business,” says Seidl. She sees a clear role for the institutions of the ETH Domain and points out that ETH was founded with the goal of helping drive forward Switzerland’s industrialisation and modernisation. “Now it’s time for ecological modernisation, which is a task at least as big!” she says.

Keeping materials in the loop

At the heart of this discussion is the way we use resources. “The extraction and processing of raw materials cause around two-thirds of global greenhouse gas emissions,” say Catharina Bening and Nicola Blum, who are senior researchers in the Group for Sustainability and Technology (SusTec) and co-leads on the Towards A Sustainable CircuLar Economy (TACLE) project.

The goal of a circular economy is to decouple economic growth from resource use and to avoid waste by keeping materials and products circulating in closed loops. It is considered by many to be the basis of sustainable development. “The concept of a circular economy has gained in acceptance considerably in recent years,” say the two researchers. In collaboration with industry partners, they are seeking ways of transforming linear production processes into circular value chains.

Time and again, they see people optimising circular systems according to the simple rule that “the more material kept in the cycle, the better it is”. Focusing on the quantity of recycled materials is a common approach, but it often fails to take into account factors such as water and energy consumption, climate impact, and economic and social repercussions. “The mere fact of keeping material circulating in a loop is not eco-friendly per se, nor is it necessarily financially sound,” Blum cautions. One example is glass recycling: although it is undoubtedly important for people to use bottle banks, the energy required to turn waste glass into new bottles may mean it is actually better for the environment to use the glass as an insulation material, which can save energy.

To make the concept of a circular economy more relevant, Blum and Bening recommend looking not only at the flow of materials, but also at how sustainable each measure is in each of the three dimensions of ecology, economy and society. “That way, you ensure any ecological benefits you achieve also make sense from an economic and social perspective,” says Bening.

In practice, however, as the two economists are quick to point out, this approach often leads to conflicting goals. For example, although PET recycling in Switzerland contributes to a sustainable circular economy in all the dimensions, a 100-percent collection rate would not necessarily be desirable from an economic standpoint. Ecological sustainability would certainly increase, but the collection costs would ultimately exceed the additional income generated by the sale of recycled PET plastic.

This shows how the goal of an economy that minimises waste and environmental damage is complex and laden with compromises. “Nonetheless, the circular economy is definitely a step in the right direction if we want to preserve natural resources,” says Blum. And if there’s any country in the world fit to play a pioneering role here, says Bening, it’s Switzerland. ○

Irmi Seidl
is Professor of Ecological Economics at WSL and ETH. An ecological economist who is critical of growth, Seidl addresses the negative consequences of economic growth and develops ideas inspired by the caring economy.
wsl.ch/en/employees/seidl

Catharina Bening
is a senior researcher in the Group for Sustainability and Technology (SusTec), where she co-leads the Towards A Sustainable CircuLar Economy (TACLE) project. Part of her work involves exploring the institutional, regulatory and economic requirements for sustainable circular solutions.
sustec.ethz.ch/people/sr/cbening

Nicola Blum
is co-lead of the Towards A Sustainable CircuLar Economy (TACLE) project at SusTec. She conducts research into how linear industrial processes can be transformed into circular value chains.
sustec.ethz.ch/people/sr/nblum

Images: R. Hofstetter; courtesy of C. Bening and N. Blum; Oliver Bartenschlager; Gian Marco Castelberg

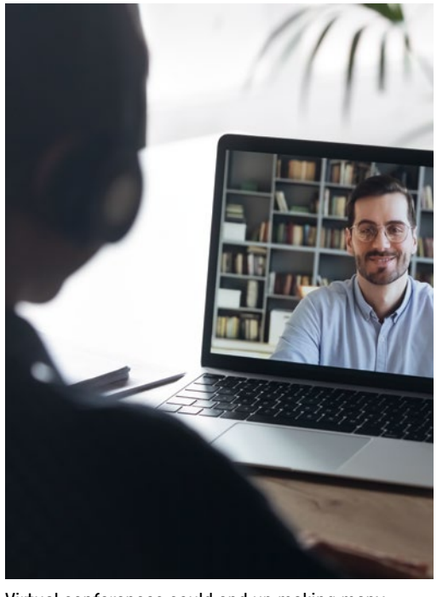
● Culture shift for a sustainable future

Anna Knörr may be passionate about theoretical physics, but that certainly doesn’t mean she ignores social problems. In fact, the physics student has spent several semesters as a member of the Student Sustainability Commission (SSC) of VSETH. “At ETH, I can put concrete projects into practice on a local level. That may not change the global system, but tackling more easily solvable problems with fewer unknowns is a good start,” she says with a smile. One example was her role as a student representative in the CO_2 working group set up by the Department of Physics, which last spring developed a series of strategies to adapt research, teaching and administration at D-PHYS. “The key to putting these into practice is to promote a culture change – and to do that faster than climate change!” says Anna. She hopes to make a contribution with her part of the project, which features video messages from professors who are passionate about sustainability. These aim to show students that it’s possible “to be a successful and sustainable researcher”.

Campus policies drive societal change

The coronavirus crisis has triggered a boom in virtual collaboration as an alternative to flying. Might it be possible to seize on this experience to shape the future of sustainable mobility?

TEXT Michael Keller



Virtual conferences could end up making many flights unnecessary.

ETH Zurich is primarily known for its outstanding research and teaching. But it also strives to apply the principles of sustainability on campus and channel them into wider society. "Our decisions and actions set important examples, especially in regard to the climate," says Ulrich Weidmann, Vice President for Infrastructure. That's why ETH strives to make sustainability an integral part of its research, teaching and working practices – for example, by operating an Anergy Grid and deploying battery-powered buses for the shuttle service between the Zentrum and Hönggerberg campuses.

Two more striking examples of this commitment are an ETH staff unit responsible for sustainability and a dedicated hub for mobility questions. The first of these – ETH Sustainability – connects up stakeholders and initiatives in the field of sustainability as well as implementing its own projects. These include the Climate Programme for ETH Catering, which seeks to help on-campus catering companies find eco-friendly ways to feed their customers. The second example is the mobility platform, which is a hub for climate-friendly business trips and campus mobility. One pioneering initiative is a project to reduce air travel, which Weidmann launched in 2017. The popularity of virtual meetings as an alternative to flying received an unexpected boost this year as a result of the pandemic.

