ETH zürich

NO. 2 / 2017

GLOBE

FOCUS

EVERYTHING GOES DIGITAL

How data science is changing the world

PAGE 14

Start-up:
The eyes have it
PAGE 10

Research funding:
Made in Europe
PAGE 34

Sabine Döbeli makes finance sustainable
PAGE 46

REFINING DATA

Lino Guzzella, President of ETH Zurich

Using a mobile phone to find data on the internet, at any time and in any place, has become something we take for granted. Nowadays, health apps gather data that will soon inform doctors' diagnoses and industry collects more and more data for applications that manage and optimise processes along the entire value chain.

Collecting data alone is not enough. Just as crude oil must first be refined into fuel, data science will need to distil big data into valuable information and insights. The prospect opens up a rich array of opportunities – but it also raises many questions.

Data science is a key focus for ETH Zurich. We recently co-founded the Swiss Data Science Center, for example, and our researchers are also involved in Switzerland's "Big Data" national research programme (NRP 75). The Zurich Information Security & Privacy Center (ZISC), which ETH Zurich has operated in cooperation with industry partners since 2003, examines those aspects of our information- and data-driven society that concern security.

Turn to page 24 to read how ETH researchers are making the internet of the future more secure.

With this issue of *Globe*, as well as in direct discussion with you, we aim to illustrate how data science will shape our future. For this reason the upcoming Zurich Science Days event, Scientifica, is dedicated to the topic of "What data reveal". Join us from 1 to 3 September 2017 at the University of Zurich and ETH Zurich – where we will have many exciting exhibits in store.

We hope you enjoy reading this issue of *Globe* – and I look forward to seeing you at Scientifica!

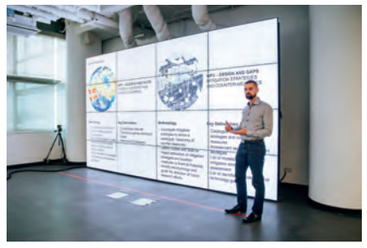
Lino Guzzella, President of ETH Zurich

Cover image: Carl De Torres, Story[TK] / Editorial: Giulia Marthaler

GLOBE
NO. 2 / 2017

CONTENTS

Soon a robot could take over eye-injection procedures. – Page 10



Tests currently underway in Singapore could also benefit other cities. – Page 38

MIX Paper from responsible sources FSC® C016003 www.fsc.org

ClimatePartner climate neutral
Print | ID: 53232-1502-1013

Publisher: ETH Alumni/ETH Zurich, ISSN 2235-7289 **Editorial team:** Martina Märki (head), Fabio Bergamin, Corinne Johannssen-Hodel, Nicole Kasielke, Florian Meyer, Meryem Riahi, Felix Würsten **Contributors:** Claudia Hoffmann, Samuel Schlaefli, Andrea Schmits **Advertising administration:** ETH Alumni Communications, globe@alumni.ethz.ch, +41 44 632 51 24 **Advertising management:** Zürichsee Werbe AG, Fachmedien, Stäfa, info@fachmedien.ch, +41 44 928 56 53 **Design:** Crafft Kommunikation AG, Zurich **Printing and proofreading:** Neidhart + Schön AG, Zurich **Translation:** Burton, Van Iersel & Whitney GmbH, Munich; Anna Focà, ETH Zurich **Circulation:** German: 34,600; English: 31,400; published quarterly **Subscriptions:** *Globe* is available in print in German or English for CHF 20.– annually (four issues); full membership of the ETH Alumni Association includes an annual subscription to *Globe*. **Orders and changes 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 ***Globe* is also available in English and German as a free tablet version for iPad and Android devices.**

Image: Jodi Jacobson/iStock; Lina Meisen; Annick Ramp

NEW AND NOTED

Trees along the streets help improve the urban climate, for example in Singapore.

Environmental research

GOOGLE AS A BASIS

Using a new method, researchers at the Future Cities Laboratory have succeeded in demonstrating the importance of trees for urban ecosystems. They extracted almost 100,000 images from Google Street View and used an algorithm to calculate the area of treetop coverage in each picture. Next, they estimated the volume of sunlight that reached the ground through the canopy of trees. This allows them to determine how much the trees help to regulate the temperature in that particular area of the town.

Nanoscience

PLATELETS INSTEAD OF DOTS

They are just a few layers of atoms thick and were discovered only a few years ago: rectangular, ultra-thin nanoplatelets. More extensive research has already been conducted on quantum dots, closely related nanocrystals, which are already used in everyday electrical goods (televisions, for example). The platelets could also benefit the electronics industry, as they can increase the brightness of certain colours. They also transmit energy efficiently, which would make them ideal for use in solar cells.

Unlike with the dots, exactly how the platelets form has been a mystery to scientists until now. It was previously assumed that this highly precise form required a kind of template. Using an experiment with cadmium selenide (also known as pyrite), researchers at ETH Zurich have now been able to disprove this assumption.

In their experiment, the crystallised core developed spontaneously from just a few atoms. Once the core had exceeded a certain size, it grew to form a platelet. For energy-related reasons, the atoms stuck only to the sides of the core, and consequently spread out along only two dimensions. This ultimately resulted in flat, rectangular platelets rather than round quantum dots.

Pyrite, however, is highly toxic and thus unsuitable for everyday use. One of the researchers' goals, therefore, is to produce nanoplatelets made from less toxic or non-toxic substances. This study serves as an important platform for additional research into a wide range of further nanoplatelet materials.