Lessons from a crisis

The coronavirus crisis has given a powerful boost to digital communications and fuelled a shift towards online teaching, virtual conferences and working from home. "The past few months have shown what's possible," says Susann Görlinger, who heads up the air travel project. She argues the time has come to harness this momentum and encourage the scientific community to embrace sustainable mobility. Görlinger is aware that the decision to avoid flying has not come voluntarily, but points out how impressive it is to see that people have been able to change their habits so quickly.

Having spent the past four years promoting an ETH-wide reassessment of the need for air travel, she is something of an expert in this field. The project's slogan is "Stay grounded – keep connected", and the aim is to reduce the CO_2 emissions of business trips made by air. Video conferences have been a high priority right from the start. The project is seen as particularly ambitious because it seeks to motivate members of ETH to make conscious choices to change their behaviour, as well as striving for a long-term shift in values among the academic community. This makes ETH one of the first universities in the world to address a serious conflict of interests: research needs international collaboration, yet universities are precisely the kind of institutions that should be promoting climate-sensitive policies. For too many years, working together was synonymous with taking flights.

All that changed when the crisis hit. "As you might expect, this spring saw a big jump in people's willingness to opt for virtual forms of collaboration over flying," says Görlinger. This is also reflected in an ongoing online survey of people's experiences with online events, which was launched in early March by the air travel project in collaboration with the Institute of Geography at Heidelberg University.

The coffee break challenge

"Moving events online offers all sorts of benefits – and not just for the environment," says Görlinger. As well as cutting costs, it also saves time and is widely regarded as more family-friendly. In short, going virtual is not just more eco-friendly but also more cost-effective and socially responsible – not least because it opens the door for regions and communities with small budgets to participate in conferences. One major downside is the difficulty of finding virtual substitutes for informal moments such as coffee breaks to engage with participants one-on-one. Scientific support for the air travel project is provided by graduate psychologist Agnes Kreil, a doctoral student in the Transdisciplinarity Lab at ETH Zurich. She admits there are those who feel the coronavirus is just something to be overcome before returning to how things were before. "But most people are showing at least some signs of rethinking their attitude," she says.

Maintaining the momentum

But will that be enough for lasting change? Kreil says it depends: "This experience has shown us how to run virtual meetings. But if we choose to stop here and just criticise all the shortcomings, we'll lose our impetus." To lock in the behavioural changes after the pandemic, we also need to be creative and find attractive solutions that people like to use – including ways to forge closer ties between people online.

"It's not just about individuals taking responsibility," says Görlinger. "You also need institutions to put the right frameworks in place." That's why the air travel project is always on the lookout for innovative tools, tips and formats to highlight as best practices on their website. Good examples are often hard to find, particularly for bigger events. To get a better idea of people's attitudes towards air travel and the information they need, the team is also planning to survey additional groups such as scientific staff and students.

Görlinger has already presented the air travel project to a number of networks and committees. Her experiences have attracted considerable interest from universities and other organisations in Switzerland and abroad. Numerous universities have already launched similar initiatives. If the air travel project succeeds in achieving the desired change in values, ETH could be on course to maintain, or even extend, its pioneering role. Ultimately, advocating a more sensible approach to flying could also serve as a model for the rest of society. ○

Ulrich Weidmann
is a Professor of Transport Systems at ETH Zurich and serves as Vice President for Infrastructure.
ethz.ch/vicepresident-infrastructure

Susann Görlinger
heads up the air travel project.
ethz.ch/air-travel

Agnes Kreil
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tdlab.usys.ethz.ch

Images: Colourbox; Markus Bertschi; courtesy of anonymous (2)

COMMUNITY

Due to the coronavirus pandemic, ETH Day 2020 was held on a smaller scale and livestreamed from the Semper Aula, where Rector Sarah Springman welcomed guests.

ETH Day 2020

AWARDS

Two important scientists received honorary doctorates at ETH Day 2020:

Frans Spaepen, professor at Harvard University, for his outstanding contributions to materials science and applied physics; and Stephen Quake, professor at Stanford University, for his technological innovation and entrepreneurship at the interface between biology, biotechnology, medicine and physics.

ETH Zurich also awarded the title of Honorary Councillor to two prominent figures from the business world: Adrian Weiss and Calvin Grieder were both recognised for their outstanding personal philanthropic contribution to promoting teaching and research at ETH Zurich.

Bachelor of Medicine at ETH

TRIED AND TESTED

Since autumn 2017, ETH Zurich has been offering 100 places a year to study human medicine. The Bachelor's degree programme, which was made possible by the federal government's special programme for human medicine, was developed from scratch in close collaboration with university and clinical partners. It was initially launched as a pilot project, with the first medical students graduating with a Bachelor's degree this summer. ETH Zurich will continue running the degree programme as a standard course from January 2021.

Equality

MEASURES PROVE EFFECTIVE

The recently published Equality Monitoring 2019/2020 reports an encouraging new record in the number of female professors at ETH Zurich. This leap forward owes much to targeted efforts by the ETH President and the academic departments to appoint more women. In 2019, half of all new appointments to assistant professorships went to women, as well as 21 percent of permanent professorships. "I'm delighted to see that the series of measures we've taken is now having an impact on appointments," says ETH President Joël Mesot. "But these are just the first steps." Women continue to be under-represented at ETH Zurich at every stage of their academic career. Across all degree programmes, just under a third of students are women, though this figure is as low as a tenth in some, and well over half in others. Only one in seven permanent professorships is held by a woman. What's more, the "leaky pipeline" effect continues to apply, with the proportion of women falling as they move up the academic career ladder from the Master's and doctoral level to professor level.

Nonetheless, Renate Schubert, the ETH President's delegate for equal opportunities, is optimistic that the growing number of female professors will increasingly encourage young women to tackle the next rung on the academic career ladder.

Image: Oliver Bartenschlager

Mobility Initiative

SOLUTIONS FOR THE FUTURE OF MOBILITY

Partnerships with businesses help ETH Zurich incorporate real-world concerns into its research and accelerate the transfer of knowledge into practical applications.

AMAG – currently celebrating its 75th anniversary – recently signed up as a funding partner to the ETH Mobility Initiative, which provides a research framework for nearly 40 professorships currently working on mobility issues. Their work is closely intertwined with climate and energy research and heavily influenced by digital transformation. AMAG Group CEO Morten Hannesbo and ETH President Joël Mesot expressed excitement about the new partnership at the signing of the agreement in early November. Alongside the two other funding partners, SBB and Siemens Mobility, AMAG promises to give a major boost to the Mobility Initiative. As well as bringing a fresh perspective to the table, AMAG will contribute its broad knowledge of mobility both on and off the road.

Help support the future of mobility:
→ www.ethz-foundation.ch/en/mobility

Spark Award

ILLUMINATING TUMOURS

Making tumours visible so that surgeons remove only as much tissue as necessary – that's the goal of an invention by ETH organic chemists Helma Wennemers and Matthew Aronoff. The two scientists received the Spark Award for their achievement. This prize is awarded to the most innovative and commercially promising invention at ETH from the preceding year.

Perfectly targeted
Their invention targets a very specific process. The body needs collagen to create tissue. In cases of cancer and various fibrotic conditions, however, tissue production goes into overdrive. To make this abnormal tissue production visible, the two researchers rely on the enzyme LOX, which induces collagen cross-linking in tissue. Their marker accumulates where LOX is active, thereby showing the surgeon where the pathologically altered tissue is located. "Our innovation has now reached a level where we have a realistic hope of being able to help patients in the future," says Wennemers. The next steps towards real-world applications are already underway. "We're looking into the possibility of a spin-off," says her collaborator Aronoff.

Wennemer's and Aronoff's invention had to clear a very high bar to win this award. The other four projects nominated were also of exceptionally high quality, with finalists vying for the top spot with 3D-printed implants, a new salmonella vaccine for animals, a faster payment concept for bitcoin and ultra-sharp tips for atomic force microscopy. ETH Zurich registered a total of 185 inventions last year.

"We've spent 10 years researching collagen to improve our understanding of this protein at the molecular level."

The winners of the 2020 Spark Award: Helma Wennemers and Matthew Aronoff.

Image: Martin Rütsche

rETHink project

Preparing for the next 20 years

Rising expectations from both inside and outside the university have prompted the Executive Board to launch rETHink. One year on, this organisational development project is steadily gaining momentum.

ETH has expanded its Executive Board to include two additional vice presidents: Vanessa Wood (left) and Julia Dannath-Schuh (right), with Joël Mesot.

Image: ETH Zurich

ETH Zurich is a success story. The university enjoys a top international ranking in the fields of teaching, research and knowledge transfer. "But the pressure on ETH is growing," said ETH President Joël Mesot when he took the helm in 2019.

Some of this pressure stems from tougher global competition in higher education and research, including from up-and-coming universities in Asia. Equally challenging is the race to recruit new talent, with the private sector and the academic community increasingly competing for the same people. Swiss politicians are proud of "their" ETH, but questions about its governance are getting louder, particularly in response to isolated but headline-grabbing cases of misconduct. Shifts in societal values are also making themselves felt in the world of higher education, and employees now expect more in the way of professional strategic leadership and personnel management. Diversity in the workplace is now more important than ever.

"ETH Zurich has grown fast in recent years – the number of students alone has more than doubled since the year 2000 – and it has become steadily more diverse, both culturally and academically," says Mesot. Yet he notes that the university's structures and processes have long remained largely unchanged. This situation led the ETH President to join forces with the Executive Board last year to launch rETHink, an organisational development project that seeks to take a participatory approach to addressing the key issues facing the university.

Staying in the top tier

"The idea behind rETHink is to ensure ETH maintains its top-tier position over the next 20 years," says Mesot. A key goal is to improve the cooperation between professorships, academic departments and central administrative units. This will help researchers and teaching staff perform their core duties more efficiently. "At the same time, we also want our university to be one of the world's best in terms of leadership culture and personnel development and to cement our position as one of the key drivers of Swiss innovation," he adds. Last but not least, Mesot is keen to lead a wide-ranging debate on the internal culture at ETH.

The rETHink project has been gaining momentum in recent months. One of the changes that is most visible to the wider community is the expansion of the university's Executive Board: Julia Dannath-Schuh was appointed as the new Vice President for Personnel Development and Leadership on 1 November, and Vanessa Wood will be taking up her post as the new Vice President for Knowledge Transfer and Corporate Relations on 1 January 2021. This will consolidate and expand existing expertise in these two areas of responsibility.

rETHink takes shape

But rETHink is increasingly taking shape within the university, too. In the autumn of 2020, over 130 members of ETH drawn from all the university's different groups – employees, students, and teaching staff of all levels – assembled in various focus groups to discuss fundamental issues concerning professorships. The participants debated the duties of a professorship, new duties stemming from increased expectations, and related questions concerning the use of resources. They also discussed the importance of autonomy for professorships and examined issues of leadership and supervision as well as other aspects such as cooperation within academic departments and with administrative units.

The results of the focus groups are now being evaluated and compiled to reveal possible measures that could be incorporated in the ongoing discussion. Building on these results, further groups will discuss what consequences this should have for ETH structures – in other words, how it should affect the organisation and responsibilities of the institutes, academic departments and central administrative units.

In parallel, the ETH President and the Rector have launched a wide-ranging discussion on the university's values. This is based on the five values that were defined by the Strategy Commission for the Strategy and Development Plan 2021–2024: responsibility, openness, diversity, team spirit and excellence. Does ETH already live up to these values? How are they put into practice on a day-to-day basis? And are there any other values that are essential for good collaboration? Following initial discussions in the workshops, ETH launched a blog that invited all members of ETH to respond to these questions. Based on this feedback, the discussion of values will now be systematically rolled out on a university-wide basis over the coming year. The goal is to promote wide-ranging reflections on the culture at ETH.

"I'm absolutely delighted with the traction this project has gained, even with the huge additional burden that the coronavirus crisis has imposed on all the members of ETH," says Mesot, summing up the situation so far. As the discussion widens to encompass new topics and delves deeper into existing ones, the opportunities to participate will increase. This is where Mesot is hoping for the maximum involvement of ETH members. After that, a consolidation phase will lead rETHink into an ongoing process of discussion and review of the ETH organisation and culture – for example, in the form of annual workshops. — Roland Baumann

Image: Eline Keller-Soerensen

Philanthropy

The happiest time of her life

By Donald Tillman

Recently, the ETH Foundation got the chance to talk to alumna Dr Susan Richards about the legacy left by her mother, Ursula Himmel-Glarner. Listening to Richards talk about her mother affected me deeply, particularly as the father of a daughter who recently started school.