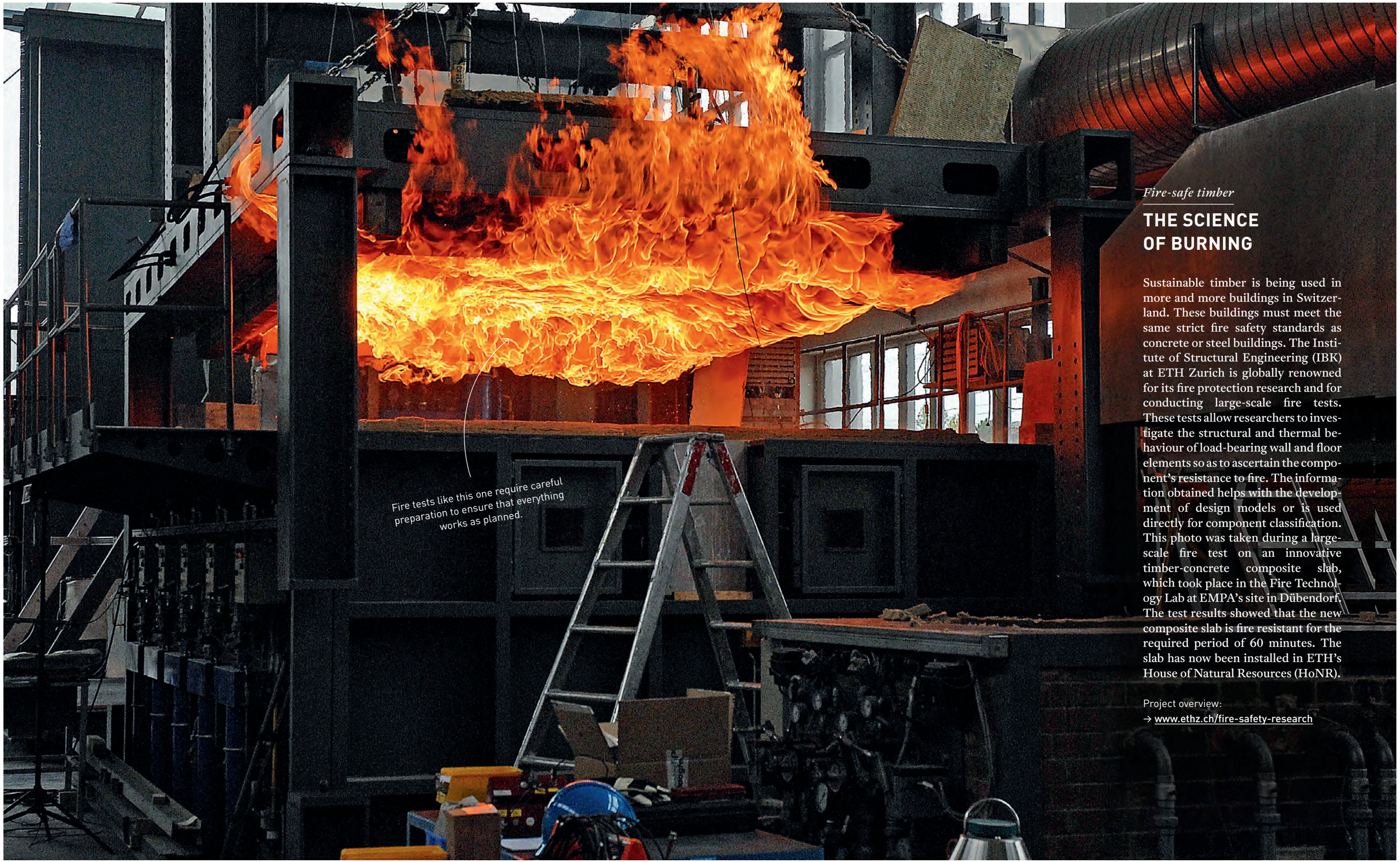
Autism research

NEURAL EMPATHY

ETH Professor Nicole Wenderoth and her team have demonstrated that the area of the brain associated with empathy is only weakly active in people with autism. In the study autistic and non-autistic adolescents were asked to judge whether someone was positively or negatively surprised in game situations. MRI images showed that neural activity in the region of the brain that controls empathy was significantly weaker in the autistic adolescents.

Image: colourbox.com; Joshua Balsters

NEW AND NOTED



Fire tests like this one require careful preparation to ensure that everything works as planned.

Fire-safe timber

THE SCIENCE OF BURNING

Sustainable timber is being used in more and more buildings in Switzerland. These buildings must meet the same strict fire safety standards as concrete or steel buildings. The Institute of Structural Engineering (IBK) at ETH Zurich is globally renowned for its fire protection research and for conducting large-scale fire tests. These tests allow researchers to investigate the structural and thermal behaviour of load-bearing wall and floor elements so as to ascertain the component's resistance to fire. The information obtained helps with the development of design models or is used directly for component classification. This photo was taken during a large-scale fire test on an innovative timber-concrete composite slab, which took place in the Fire Technology Lab at EMPA's site in Dübendorf. The test results showed that the new composite slab is fire resistant for the required period of 60 minutes. The slab has now been installed in ETH's House of Natural Resources (HoNR).

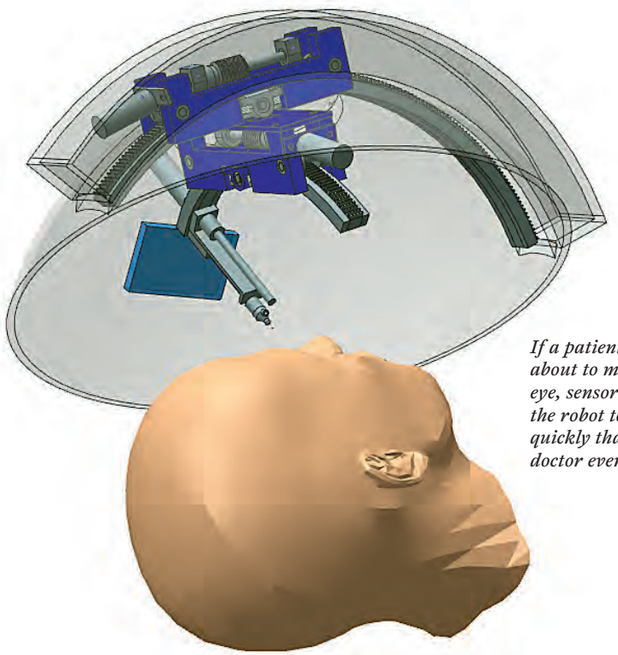
Project overview:
→ www.ethz.ch/fire-safety-research

Image: IBK, ETH Zurich

Safe and precise

The eyes have it

Patients with age-related retinal disease need regular injections in the eye. At the moment, these must be given by specially trained medical doctors, but a robot may well handle this task in the near future.



If a patient is about to move their eye, sensors help the robot to react more quickly than a doctor ever could.

In Switzerland, the most frequent cause of serious visual impairment among older people is macular degeneration, affecting one fifth of those over 80. The condition rarely leads to complete blindness, but it severely worsens a person's vision. Those who suffer from it are often left with blurred vision and can no longer read or drive. In serious cases, they can only distinguish between light and dark.

Macular degeneration is incurable, but its advanced stages are manageable with medication. This slows the progress of the disease and in some cases even helps the patient regain some visual acuity. The treatment calls for injections every four to six weeks – directly into the eye. "The procedure is unpleasant, but not painful for most people," says Professor Stephan Michels, Deputy Chief Physician of the eye clinic at Triemli Hospital in Zurich. Triemli alone carries out 7,500 eye injections every year, and when looking at Switzerland as a whole, that figure climbs to some 100,000. "Sometimes I treat up to 60 patients in one day," Michels says.

Injections at the touch of a button

In future, he and his colleagues may get support from a robot currently in development at ETH start-up Ophthorobotics. The company was founded by researchers from ETH's Multi-Scale Robotics Lab together with retinal specialists from Triemli Hospital. "Our robot will be the first to help in administering eye injections," says Franziska Ullrich, a mechanical engineer at ETH and the CEO of Ophthorobotics. Thanks to the robot, doctors no longer need to give the injections themselves. Instead, the robot – a mobile device – is positioned above the head of the patient, who is lying down. Using two cameras, the robot produces a 3D image of the eye to be injected. It then calculates where the injection site should be and independently positions the needle. The ophthalmologist initiates and monitors everything on a screen in real time; they must only briefly check the settings and then press a button to start the injection. "The robot makes the injection more precise and thus safer," says Ullrich. She is working on refining the device, which currently exists only as a prototype in the lab.

At present, doctors give the eye injections by hand in an operating room. There, the nursing staff first prep the patient by numbing the eye with a local anaesthetic and disinfecting it. The eyelid is carefully held open with a lid speculum. Then, the doctor fits the syringe with a very fine needle. The injection site is comprised of a very narrow band between the iris and the outermost corner of the eye. During the actual injection, the patient must hold their eye still in order to avoid the risk of injuring it, although "that happens extremely rarely," says Michels.

The robot will nevertheless offer an even greater degree of safety. That's because it uses sensors to detect whether the patient is about to move their eye just before the injection begins. If that happens, the device immediately halts the procedure. "It can react faster than we can as doctors," Michels says. A further advantage is that the robot can identify every patient with certainty by means of an iris scan, which in turn should prevent injections being given to the wrong patient or in the wrong eye. The system is also designed to be able to automatically retrieve the patient's file, which contains a record of all previous treatments – as well as information on which of the two eyes is to receive the injection and with what dosage of medication, for example. It even records the exact injection site of every treatment and then calculates a slightly different position for the next time. This is important, as too many injections on the same site could lead to thinning of the sclera.

Better use of doctors' time

However, Michels believes the robot's greatest advantage will be in that it saves doctors time and grants them more flexibility. The current procedure requires them to wait around in the operating room until the next patient has been prepped and they can set up the injection: unused time that quickly adds up to several hours a day. Yet the injection itself lasts just 30 seconds. "With the robot, doctors will no longer have to be physically present in the operating room," Ullrich says. Instead, they can control the device from another location, such as their consultation room. Thus, as Ullrich points out, they can use the time between injections for other tasks.