Ursula Himmel-Glarner attended ETH at a time when few women had the opportunity to enter higher education. She always referred to her pharmacy studies as the happiest time of her life. It wasn't until later in life, after many years as a full-time housewife and mother, that she worked as a pharmacist. Yet her belief in the importance of a good education, especially for women, never wavered. That's why Ursula Himmel-Glarner supported the ETH Zurich Foundation for so many years, right up until her death in 2019. She also left a provision in her will to maintain this commitment in the future by supporting outstanding female Master's students. We hope her legacy will help as many scholarship recipients as possible fulfil their career goals.

→ www.ethz-foundation.ch/en

Excellence Scholars have their photo taken with ETH Rector Sarah Springman (front row, centre).

Excellence Scholarships

WELCOMING THE TALENTED 53

Fifty-three new Excellence Scholars began Master's programmes in 15 different academic departments this September. Rector Sarah Springman was on hand to welcome the talented individuals, who hail from a total of 21 countries. Thanks to the support provided by donors and partners, the students can focus entirely on their studies and acquire the necessary skills to advance the progress of industry, science and society.

Foster excellence by supporting emerging talent:
→ www.ethz-foundation.ch/en/esop

Changes ahead

GOODBYE TABLET, HELLO WEB

To reflect evolving preferences, ETH Zurich's *Globe* magazine will discontinue its tablet edition at the end of this year. At the same time, it will be expanding its online presence to ensure *Globe* readers who prefer a digital version can access all the main articles on the *Globe* website. A newsletter will keep people up to date with the latest issues and articles.

Globe newsletter:
→ ethz.ch/news-signup
Globe website:
→ www.ethz.ch/globe-en

Engineering programme

IN AFRICA, FOR AFRICA

Sustainable development across the globe hinges on the African continent, where the population is projected to grow faster than anywhere else in the world. To set industrial development on a sustainable course, Africa will need qualified home-grown engineers. To help achieve this, ETH Zurich has teamed up with Ashesi University – located near Ghana's capital, Accra – and industry partners on the ETH for Development (ETH4D) initiative. The goal is to develop a new Master's programme for students from sub-Saharan Africa.

In addition to donations raised through the ETH Foundation, this pioneering project is also supported by funding and scholarships from industry partners ABB, Barry Callebaut, Bühler, LafargeHolcim and Nestlé. These companies will also offer internships and career opportunities at their African locations. "We want this Master's programme to have a real and significant impact on sustainable development," says Sarah Springman, Rector of ETH Zurich. The joint degree programme is due to start in the 2021 Autumn Semester. Teaching will be conducted in blocks at Ashesi University. Each year, 25 to 30 students will join the Master's programme from across sub-Saharan Africa. Once the first five cohorts have graduated, ETH will withdraw from the degree programme, leaving Ashesi University to run it independently.

Support the Master's programme in Ghana:
→ www.ethz-foundation.ch/en/eth4d

Image: Hannes Heinzer

Transfer

Avatars: your friends and helpers

Ticket machines can be fiendishly difficult to use – and booking a hotel online often feels like an obstacle course. The founders of ETH spin-off Animatico decided there must be a better solution. This led them to develop software that uses interactive, talking avatars as a user interface for digital devices.

The avatars use voice, gestures, emotions and visuals to guide users through tasks step by step. The result is a simpler, more intuitive customer experience at self-service terminals.

Key technologies include dynamic rendering of the avatars and a small camera to detect user interactions. The system can be used without touching the screen, though users can also opt for the more traditional approach of tapping on-screen buttons. The avatars can quickly be adapted to suit different applications.

Animatico's products benefit customers across all industries, including healthcare, hotels, retirement homes, finance, insurance, mobility and entertainment.

Animatico
ETH spin-off, established in 2019
Product: interactive talking avatars
→ animati.co

Benefits
- Natural and intuitive
- Adaptable to many applications
- Available on standard devices
- Touchless

Illustration: Carolin Eitel

Download, print and save the reef!

Coral reefs are home to 25 percent of marine life. Yet these complex structures and the ecosystem they support are in acute danger of disappearing due to climate change. An artist and a marine biologist have taken up the challenge of rebuilding the reefs by harnessing the power of 3D printers.

TEXT Stéphanie Hegelbach

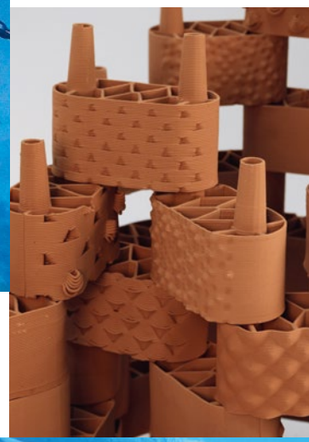
The artist Marie Griesmar never goes diving without an underwater pencil and paper. With a weight belt strapped around her waist, she kneels on the seabed and sketches the shapes of corals, part of an underwater world that has fascinated her since she was a child. “When I look at a coral reef, I feel so incredibly tiny. The reef reminds us how time and space are related, and I find that very moving,” she says. This extraordinary underwater realm is thousands of years old and home to more species than any other underwater habitat. Yet, far out of sight, it is starting to crumble, with rising sea temperatures causing coral bleaching and the death of entire reefs.

How can we combat this in a world where climate change remains out of control? Marie Griesmar has come up with an innovative solution called rrreefs. Working at ETH in collaboration with marine biologist Ulrike Pfreundt, she has developed 3D-printed bricks that can be assembled underwater to create artificial reefs. The surface of the bricks is specially designed to create turbulence in the water, increasing the likelihood that coral larvae will approach the bricks and settle.