To ensure that doctors can still communicate with their patients, Ophthorobotics is integrating a screen, microphone and loudspeaker into the device. As a result, doctor and patient can see and speak to each other during the procedure, similar to a Skype conversation. The screen also serves as a point for the patient to focus their gaze on during the injection, so the eye is less likely to move. Exactly which images should be displayed on the screen to achieve this is currently being tested in collaboration with the University of Applied Sciences HTW Chur.

Strong acceptance among patients

Ophthorobotics has already conducted an initial survey of 15 people with macular degeneration. Non-representative results from this survey indicate that patients will genuinely trust the robot. "We were surprised at how positive the response was," says Ullrich. Most patients reported that they would let the robot treat them, even if the doctor is out of the room – provided they could still communicate.

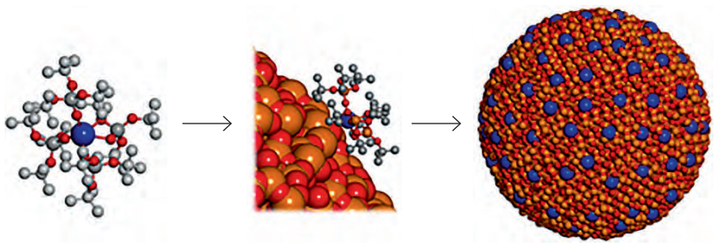
Eye specialists were equally positive in their response: five eye clinics have already expressed interest in purchasing the injection robot. First, however, the researchers have to develop their existing prototype into a device suitable for clinical use, then test it and have it certified. To achieve this, they are currently seeking the necessary funding. They have had one success in this respect already: the start-up is receiving a sponsorship award from the Swiss National Science Foundation and the Commission for Technology and Innovation. Endowed with 130,000 Swiss francs, the award is intended to accelerate the transfer of research findings into industry.

— Claudia Hoffmann

More about the ETH start-up at:
→ www.ophthorobotics.com

The eye robot not only carries out the injection, it also provides the doctor with relevant patient information.

Image: Ophthorobotics (2)



Molecules with a dysprosium atom (blue) are deposited on and then fused to the surface of a nanoparticle (red and orange).

Data storage

TINY MAGNETS ON NANOPARTICLE SURFACES

The idea is an intriguing one: if the only thing needed to store a single unit of data (a zero or a one in binary digital technology) was a single atom or small molecule, massive volumes of data could be stored in the tiniest amount of space. This is theoretically possible if certain atoms are magnetised in one of two possible directions: "spin up" or "spin down". Information could then be stored in the sequence of the magnetisation directions.

However, several obstacles still need to be overcome before data storage with a single-molecule magnet becomes a reality. One of the hurdles is how to arrange these magnetisable molecules on a solid surface. An international team of researchers led by scientists from ETH Zurich have come up with a solution to this problem: with their new method, they succeeded in arranging magnetisable dysprosium atoms on the surface of nanoparticles. The researchers placed the atoms in a molecular scaffold and fused them with the particles at 400 degrees Celsius.

Compared with other nano-level storage solutions, this new method is particularly simple: depositing the atoms onto the surface of nanoparticles does not require a cleanroom or any complex equipment. In addition, the nanoparticles can be stored at room temperature and reused.

Disadvantages, however, are that the magnetisation process currently works only at around minus 270 degrees Celsius, and the magnetisation can be maintained for up to just one and a half minutes. The scientists are therefore looking for methods that will allow the magnetisation to be stabilised at higher temperatures and for longer periods of time. They are also exploring ways to fuse magnetisable atoms to a flat surface instead of to nanoparticles.

Climate research

SENSITIVITY OF THE TROPICAL RAIN BELT

For the first time, scientists have conducted a study of global weather data from the last 2,000 years. They discovered that even small temperature fluctuations can influence the tropical rain belt, which explains why it shifted a fair way south between 1450 and 1850. This shift is linked to the Little Ice Age, which caused global temperatures to sink, albeit the average temperature difference was just 0.4 degrees Celsius. Changes in the position of the rain belt can have fatal consequences, especially for agriculture in the tropics and subtropics, triggering phenomena like major droughts or heavy rainfall.

Microbiology

DIARRHOEA PATHOGENS

ETH biologists have clarified how vaccinations can combat bacterial intestinal diseases: vaccine-induced antibodies "chain up" pathogens as they grow in the intestine. The pathogens can continue to multiply, but they remain trapped in clumps. This prevents them from attacking intestinal tissue, accelerates excretion of the pathogen and prevents genetic exchange between bacteria enchained in different clumps.

Image: Allouche F. et al., ACS Central Science 2017

Architecture

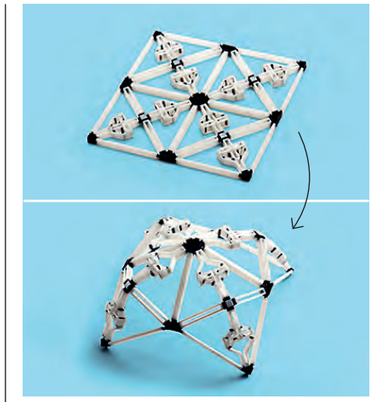
LIGHT YET STABLE

In the urban environment, space is at a premium. Architects therefore look for ways to make buildings more compact – and as cost-effective and environmentally friendly as possible. One approach to this is lightweight construction. Take for example a multistorey building: the thinner the ceilings, the more space is left for additional floors. It is possible to save on construction materials in the foundations, as there is less weight for them to support, which in turn lowers costs. Today's conventional construction using concrete makes it nearly impossible to reduce weight in this example. For the floors of each storey to support the necessary load, they must be an average of 25 centimetres thick and must also be reinforced internally with steel bars or grids. This amount of material makes them very heavy.

Architects at ETH Zurich have now come up with a new approach: they have developed concrete floor elements in which the load-bearing slab is just two centimetres thick and yet extremely stable. This makes them 70 percent lighter than conventional concrete floors. Instead of being flat, the slabs are arched like the vaulted ceilings of Gothic cathedrals; this enables them to support very heavy loads, and so they do not require any reinforcing steel. The innovative flooring slabs are now being tested in practice at the NEST research building in Dübendorf.

To produce the slabs, the researchers used moulds, which are very expensive. To bring the costs down, the team has now produced the first elements from sand using 3D printing. These elements can withstand a load of 1.4 tonnes and so also comply with Swiss building standards.

ETH researcher Philippe Block standing on a floor prototype printed using sand.



The object is printed flat and can then be made into other shapes.

Production technology

FOURTH DIMENSION

3D printers have become a standard fixture in many laboratories. Now, 4D printing is emerging as a technology for creating moveable objects that can change shape, such as flat components that can be made into three-dimensional objects at a later point. ETH scientists have now developed a construction principle that allows them to precisely control the geometric changes. The flat structures they produce do not change their configuration arbitrarily, but rather in exactly the way the researchers design them to. Another advantage is that the structures can support weight. The ETH scientists are the first to create these kinds of load-bearing 4D-printed objects.

You can find more information on this topic and other research news from ETH Zurich at:
→ www.ethz.ch/news

Image: Peter Rüegg ; Tian Chen

IN THE SEA OF DATA

In the blink of an eye on the internet: every second we send more than 2 million emails around the world, start some 60,000 Google searches, and “like” about 70,000 posts on Facebook. And that is just the tip of the iceberg. We are increasingly reliant on huge amounts of data being processed securely. This issue of Globe focuses on data science, which helps us to make sense out of the vast sea of data.

FOCUS ILLUSTRATIONS:
Carl De Torres, Story[TK]

IN A SINGLE SECOND ON THE INTERNET:

EMAILS SENT – 2,557,933

GOOGLE SEARCHES – 59,601

TWEETS SENT – 7,567

FACEBOOK LIKES – 66,666

YOUTUBE VIDEOS VIEWED – 68,747

INSTAGRAM PHOTOS UPLOADED – 774

WEBSITES HACKED – 0.9

SKYPE CALLS – 2,529

TUMBLR POSTS – 1,226

Source:
www.internetlivestats.com

“Machines don’t have morals yet”

The digital revolution is a hot topic – but for Patrick Burkhalter, former CEO of software firm Ergon, and Friedemann Mattern, Professor of Computer Science, it began long ago.