Giving reproduction a helping hand

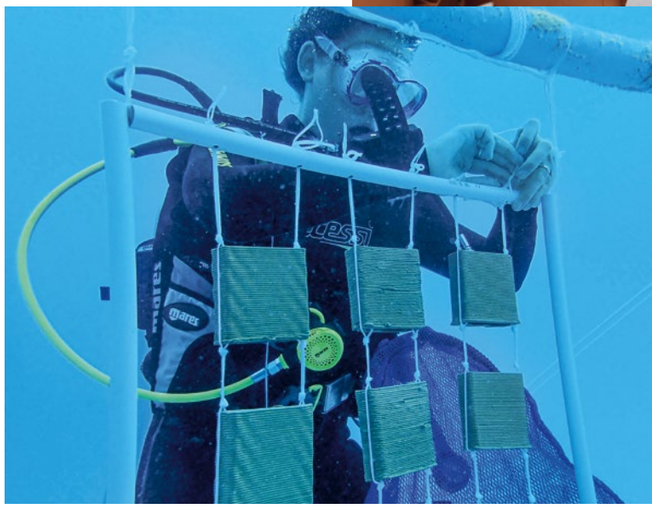
Most corals only release eggs and sperm cells once a year, typically over the course of a few nights after a full moon. By simultaneously releasing both male and female reproductive cells, the animals maximise the chance of fertilisation. Fertilised eggs develop into elongated coral larvae, which drift away with the current. Those larvae that are fortunate enough to settle in a suitable spot can then grow into a new polyp and start a new coral colony. This is where rrreefs lends a helping hand: “If we can improve the growing conditions for larvae by creating an artificial reef, then we can actually help the corals reproduce,” say Griesmar and Pfreundt. “Coral reproduction has a very low success rate, only about one in a million,” explains Pfreundt. “That was fine in the past, because a coral reef used to be an ecosystem with a long lifespan, but now corals are struggling to adapt and repopulate.” The duo’s plan is to combine natural larval settlement on artificial brick reefs with the method of assisted evolution. Unlike in asexual coral breeding, where parts of a colony are broken off and reattached somewhere else in a process known as “fragging”, assisted evolution involves retrieving eggs and sperm from more resistant corals and artificially fertilising the eggs. This ensures genetic variability, which is crucial when it comes to adapting to warmer ocean temperatures.

The world has already lost half of all coral reefs. One of the key causes is coral bleaching, a process in which rising sea temperatures and water pollution destroy the symbiotic relationship between the coral and a specific type of algae called zooxanthellae. As well as giving corals their colour, zooxanthellae use photosynthesis to produce oxygen and sugar as the corals’ primary food source. “When the water temperature gets too high, scientists suspect this interferes with the algae’s photosynthesis. As a result, the corals start to view them as a parasite and repel them,” says Pfreundt. This causes the coral to bleach and eventually die. The bare calcium skeleton of the coral reef begins to crumble and all that remains is a cemetery choked with algae – and countless sea creatures without a home. Griesmar saw this process for herself on a diving course in the Seychelles: “It was disturbing to see it up close.” The collapse of the foundations on which this ecosystem is based also has major implications for humans, because reefs protect the coastline against erosion and are a key source of income for tourism and fishing. ›



Below: Stacked and assembled into a sculpture: these 3D-printed clay bricks are designed to give corals a new home.

Above: Marie Griesmar on one of her dives.
Below: The Marine Research and High Education Center (MaRHE) is testing clay prototypes with different surfaces.



Images: LeilaTaz (2); Ulrike Pfreundt

A stroke of luck

"This problem is a major global challenge that can no longer be solved within the confines of a single discipline," says Maximiliane Okonnek, Managing Director of the ETH Library Lab. She first met the dedicated young artist during her art residency in San Francisco. They got chatting, and Okonnek mentioned the Innovator Fellowship at the ETH Library Lab. For Griesmar, the timing was perfect. Having already worked on the development of underwater structures with the Reef Genomics Lab in Saudi Arabia, she was planning her next step. "I realised that I would need new technologies like 3D printing to move forward," she says, explaining what prompted her to apply to ETH. Her collaboration with the ETH Library Lab produced benefits on both sides: Griesmar was able to work with 3D printers, while the Library Lab gained insights into the data and information infrastructure underpinning her methods. Griesmar also used 3D-printing techniques to make models for the Swiss-wide Material Archive network. "3D printing is becoming increasingly important in the scientific community. It's important for libraries to keep track of relevant infrastructure for sharing information in this field and record how people are using the data and software," says Okonnek, highlighting how the project dovetails with the goals of the ETH Library Lab.

Griesmar's successful pitch of her "Beneath the Sea" project led to offers of support for her research into fabricating reef bricks out of clay – both from the Gramazio Kohler Research group at the ETH Chair of Architecture and Digital Fabrication and from Zurich University of the Arts

A good team: artist Marie Griesmar and marine biologist Ulrike Pfreundt with the reef brick they developed.

"The moment I heard about her work, I realised we should combine our strengths."

Marie Griesmar

Marie Griesmar and MAS student Nicolas Feihl try out digital fabrication methods in the Computational Clay Coral Cities (CCCC) project.

(ZHdK). "First, we had to learn to speak the same language – and I had to learn CAD design and programming. That took a little while," says Griesmar. Even getting the right blend of clay for 3D printing required a lot of trial and error on Griesmar's part: "Luckily, clay is easy to recycle. And a local family-run company, Bodmer Ton, gave me a tonne of it to work with."

Meanwhile, marine biologist Pfreundt was working on the same topic in the same building, though the two women were completely unaware of it at the time. Pfreundt was investigating 3D printing with sand to find out what shapes and structures might help coral larvae settle. "The moment I heard about her work, I realised we should combine our strengths!" says Griesmar. The two researchers share the vision of fabricating a low-cost artificial reef by harnessing new technologies and the support of the local community, with the ultimate aim of regenerating coral reefs. Their overlapping research interests gave rise to the MAS DFAB research thesis "Computational Clay Coral Cities", which also involved the participation of the Chair of Digital Building Technologies. The thesis provided the framework for two Master's students from the Department of Architecture to study whether "rapid clay formation" could be used to help build artificial reefs. Rapid clay formation is a method in which robotic arms grab cylindrical pieces of clay and press them together according to defined parameters. The students used data from the Marine Research and High Education Center (MaRHE), while researchers at the Chair of Environmental Fluid Mechanics studied the flow pattern along the artificial reef.