INTERVIEW Martina Märki and Nicole Kasielke
IMAGE Gerber/Loesch

Mr Burkhalter, in 1997, your company collaborated with Credit Suisse to develop Switzerland’s first online banking system. What milestone are you working toward today?

PATRICK BURKHALTER – One current example is the use of machine learning in financial transaction environments. We’re developing a learning system that can detect fraud. We were able to show that this method works better than rule-based systems, which is what most banks are currently using.

FRIEDEMANN MATTERN – Indeed, we are seeing in a number of fields that self-learning methods are better than the results of sets of rules on a given topic that experts previously had to laboriously incorporate into machines. In areas such as image recognition, for instance, where human experts used to be indispensable, machines today can often make better decisions than people, provided they have sufficient learning material. But they have one drawback: machines currently don’t reflect on their decisions on a meta-level. They don’t yet have a moral-ethical sensory apparatus.

Is something like that even possible?

BURKHALTER – Our system recognises patterns that deviate from the norm and reacts to conspicuous anomalies. It doesn’t make any moral decisions.

MATTERN – How one could formalise morality in such a way that machines could implement it is one of the most difficult questions there is. After all, ideas about what is morally correct differ from one culture to another and from one era to the next. But there have been some interesting experiments. For instance, efforts are currently underway to build systems that do nothing but read newspapers and, in so doing, acquire knowledge about the world. In this way, these systems learn, for example, that every human has parents. But they fail when it comes to the question of whether mothers-in-law are nice or mean, because both variants occur in the texts.

Artificial intelligence was already a topic back in the 1980s. Why is there so much talk about a digital revolution now?

BURKHALTER – As a computer scientist, I see it as more of an evolution. There are new developments in research every couple of years. That people are speaking of a digital revolution all of a sudden could be because they are suddenly more aware that software is taking on an ever-greater role in more and more everyday objects.

MATTERN – Digitalisation has been taking place for quite a while now. The first computers have been around since the second world war, and many bank applications were created as early as the 1950s. Then PCs shook up the office environment in the 1980s, telephony was digitalised in the 1990s,

PATRICK BURKHALTER is Chairman of the Board of Directors of Ergon Informatik AG in Zurich, where he was CEO from 1992 to 2016. As one of 50 “digital shapers”, he was involved in developing the Digital Manifesto for Switzerland, which was presented in collaboration with digitalswitzerland and Swiss President Johann Schneider-Ammann in January 2017.

FRIEDEMANN MATTERN is a Professor at ETH Zurich. He leads the distributed systems research group in the Department of Computer Science. His research interests include distributed systems, ubiquitous computing, sensor networks and the internet of things. He and his group are concerned not so much with individual applications as with fundamental concepts that can serve as the basis for as many applications as possible.

and finally came the digitalisation of photography, music and television. Digitalisation has always come in waves and has turned entire sectors upside down, with consequences for the working world and the accompanying concern for jobs.

So is digitalisation just a new buzzword, then?
MATTERN – Not really. There are a number of technologies that have matured. Mobiles have been around for decades, but only now have they become sufficiently small and inexpensive that everyone has one. Cloud computing sprang up quickly because connectivity has become extremely cheap, and because enormous data storage facilities are now available. Collectively, these developments suddenly create new potential, and synergies lead to avalanche effects.
BURKHALTER – Also on the demand side, we sense that something's brewing here. Suddenly everyone wants to digitalise – very few know what, exactly, but most of them have money. The last time I experienced something similar was in 1996, when the internet was emerging.

Back then, the internet boom was followed by the bubble …
BURKHALTER – There's one important difference: today's digitalisation projects are usually linked to something physical. Software engineering is becoming an ever more important component when it comes to making products better or offering related services.
MATTERN – But this also means that this wave of digitalisation will likely be accompanied by a much more permanent and comprehensive shift in society. Rather than affecting only a few sectors, it will have a major impact on industry, politics and our social life. This may not happen overnight, it could unfold more gradually, but it will change the world.

Can you give some examples of what we can expect?
BURKHALTER – One of our customers, which operates in the heating, ventilation and air conditioning segment, recently released its first product with a cloud connection. The product is a valve that measures the flow rate as well as the incoming and outgoing temperature of the water in heating and cooling systems. As this valve is now connected to the cloud, the company can continuously monitor energy consumption and adjust it to achieve optimum efficiency – anywhere in the world. This relatively simple device is already helping MIT save 1.5 million dollars per year in energy costs.
MATTERN – Smart power meters can also determine the household type – family, single-person, etc. – based on electricity consumption. This makes it possible to offer targeted energy-saving tips, such as: "Your washing machine consumes twice as much electricity as a household of similar size. Perhaps you should buy a more economical washing machine." And all of this with the relevant links so the resident can get the new washing machine with just a few clicks. We could take a similar approach in industry to further optimise energy consumption using sensors and intelligent data analysis. There is enormous potential for smart technology in the energy sector.

How well will this kind of new technology be accepted? After all, it collects quite a lot of personal data.
MATTERN – It always depends on the context in which the new technology is introduced. If something promises a direct benefit or fun, people tend not to think about the potential damage. Think of the smart home: as an older person with health issues, I may be quite happy to have this mild form of monitoring, and to have technology that raises an alarm if I fall. On the other hand, this sort of technology – and this goes beyond the data protection issue – can also degenerate into paternalism. Machines will presumably increasingly act as our guardians for our own safety. Cars, for instance, generally won't drive faster than the speed limit allows on a given route. We are already quite close to this today. It's all well-intentioned, but it limits our freedom of action.

Machines will decide what's good for me. Is there even any way to escape this?
BURKHALTER – To a certain extent we won't want to do without the advantages that technologies like these offer us. But in the future we will surely need more than mere data protection; we will need data ethics.
MATTERN – Health bracelets, smartphones, etc. need to know and learn things about us if they are to be worthwhile. Of course this should be legally regulated to a certain degree. However, if we establish overly strict regulations on what data can be used and passed on and in what way, then the service either won't be offered or it will be very expensive. I'm afraid we won't be able to stop this development of more and more things requiring more data.

Are there cultural differences regarding the acceptance of smart technologies?
MATTERN – Certainly. In China, the individual is less important than society. There, every car must transmit its position. This couldn't be done in our individualised society. In America, data are considered to be a commodity – here in Switzerland, we say you can't simply sell your personal data like property. The key question is who has the power to impose their standards. Practically all the major developments of recent years that are changing our lives today came from the US. Google, Facebook, Uber – it's the major American companies that set the standards. In contrast, anyone who wants to sell servers in China must guarantee that the data will remain in China. We in Europe negotiate something, and countries in Africa and elsewhere are completely at the mercy of the result. I believe the values are ultimately set by those who wield the economic and industrial power.

> "We will need more than mere data protection; we will need data ethics."
> Patrick Burkhalter

Switzerland is small, but it enjoys a high standard of technology. Can it play in the big league?
BURKHALTER – Based purely on knowledge, yes. But we simply don't have as many intelligent software engineers available in Switzerland as they do in Silicon Valley, for instance. We need to systematically focus on becoming a hotspot. There are some decent foundations for this already in place. We have Google here, and we're a leading European IT centre. But this is far different than in the US, with its huge market and a single language and culture. Asia is simply too far away for us. From Switzerland, we can occupy certain niches, we're even the market leader in some of them, but I'm not sure whether that's sufficient to set global standards.
MATTERN – I'm not as optimistic as far as Switzerland is concerned. There are some four or five IT hubs in the world: Stanford and Silicon Valley, Berkeley and California as a whole, and Boston with MIT and Harvard. Israel should also be mentioned, where this field is massively subsidised by the military. A prominent university of a certain size is always a prerequisite for such a hub, and that's where Switzerland has a problem. ETH is too small in key areas. Sure, thanks also to support from industry partners, we have achieved a lot in recent years: the Disney Research, for instance, and the Zurich Information Security and Privacy Center*. But we simply can't cover all the important fields to a sufficient extent. There are also opportunities for additional hubs in Europe and Asia. China definitely has the political will for this. In Europe, Zurich would have a good chance, but we would have to greatly expand ETH capacities in information technology again. And we would have to attract a couple more major companies here – none of which can happen overnight. I'm afraid we don't yet really have the political courage to make the necessary investments.

Shouldn't we be thinking beyond Zurich? Couldn't a hub like that be established in Zurich and Lausanne?
MATTERN – That's a fantasy. In practise, we have seen time and again that a hub really needs to be focused locally. That's the only way to foster the exchange that sparks creativity.
BURKHALTER – This was precisely our experience as a company. We asked our employees where our offices should be located: in the city of Zurich, where it is very expensive, or somewhere on the outskirts, with good and convenient transportation connections, where it is inexpensive. And we would have paid our employees the money we saved in the form of an additional salary. Still, 80 percent of them voted decisively for Zurich.
MATTERN – Even Google isn't located on a greenfield site, but rather in the centre of the centre, very close to Zurich's main railway station. If we want to have a hub in Switzerland, we have to fight for a Zurich hub. I know that contradicts Swiss thinking to some extent, but we shouldn't try to spread our limited resources across the entire country. And we can't impede the influx of bright minds from all over the world. If we don't become a computer science hub in Europe, we will continue to struggle to produce unicorns in this field that are "Made in Switzerland". But I am certain that Europe needs such a hub – also to ensure that the tried and tested European values will be reflected in our digitalised future. //

> "Anyone who wants a Switzerland hub must fight for a Zurich hub."
> Friedemann Mattern

* The Zurich Information Security and Privacy Center (ZISC) is supported by donations to the ETH Zurich Foundation from dormakaba, Open Systems, SIX Group, Swisscom, Swiss Post, ZKB, Zurich Insurance.

Medicine is awash in data

Genomics, digital patient files and real-time health surveillance – never before have we had access to so much health data.

TEXT Samuel Schlaefli

Karsten Borgwardt speaks calmly and deliberately, thereby trying to bring some tranquillity to a research field in which turbulence prevails. Data science is currently experiencing a boom in biomedical research: more professors, more funding, more computing capacity and more research cooperations. Since its founding in June 2014, Borgwardt's Machine Learning & Computational Biology Lab in the Department of Biosystems Science and Engineering (D-BSSE) in Basel has grown to 15 employees – and this growth is expected to continue.

The 36-year-old professor embodies a new type of data scientist, the kind that will likely become a permanent fixture in the medicine of the future. He studied computer science with a minor in biology in Munich, also obtaining a Master's degree in the latter from Oxford University in his fourth year of studies. Borgwardt grew up as the first human genome was being decoded, and he was fascinated by the emerging possibilities in genomics while still at university.

Today, though, he knows that the initial expectations were often exaggerated, saying: "We are still a long way from being able to infer the exact risk of occurrence of complex diseases based on a person's genome." One possible explanation for this is that complex diseases such as cancer and diabetes are not caused by individual changes in the genome, but rather by the interactions among millions of base pairs in human DNA. This is where computer science comes into play.

A DATA EXPLOSION IN GENOMICS

Exploring and analysing these interactions requires vast quantities of data. Today – 16 years after the sequence of the human genome was published – the necessary data sources are available. "We are currently observing an explosion of data volume in multiple dimensions," says Borgwardt. Thanks to technological advances in genomics, it is now possible to sequence billions of base pairs of a human genome in a matter of days – and at a cost of less than 2,000 Swiss francs. This opens up completely new possibilities: whereas researchers previously focused on questions at the molecular level of the individual, today they are increasingly concerned with matters at the population level and ultimately also with the DNA of humankind as a whole.

At the same time, health surveillance is shifting from sporadic measurements, for instance at an annual check-up, to continuous real-time measurements. Thanks to wearables and smartphone apps, we already have the ability to chart our pulse, body temperature and exercise habits. On top of these new possibilities in health surveillance and genomics, hospital patient files are increasingly becoming available in electronic format.

All this data harbours great potential. Researchers hope that using it in a focused manner will help in creating personalised therapies and boosting their effectiveness. "This is where probability becomes an extremely important aspect," explains Borgwardt. Algorithms must be able to distinguish random correlations between patient data and the occurrence of a disease from statistically significant correlations. "The sheer size of the multidimensional dataspaces creates entirely new perspectives on these classical statistical problems." His group receives funding from an SNSF Starting Grant to develop new algorithms that spot statistically significant patterns in enormous collections of data. They are faster, require less computing capacity and can separate relevant data from irrelevant data much more efficiently than before. ›

Within five years, the genome of 15 percent of the population in industrialised countries will have been sequenced. Algorithms will then search through billions of base pairs for patterns indicative of disease.

FOR THE INTENSIVE CARE WARD

Thanks to the advances in genomics and the increasing digitisation of patient data, data science is becoming relevant to medicine. The European Bioinformatics Institute predicts that within five years, the genome of 15 percent of the population in industrialised countries, or 150 million people, will have been sequenced. Gunnar Rätsch, Professor of Biomedical Informatics, does the maths: that would be around 28 exabytes (= 28×10^9 gigabytes) of data. With this amount of information, new and efficient algorithms will be required in order to glean knowledge that can be used for research and patients and that contributes to more precise and personalised therapies. For example, they will have to search through billions of base pairs for interactions associated with disease. As part of a project in the "Big Data" national research programme (NRP 75), Rätsch's group is working on the efficient storage and analysis of these large quantities of genome data. "We're in the midst of a breakthrough!" exclaims the data scientist euphorically.

But how, specifically, can patients benefit from these kinds of smart algorithms? Rätsch offers a practical example: in close collaboration with Inselspital, the Bern University Hospital, his group is currently developing an early warning system for organ failure in the intensive care ward. Over a period of ten years, the hospital recorded data on blood pressure, pulse, temperature, medication, glucose and lactose levels, and electrocardiograms (EKGs) for nearly 54,000 patients. Rätsch is now developing algorithms to analyse these 500 gigabytes of data containing some 3.5 billion individual measurements to find patterns that indicate an imminent emergency. This would enable doctors and nurses to intervene before a patient's medical condition deteriorates. Systems like this require machine learning, an important branch of data science. The idea is for programs to recognise patterns and rules from a given dataset, and continuously learn to do so better and better.

AUTOMATED RADIOLOGY

Machine learning plays an important role not only in evaluating patient data, but also in improving medical technology. A prime example is magnetic resonance imaging (MRI), which is one of the most important medical examination methods in use today, particularly for soft tissue. Klaas Prüssmann, Professor at the Institute for Biomedical Engineering, a joint institution of ETH Zurich and the University of Zurich, has devoted himself to the further development of MRI technology. In a recently published article, he describes a system that uses 30 temperature sensors and 16 magnetic sensors to run a self-diagnostic of the MRI unit. In the future, suspicious patterns could give technicians an early warning, thus reducing unit downtimes in the hospital and saving costs.

Prüssmann also feels that his field of research is "on the verge of a gold rush". He expects data science to change not only MRI equipment, but the imaging as well. "If we succeed in translating relevant prior knowledge from MRI records – for instance that we are examining a brain and not a heart – into a manageable form, then we could greatly increase the speed and efficiency of the measurements." Prüssmann predicts a seismic shift in radiology, too: in the future it will be possible to compare millions of existing MRI images with one current measurement. This can help in identifying important indicators of certain diseases. In addition, applying algorithms to MRI images can reveal patterns that are not visible to the naked eye.