Buoyed by the interdisciplinary findings, Griesmar decided to produce her own structure out of clay using conventional 3D printing. "This method requires less material, and it also means the bricks and printer are easier to transport, which makes it easier to adapt to local conditions," says the artist. With the help of programmer Jonas Ward Van den Bulcke, she produced building blocks complete with two connectors that make them stackable. Once assembled, they form a robust structure that is able to spread the impact of external forces. "My goal was to create a modular brick system with a playful vibe that is easy to install and appealing to look at," says Griesmar. Pfreundt's research results were also incorporated into the process: "Clay has a rough surface that's perfect for coral larvae. And the sections that protrude a few centimetres from ›

Images: Yvonne Fuchs; Roland Lanz for ETH Zurich/ETH Library Lab

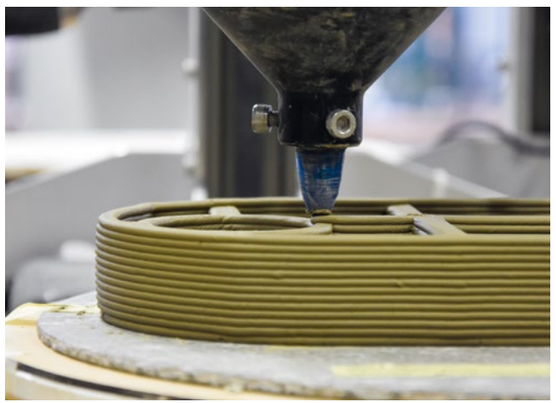
the side of the bricks protect the larvae from sand and the jaws of hungry fish," says the marine biologist. Samples of Griesmar's textured clay surfaces are currently hanging in the Indian Ocean, where MaRHE researchers are monitoring the settlement patterns of coral larvae.

Lego based on science

"The ETH Library Lab helped me find the right people and gave me the methodological framework I needed for my interdisciplinary approach. That was very useful," says Griesmar. After completing her Fellowship at ETH, she joined forces with Pfreundt to set up an NGO called rrreefs – the three "Rs" stand for rethinking, rebuilding and regenerating reefs. "Our aim is to find a holistic solution that gets local communities involved," says Griesmar. The basis for this is the rrreef brick system that she developed. The duo is hoping to organise workshops with volunteers to construct two pilot reefs in Colombia and the Maldives. "If I can just get people to experience the majestic beauty of the reef, not to lose hope, and perhaps even to take action, that will be a great start!" says Griesmar. The two are keen to pass on their expertise in reef building and monitoring. "What bothers me as a biologist is that most of the artificial reefs that have been built to date are not being rigorously monitored and evaluated," says Pfreundt. She and Griesmar therefore intend to document the biodiversity and coral growth on their pilot reefs for at least two years. To continuously refine their approach, they will plough the knowledge and insights they gain back into the project and their research.

RRReefs has set the goal of producing 200 bricks for each location and shipping them to the pilot reef sites.

These computer renderings show what the artificial reefs may look like one day. Above: a freshly installed reef. Below: an artificial reef covered with coral.



Up close: the bricks are printed layer by layer.

Images: Marie Griesmar; Simon Renfer (2)

RRReefs has set the goal of producing 200 bricks for each location and shipping them to the pilot reef sites. "It's a labour-intensive, time-consuming business, especially when it comes to preparing the material," says Griesmar. Hence the decision to launch a crowdfunding campaign where people can sponsor a brick or even participate in the construction of the reef. In the future, local residents could be given the training they need to download the data themselves, print the bricks and stack them in the sea. In the meantime, the team still needs to find a solution to simplify the brick-firing process – for example, by identifying additives that will allow them to reduce the firing temperature. With the passion these two researchers have for combating climate change, it shouldn't take them long to find an answer. ○

ETH Library Lab

KNOWLEDGE TRANSFER

The ETH Library Lab was established in 2018 as an initiative of the ETH Library and the library of the Karlsruhe Institute of Technology. It focuses on the future of academic libraries and new methods of knowledge transfer. The initiative is based on the concept of open science, which aims to make scientific output accessible to everyone. Twice a year, the ETH Library Lab invites Master's students, artists and researchers to apply for an Innovator Fellowship and put their innovative concepts to the test. Marie Griesmar's "Beneath the Sea" project improved the sharing of information on 3D printing in the library. Her models can now be found in the Material Archive run by Zurich University of the Arts and in the online database. You can find out more about working with clay and 3D printing on the Library Lab blog and on the ETH Library's Explora website. Information on other Library Lab projects is also available on the website.

→ librarylab.ethz.ch
→ explora.ethz.ch/en

Due to the coronavirus, events may be cancelled or postponed at short notice. Please check the organiser's website.

Agenda

DISCOVER

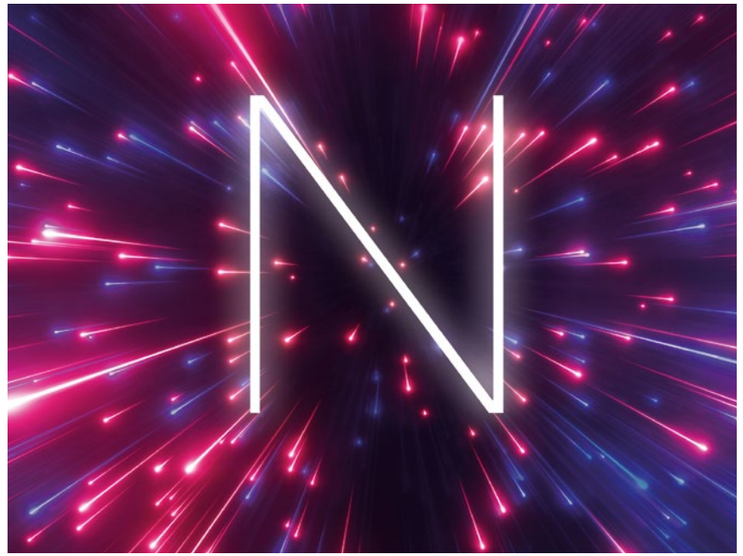
From February 2021

Bringing electrical engineering to life

Magic Cube is a new teaching tool developed by ETH Zurich, ABB and mint & pepper, a youth outreach initiative of Wyss Zurich. It uses a playful approach to spark young students' interest in electrical engineering and teach them some fundamentals of the field.
Find out more:
→ mintpepper.ch/en/projects/magiccube

Rocks, minerals, fossils

On the first Thursday of each month, visitors to the Earth Science Collections will be able to bring along their own rocks, minerals and fossils and have them identified by the two new curators.
focusTerra, Sonneggstrasse 5, (Atrium)
Find out more:
→ focusterra.ethz.ch/en/your-visit/rock-determination



Nightactive offers scientainment for young people.