A CALL FOR HARMONISATION

Experts agree that one of the greatest challenges for data science applications in healthcare is the lack of data harmonisation. "Anonymised datasets obtained from different hospitals for research purposes are often not directly comparable," Borgwardt says. His colleague Rätsch adds: "In hospitals, data has thus far often been collected for health insurance billing, not for further analysis." He has high hopes for the Swiss Personalized Health Network (SPHN), in which Swiss universities and university hospitals are participating, to ensure data interoperability and to facilitate data transfer between hospitals and research institutions. At the same time, Rätsch foresees additional challenges: "In everyday hospital operations, the primary concerns are patients and data security, not recording all relevant data for more in-depth big data research." Data scientists need to show more clearly how they can support medical professionals without disrupting day-to-day routines or jeopardising data security. For this reason, he welcomes the Bachelor's degree in medicine that will be offered for the first time at ETH in autumn 2017; as it includes courses in computer science and machine learning, the programme is an important step in bringing the data sciences and medicine closer together. Rätsch is convinced that "the rise of data science in hospitals will also produce a new generation of doctors." //

KARSTEN BORGWARDT is a Professor of Data Mining in the Department of Biosystems Science and Engineering (D-BSSE) at ETH Zurich in Basel. His research focus is the development of algorithms for efficient searching in rapidly growing databases.

GUNNAR RÄTSCH has been a Professor of Biomedical Informatics in the Department of Computer Science at ETH Zurich since May 2016. He develops machine learning algorithms for analysing biological and medical data.

KLAAS PRÜSSMANN is a Professor of Bioimaging at the Institute for Biomedical Engineering of the University of Zurich and ETH Zurich. His research is dedicated to the development of medical imaging methods based on nuclear magnetic resonance.

Data science will revolutionise the imaging of the future.

MACHINE LEARNING & COMPUTATIONAL BIOLOGY LAB:
www.bsse.ethz.ch/mlcb

BIOMEDICAL INFORMATICS GROUP:
bmi.inf.ethz.ch

BIOMEDICAL IMAGING:
www.mrtm.ethz.ch

PROMOTING MEDICINE AND DATA SCIENCE

For the first time, ETH Zurich is inviting applications for a professorship in genome biology, thus further strengthening its leading international position in the field of personalised medicine. The new position is made possible by donations to the ETH Zurich Foundation from the NOMIS Foundation and the Lotte and Adolf Hotz-Sprenger Foundation. The new professor will work closely with other researchers in the ETH Zurich Department of Biology in the fields of proteomics, genetics, systems biology, cell dynamics and molecular biology. There will be a strong focus on the link with computer sciences, with the aim of enabling clinical decisions in the future to be taken rationally based on computer-aided analyses of complex patient data.

www.ethz-foundation.ch

Image: Giulia Marthaler (3)

Image: Scanderbeg Sauer

A new foundation

Global data traffic is based on outdated technologies. A new internet architecture is expected to remedy this.

TEXT Felix Würsten

It started with a thought experiment: given the many security flaws that plague the internet today, Adrian Perrig asked himself how secure an internet could possibly be designed. Over the past seven years, this question has developed into a large-scale project that has the potential to fundamentally change the digital world as we know it. Perrig, a Professor of Network Security in the department of Computer Science, is working with his team at the Zurich Information Security and Privacy Center (ZISC) to create a new, stronger foundation for the internet. As he explains, "Our approach will make the internet not only safer, but also more reliable and even faster."

FUNDAMENTAL ERRORS

Restarting the internet: at first glance, it seems an impossible task, considering how branched out and complex the interplay of the countless thousands of servers and computers has become. Nevertheless, Perrig is firmly convinced that his approach will solve, in one fell swoop, numerous fundamental problems that the internet community has struggled with for years. "The basis for today's internet was developed in the 1970s – at a time when no one could yet imagine the proportions that the global exchange of data would one day reach."

The current problems begin with very basic things, such as the Domain Name System (DNS): this hierarchical directory service, distributed across thousands of servers worldwide, is the very system that allows internet domain names – written in a way people can understand – to get translated into network addresses to direct information to the correct destinations. The problem here is that whoever controls the main server can, in principle, unceremoniously disconnect entire countries from the web – without those countries being able to fight back. Also the HTTPS protocol, which is confidently used today to ensure secure data transfer, isn't nearly as secure as users imagine. As Perrig explains, it's even relatively simple to manipulate this system to allow data to be rerouted and permit unauthorised parties to read and modify it. Another severe problem that the internet struggles with: time and again, internet paths become unavailable for several seconds, sometimes even for minutes. What may be merely an annoying flaw for individual users at home can have serious consequences for the business world, where time-critical data must be exchanged in real time.

NO DETOURS

"It's surprising how susceptible today's internet is to glitches," says Perrig, shaking his head. "SCION would put an end to all of this." The acronym stands for "Scalability, Control, and Isolation On Next-generation networks". The basic idea behind the abstract formula is this: in the future, the internet will be grouped into autonomous, separate subunits, known as isolation domains, in which the members agree on a common contractual and legal basis. Within an isolation domain, the internet service providers – telecom companies, businesses, universities and other organisations – then define which connections they deem reliable. This ensures that data are sent from sender to recipient on a secure path that can no longer be manipulated. With this kind of network architecture, telecom companies could, for instance, guarantee their customers that data will no longer be routed via any server in certain countries. Of course, Perrig concedes, even with SCION, it would still be possible to censor certain areas of the internet. "There is no internet structure that can prevent that kind of control. But since senders can see and control ›

Today we are completely unaware of the tangled paths our data takes through the internet. In future we will be able to define which path a sender uses to transmit data and design that path to be secure.

what path the data take, they can see where information exchange is being suppressed and attempt to circumvent those areas."

SIGNIFICANT ADVANTAGES

However, the new system is not without its drawbacks: the administrative effort required to manage the individual sub-networks and cryptographic keys is greater than for the existing system. Yet Perrig is convinced that the advantages are so compelling that customers would accept it: "A smartphone is more complex to use than old-style feature phones, yet we would never want to give them up any more."

Perrig has now chalked up his first successes with his project. "It's going well," he notes with satisfaction. "We have two important partners, Swisscom and Switch, already on board. Two Swiss banks, the Federal Office of Information Technology and several companies are also currently testing our system." Abroad, too, Perrig has turned colleagues into partners: SCION routers based on this new architecture are now set up around the world. Together with David Basin and Peter Müller, both professors in the Department of Computer Science, Perrig founded the company Anapaya Systems, through which he intends to commercialise the SCION network architecture.

"We plan to build highly secure routers 'made in Switzerland'," says Perrig enthusiastically.

Nevertheless, it's going to take a bit more persuasion: "To recognise the advantages of our system, one must first understand the new architecture. With SCION, we are creating an internet that works somewhat differently than the current system. Fortunately, conventional networks will require only small changes to unlock the advantages of the new architecture." //

THE NETWORK SECURITIY GROUP:
www.netsec.ethz.ch

ADRIAN PERRIG is a Professor of Network Security and Head of the Institute of Information Security. His research encompasses the development of new technologies for secure and reliable data exchange in networks.

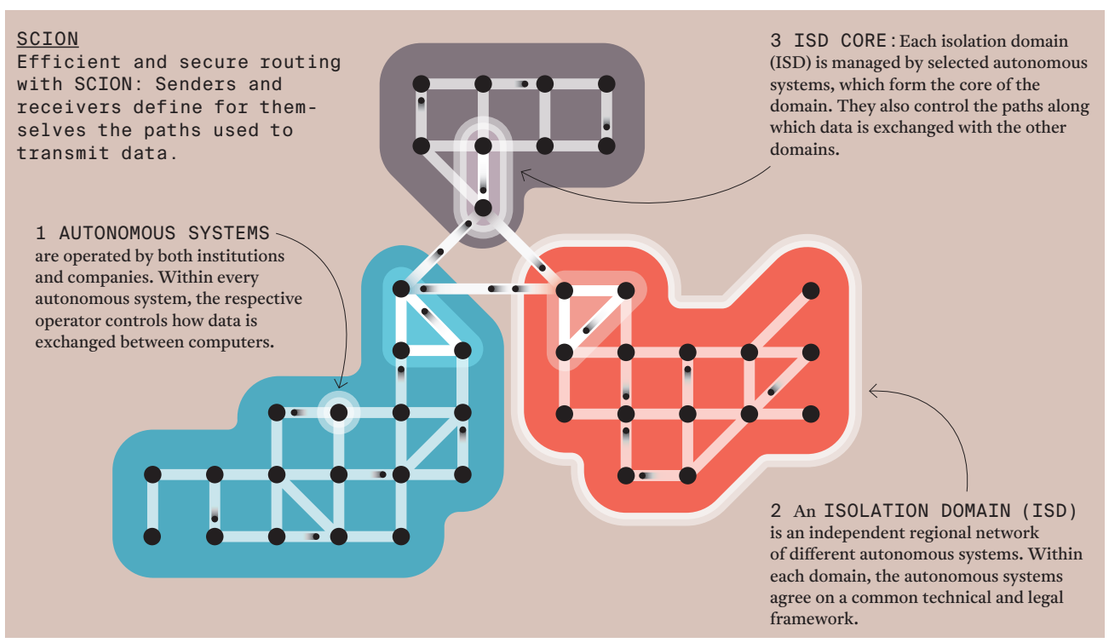


Image: Giulia Marthaler / Infographic: Francesco Muzzi, Story[TK]

Learning starts with people

Fast, intelligent data systems are Ce Zhang's speciality. To make sure they function smoothly, the data scientist combines basic research with service and dialogue.

TEXT Florian Meyer

CE ZHANG of China has been teaching and conducting research in the Department of Computer Science since autumn 2016, focusing on data systems, databases, data processing and machine learning. Born in 1987, he is one of the youngest professors at ETH.

Ce Zhang loves to talk with researchers from other disciplines. For the computer science professor, discussions with colleagues are a constant source of inspiration and motivation. Zhang, a native of China, is a computer scientist by training with a focus on interdisciplinary, data-driven research. He specialises in data systems that enable machine learning and artificial intelligence – in other words, applications that automatically comb through data to find information researchers could not otherwise obtain on their own. "The goal of my research is really quite simple," explains Zhang. "I support other researchers so that they can apply the latest developments of modern-day data analysis and expand their knowledge."

For example, Zhang's team is working on an adaptive machine application for biologists at ETH Zurich. The goal of the application is that it will read scientific journals in order to automatically glean the key information from the articles, since today it is impossible for anyone to read every biology publication themselves. Working with a team of astrophysicists headed by ETH Professor Kevin Schawinski, Zhang's group also recently developed a machine learning system that automatically processes telescope images to make it much easier for the astrophysicists to detect faraway galaxies.

Zhang is collaborating on similar projects with the private sector: his team is developing another adaptive application, this time for a communications company, that automatically filters information from PDF documents.

A FLAIR FOR USER PSYCHOLOGY

This type of interdisciplinary collaboration, which also involves the user in the development process, is typical of Zhang's work – and for data science in general. It also explains why, in talks with researchers, he places such value on teasing out the genuine need and building a data system around it. Data systems function better when they are designed with the user's needs and certain human characteristics in mind.

"When a data-driven application helps scientists free up more time for actual research by relieving them of routine tasks, that's when it feels my work has been truly worthwhile," says Zhang. His knack for understanding user psychology goes back to his early days in this field: before beginning advanced computer science studies at the University of Wisconsin-Madison and Stanford University in the United States, Zhang graduated from Peking University with a Bachelor's degree in machine intelligence. The programme, which was new at the time, linked computer science to the neurosciences and experimental psychology.

More specifically, Zhang focuses primarily on the next generation of data systems. "We want to make the data systems as fast as possible," he explains. That's because powerful and efficient systems provide the foundation for rapid data processing and for adaptive applications.

Collaboration with users outside computer science helps Zhang's team further simplify their systems for machine learning. Today, says Zhang, scientists still spend a lot of time writing hundreds of lines of code, since they must specify – that is, individually execute – every task that the system is expected to perform with machine learning. In future, computers are to handle this, and learn on their own how they are to find the desired information in the data. //

FURTHER INFORMATION:
www.inf.ethz.ch/personal/ce.zhang/

Image: Giulia Marthaler

Programmed by computers

Martin Vechev is automating the programming process and gets computers to write software autonomously.

TEXT Fabio Bergamin

Computer software written by computers: a fascinating idea. And a realistic one at that, says Martin Vechev, Professor of Computer Science. He's one of the founders of a new field of research in which computer scientists are seeking to largely automate the programming process. Assistance programs are already helping to facilitate software developers' work, and it won't be long before such programs enable normal developers to program to the same standards that today are achieved only by leading programming experts, says Vechev. "In ten years' time, the degree of automation will be advanced enough for computers to be able to write short programs autonomously," he predicts.

This is made possible thanks to the concept of machine learning and the huge public software databases already in existence today. "The way we see it, programming doesn't have to involve reinventing the wheel each time. Rather, it's about learning from good examples and tapping into the large pool of these existing examples," Vechev explains.

Public databases offer access to millions of computer programs containing several billion lines of program code, a colossal collection Vechev refers to as "big code". Such inconceivably large volumes of data can be overwhelming for software developers, but with the help of computers, this data can be analysed and processed to make it fit for practical use.

ARTIFICIAL INTELLIGENCE

Computers can recognise patterns in existing code and learn which ones are used in which context. In doing so, they capture not only individual characters and commands, but also their meanings and the rules for how they are used. The way computers learn these rules is similar to how machine translation works, of which Google Translate is a well-known example. "Translation tools also use intelligent machine learning technology to analyse words in their given context and then draw conclusions about their meaning and usage and about grammar rules," Vechev explains.

In the future, assistance programs for developers will work in a similar way to the auto-complete functions we use today for writing text messages on smartphones. For example, a software developer writes the first hundred lines of code, which the assistance program then analyses and compares with the existing code in the database. Based on the results, the computer then makes suggestions for how to continue the code, which the developer can either accept or reject. The computer also uses this feedback to understand the programmer's objectives and to continuously improve the suggestions it makes.