NIGHTACTIVE

Starts 29 January 2021

Nightactive is a new series of events run by the Plant Science Center. The goal is to create a space where young people can discover science and future technologies from a fresh perspective and gain inspiration for their future careers. The first event will be held on 29 January 2021 in the new WOW Museum.
Check out the locations and details of future events:
→ nachtaktiv.live

APP BRINGS ENGRAVINGS TO LIFE

9 December 2020 to 14 March 2021

The Graphische Sammlung ETH Zurich is running a joint exhibition of the works of Agostino Carracci and Hendrick Goltzius, two of the leading copperplate engravers of the late 16th century. This marks the first time that the two artists have been exhibited side by side. ETH Zurich's Game Technology Center has come up with an augmented reality app for the exhibition, which ties together art and technology in an innovative way.
ETH Zurich, Zentrum campus, Graphische Sammlung
→ gs.ethz.ch/en/agenda

Images: *focus*Terra; Veky Arnaut, Storymotion; Danny Bron

9 February 2021, 6.15 p.m.

Things will never be the same again

On 7 February 1971, Swiss women were granted the right to vote and stand for election. What traces did the women's suffrage movement leave in the Archives of Contemporary History? This evening tour offers insights into a topic that is still relevant today.
ETH Zurich, Zentrum campus, ETH Library

16 March 2021, 6.15 p.m.

Bagworm moths and praying mantises

Find out how natural scientists, historians and artists have expanded and exploited the marvels of ETH Zurich's insect collections over a period spanning almost 200 years.
ETH Zurich, Zentrum campus, WEV building, Weinbergstrasse 58

Find out more and sign up for this and other tours:
→ tours.ethz.ch

Until 31 March 2021

Translations: multilingual Max Frisch

Max Frisch with his Russian translator, Eugenia Kazewa, 1988

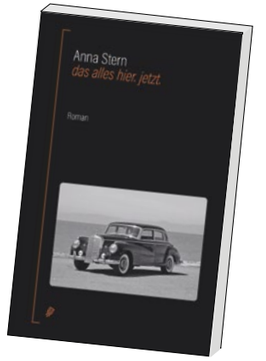
Max Frisch's novels and plays have been translated into over 40 languages and continue to be enjoyed all around the world. This exhibition takes a behind-the-scenes look at the book market to show how the author collaborated with his publishers and translators.
ETH Zurich, Zentrum campus, Reading Room Collections and Archives
→ mfa.ethz.ch/en

MUSIC

19 January 2021, 7.30 p.m.

Handel headlines virtuoso New Year's Concert

The 2021 New Year's Concert will include arias from Handel's cantatas and operas. Featuring the voice of soloist Alexander Seidel, the performance promises to be a truly memorable experience.
ETH Zurich, Zentrum campus, Audimax
Get your tickets here:
→ musicaldiscovery.ch



Recommended reading

DAS ALLES HIER, JETZT WINS 2020 SWISS BOOK PRIZE

What is the basis of attachment? And how does memory work? In her book *das alles hier, jetzt* ("all that here, now"), Anna Stern recounts a story of family and soulmates, a group of friends and the loss of a loved one. The author employs a highly original technique that allows the first-person narrator to express their powerful memories of a deceased friend. Much of the book is written in a dual format, with the text on the left set in the narrator's present after the death of their soulmate, ananke, and the text on the right exploring the narrator's memories from their childhood and youth. Since her debut novel, *Schneestill*, appeared in 2014, Stern has published four novels and a collection of stories. The first major recognition of her creative talent came in 2018, when she won the 3sat Prize in Klagenfurt, but the 2020 Swiss Book Prize is her greatest literary achievement to date. Anna Stern (Anna Bischofberger) is a doctoral student in the Institute of Integrative Biology at ETH.

Author: Anna Stern
Published by: Elster & Salis
ISBN-13: 978-3-03930-000-6
in German

Images: AfZ: NL Hans U Steger/1535; Hans-Peter Wymann; Max Frisch Archive; Musical Discovery; Elster & Salis

The sky's the limit for engineers

Changing the world with the power of ideas – that's what Martin Bosshardt finds so fascinating about being an engineer. And no matter which industry he works in, he always draws on what he learnt at ETH.

TEXT Felix Würsten IMAGE Daniel Winkler

Some moments in life are so special that we never forget them. Martin Bosshardt vividly recalls the time he spent in Japan as an ETH student working on his Master's thesis. In this context his team had set the goal of building an atomic microscope. "Constructing a device that could make individual atoms visible was something that had only recently become possible, so it was a truly groundbreaking project," he says.

The team faced challenges on multiple levels. In addition to needing lots of knowledge of physics and electrical engineering for the hardware side, the developers also required sophisticated software to control the machine and analyse the data. Whenever it was night in Zurich, the team used a mainframe computer at ETH to produce an image of the results. Bosshardt still recalls the magical moment when they saw the first atom. "It felt amazing, like landing on the moon," he says with a smile.

Many other special moments would come over the course of his career. Fresh out of university, he was employed as a commissioning engineer by the company ABB and put to work on getting a combined cycle power plant up and running in Malaysia. He also worked as I&C lead engineer on a similar site later in Indonesia. "We had 3,500 people on site, everyone focused on their own specific task," he explains. "It was fascinating to see how so many specialists could work together. Nobody really understood the entire plant in all its complexity, yet we managed to bring it on grid right on time," recalls Bosshardt. He also recalls one occasion when engineers at the Baden headquarters sent enhanced control data that boosted the plant's output by seven megawatts overnight. That was when he realised just how powerful software and networks could be.

A sudden turning point

This was one of the reasons that prompted him to leave ABB and join the web agency Futurecom. It was here that he experienced the first major boom of the internet age: "Our headcount rocketed from 20 to 120 employees in just four years." But the bursting of the dot com bubble turned everything on its head. "A lot of companies went under, but we actually came out of the crisis stronger," recalls Bosshardt with understandable pride. They stayed afloat by rethinking the business on every level and becoming more than just a supplier. "We had to learn how to identify business cases and sell products," he says.

Open Systems, a company founded by fellow ETH student Florian Gutzwiler, was also hit hard by the crisis. Gutzwiler hired Bosshardt as his new CEO to navigate the company through this period of upheaval. When the storm hit, Open Systems had been developing internet security services for banks, but this business model quickly collapsed. The company needed a new focus, so it switched from protecting portals for banks to protecting and building secure networks for industrial enterprises. Today, it offers a powerful network solution that enables companies to carry out distributed manufacturing across multiple sites. Some 3.5 million end users rely on its services.

Secure data transmission is a key part of Open Systems' business. That's why the company was keen to become a partner to the Zurich Information Security and Privacy Center (ZISC) at ETH Zurich and provide it with financial support with the help of the ETH Foundation. "ETH is a hugely important partner for our business – and not only when it comes to recruiting new staff," says Bosshardt. "Discussing technical developments with ETH computer scientists is ›

MARTIN BOSSHARDT

After completing his degree in electrical engineering at ETH Zurich, Martin Bosshardt worked in ABB's international power plant business before taking on a management role at Futurecom Interactive AG. He joined Open Systems in 2001. The company grew considerably under his leadership as CEO and now provides secure network solutions in over 180 countries. In 2020, Bosshardt joined the Board of Directors at Open Systems and was also appointed Chairman of the Board at Westhive, a company that offers flexible office solutions and co-working spaces. A married father of two sons, Bosshardt enjoys making electronic music in his free time.

"Being in the mountains and seeing the stars twinkling in the clear night sky – that's when I can really relax."

equally important because it gives us a better idea of where technology might be heading over the next few years."

A passion for technology

Bosshardt took an interest in technology from an early age. By the time he reached secondary school, one of his favourite hobbies was taking apart and reassembling electrical devices. He has never regretted his decision to study electrical engineering. "I can see now what a fantastic education I got at ETH," he says. "As a student, I often felt I was having to learn things I would never need in the future. And I imagine many of today's students feel the same. But once I started my career, I realised how wrong I was!" He recalls how ETH taught him to break things down into their basic elements: "We learnt the principles of how to analyse problems systematically and find pragmatic solutions." Even today, Bosshardt is impressed by the speed with which ETH graduates learn the ropes when they take on something new.

Bosshardt finds it remarkable how many successful companies are run by engineers. "Even though an engineering degree doesn't really teach you how to manage a company," he says. In his opinion, people shouldn't only be hearing about the great technologies developed at ETH: "It's amazing how many ETH graduates are using what they've learnt to lead large companies and make the world a better place."

Thinking ahead

Bosshardt has recently taken a step back from day-to-day business at Open Systems and joined the Board of Directors. He is now focusing some of his energies on his role as Chairman of the Board at Westhive, a company that offers shared workspaces. "I'm confident we'll see an increasing demand for flexible office solutions," he says. But success relies on more than just flexibility. At Open Systems, Bosshardt discovered that people need to feel happy and satisfied with their job in order to produce good results. That means having meaningful tasks and being able to communicate honestly and openly with managers on equal terms. But it also means having a space where people enjoy working. "We are hugely affected by the environment we work in," says Bosshardt. "It's difficult to think big in a small space!"

Right now, Westhive is growing fast and planning new locations in other cities. Its users include not only start-ups and one-person businesses, but also larger companies looking for an inspiring city location to base their development team or additional space closer to their customers. "This is a sign of just how much the world of work is changing," says Bosshardt of the current boom in these kinds of services. "The coronavirus crisis has shown us how easy it is for people in different locations to work together. At the same time, we're learning to appreciate the importance of direct physical interaction in a stimulating environment." He also argues that companies are now realising how much money they can save by adopting flexible solutions.

Although the marketing of co-working spaces and the provision of secure network solutions may appear to have little in common, Bosshardt says he has found a surprising number of parallels between the two industries. Both involve finding solutions that help people collaborate more productively, and both are about making complex things simpler and managing capacity effectively. "The two companies actually have very similar business plans," he says. "They both offer a service that wouldn't really have been seen as a commercially viable business in the past."

Mountain retreat

We finish off by talking to Bosshardt about his latest project: an old mountain lodge near Savognin. He and his wife Daniela are having the lodge renovated and are planning to reopen it in December. He has spent many holidays in this region over the years, so the choice of location was no coincidence. "I love being in the mountains, far from civilisation, and seeing the stars twinkling in the clear night sky – that's when I can really relax and connect with nature," he says, scrolling through a series of photos on his phone. "If you're constantly pushing yourself to the limit, it's important to slow things down and feel the earth beneath your feet. We want to create a space in the mountains that helps people do exactly that." ○

5 QUESTIONS

Lavinia Heisenberg has been awarded the ETH Latsis Prize for her outstanding achievements in theoretical physics. The ETH professor dreams of being an astronaut.

Could you sum up Albert Einstein's theory of relativity in just a few sentences?
Under the influence of gravity, and discounting the effect of air resistance, all objects fall at the same rate. Based on this observation, Einstein concluded that gravity could be understood as a property of space: if all objects fall in the same way, it is because they are all slipping into the same trajectories in space. He combined this idea with the special theory of relativity, in which space and time are intertwined. Since then, general relativity has defined space-time as a rubber sheet that deforms in the vicinity of mass.

How well does the theory of relativity describe the universe?
The standard model of cosmology, which comprises general relativity and the cosmological principle, forces us to introduce three unknown components in order to describe our observations properly. Together with our inability to reconcile general relativity with quantum mechanics, that's what drives the search for a new physics!

When did you become so fascinated by gravity?
As a child, I always wanted to know why magnets repel each other, even though we can't see the forces behind it. And I was absolutely fascinated by the whole kaleidoscope of astrophysical phenomena and the dynamics of the universe.

You also hope to fulfil your childhood dream of becoming an astronaut. Why?
Obviously, it would be amazing to experience weightlessness. I also think it's my duty as a scientist to advance human knowledge and contribute to the future of humankind. And if I succeed in inspiring young people to pursue a scientific career, especially young women, I will consider that a privilege.

"As a scientist, I want to push the boundaries of human knowledge."

Lavinia Heisenberg is Assistant Professor of Theoretical Cosmology at the Institute for Theoretical Physics.
→ itp.phys.ethz.ch

You grew up in various countries, and your research visits have taken you all over the world. Why settle in Zurich?
I've done a lot of travelling in recent years, and I've always tried my best to learn the local language and get to know the local culture. But right now I feel very much at home in Zurich – and I would hate to leave behind the fantastic research group I've been able to put together at ETH!
— Interview conducted by Karin Köchle

Image: Stefan Weiss

Build motors for the Mars helicopter? It would be our pleasure.

Florbela Costa, Aerospace Project Manager
The first drone flight over the surface of Mars will be a very proud moment for us – especially for Florbela. She is the project manager responsible for the DC motors that control the helicopter. She works together with our customers and the various departments at maxon, making sure our drives fulfill the challenging requirements of space missions. That is why we analyze and test all of our parts to performance at the highest level possible. Our precision and curiosity drive us to excel.
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