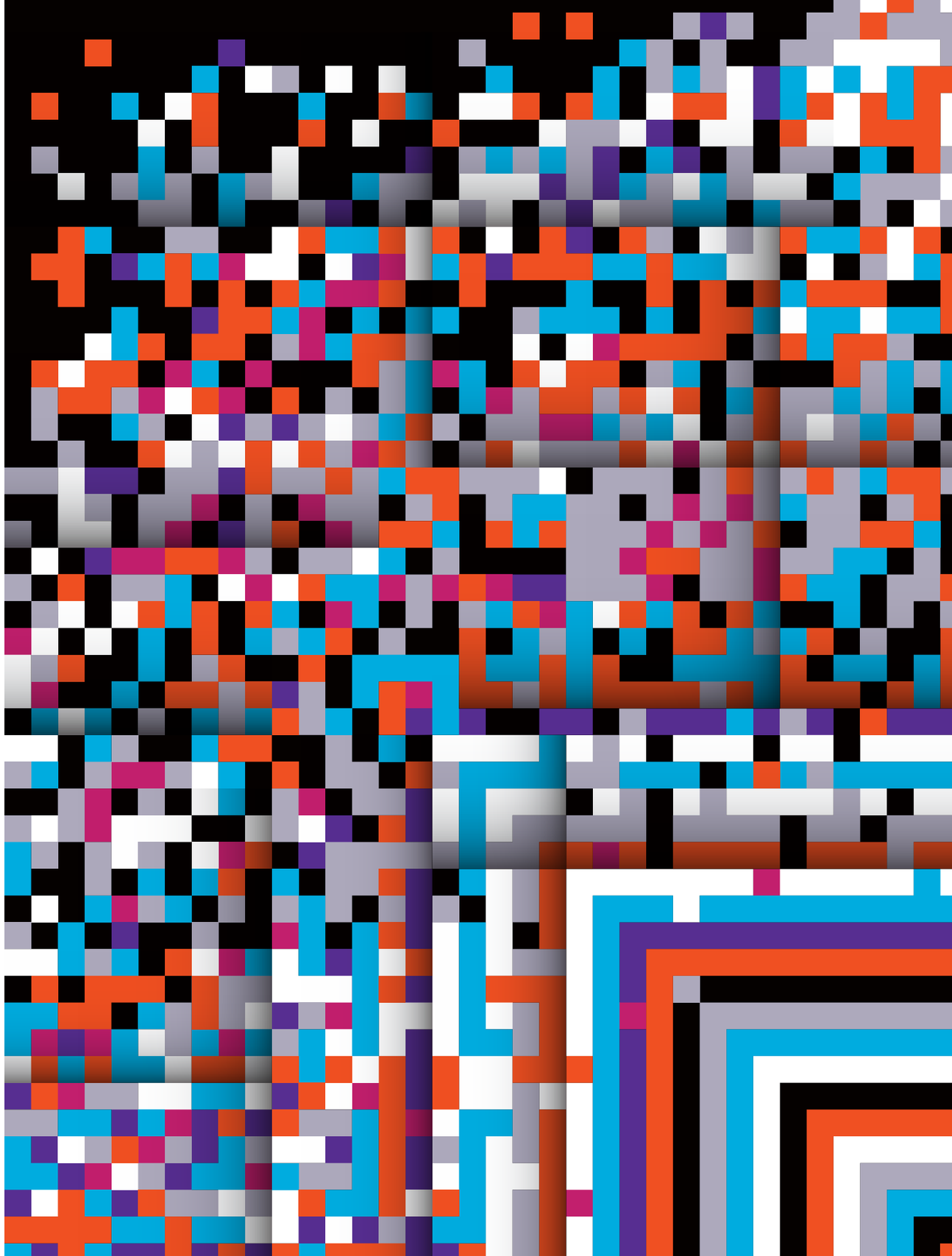
At the core of these new kinds of assistance programs sit what are known as probabilistic models. These probabilistic models are formed by learning from a vast number of already available programs and programming fragments. This allows the assistance program to use the probabilistic model to present the user with the most probable continuation options.

The ETH professor is working to come up with ever-better probabilistic models. His group recently developed one such model, named PHOG, which is currently the most precise code analysis model there is. The model is applicable to data sets beyond code – for example, to natural language. In addition and in contrast to other models, it provides not only answers, but also makes the choice of these answers comprehensible for the users. "Anyone interested in building such assistance tools can use the PHOG model as a basis," says Vechev.

PRACTICAL IMPACT

Vechev and his team also develop such assistance programs. Examples of their tools are solutions called JS Nice and APK Deguard, which are freely ›

Using a huge number of existing programs and fragments, the computer learns to write improved programs that are easier to navigate.



available online. These are a sort of correction program. Developers can use them to check their programs and to obtain suggestions on how to transform that program so that it is more easily understood by outsiders. The tools can also be used to decipher algorithms that were deliberately programmed in an obfuscating way, for example in order to obscure malware. More than 200,000 developers and IT security professionals worldwide have used JS Nice since its release. Last year, Vechev and his former PhD student Veselin Raychev founded DeepCode, an ETH spin-off. The company has set itself the task of creating new assistance programs for developers based on a direction explored in Vechev's SRL laboratory. This opens up opportunities for further applications down the line, such as programs that detect programming errors and propose fixes.

"We're seeking to develop software capable of solving challenges in software better than people can," says Vechev. "A few years ago, we were one of the first groups to set ourselves the goal of learning from 'big code'. Today, this area is attracting interest from many colleagues as well from various software companies. It's an interesting and fast-growing field of research." //

SOFTWARE RELIABILITY LAB:
www.srl.inf.ethz.ch

SPIN-OFF DEEPCODE:
www.deepcode.ai

MARTIN VECHEV is a tenure-track Assistant Professor in the Department of Computer Science at ETH Zurich and heads up the Software Reliability Lab. His primary area of interest is the application of machine learning to programming languages.

Big data for the environment

Forests, meadows and arable soils are natural stores of carbon. Researchers investigate the impacts.

TEXT Florian Meyer

Forests, meadows and farmland have an important role to play in climate change. As natural carbon stores, they can sequester carbon from the atmosphere, thereby counteracting the effects of global warming. However, the amount of carbon they are able to store is dependent on the environment around them. If temperatures continue to rise, it is possible that woods and soils would begin to release more greenhouse gases into the atmosphere while storing less and less carbon.

Investigating precisely how climate change impacts the carbon storage capacity of forests, meadows and soil is Nina Buchmann, ETH Professor of Grassland Sciences in the Department of Environmental Systems Science. As part of two major research projects – one for Switzerland (Swiss FluxNet), one for Europe (ICOS) – her research group is measuring the exchange fluxes of typical greenhouse gases such as carbon dioxide (CO_2), water vapour (H_2O), methane (CH_4) and nitrous oxide (N_2O) of forests, meadows and pastures, as well as farmland, with the atmosphere.

Measurements are being taken at six locations within Switzerland to determine the extent of the exchange of greenhouse gases between the ecosystem and the atmosphere. In doing so, the environmental researchers have employed the latest measurement techniques, which generate an almost uninterrupted stream of high-quality, high-resolution data. In the Swiss FluxNet project, for instance, wind speed, wind direction and gas concentrations are measured 20 times per second. The resulting data are then assessed for quality, combined with climatic data and ultimately used to calculate the fluxes of greenhouse gases between the ecosystems and the atmosphere. On top of this, time lapse cameras known as phenocams automatically photograph the vegetation at intervals of one to two hours throughout the day. These images can be used to identify any changes in the ecosystem.

NEW DATA, NEW QUESTIONS

Thanks to these new techniques, researchers have a mass of new data to work with. It is sorely needed, since the climatic, biological and geochemical factors at play interact in complex ways; for example, the ecosystem structure and soil climate influence the flux of greenhouse gases, as do wind turbulence, sun exposure, temperature and humidity. Plants also have an impact, such as through photosynthesis or root growth, and the same goes for microorganisms in the soil and for the people who fertilise the soil and farm the land.

Yet with this stream of new data comes a host of new questions. "If we want to understand the impact of climate change on ecosystems, we need to find a way to connect all the different data we have," says Buchmann. No easy task, since the data can be so divergent that it cannot possibly be reconciled without further work. In the ICOS project, environmental researchers are now collaborating across Europe to standardise their measurement infrastructure and data management systems.

Even so, the huge quantities of data involved and the hundreds of variables are still a sticking point in environmental research. There is a limit to what the human brain can process, and to what can be achieved with traditional statistical methods. Obtaining fresh insight from the complex data sets involves calls for new techniques of data analysis. One example of this is machine learning, in which algorithms search for recurring patterns in the data.

PUSHING THE BOUNDARIES

The issue of data analysis is what brought Buchmann to Andreas Krause. Krause is a computer science professor who specialises in machine learning and adaptive systems. In the "Big Data" national research programme (NRP 75), for instance, he is exploring how to draw together large quantities of data to facilitate efficient yet accurate machine learning. Krause is also academic co-director of the Swiss Data Science Center (SDSC), launched by ETH Zurich and EPFL in February 2017.

The SDSC forms a bridge between researchers who are producing large quantities of data, like Buchmann, and those who are developing new data systems and techniques of data analysis, like Krause. "At the SDSC, we combine the techniques of data science such as machine learning, statistics and information technology with the research skills of data-heavy disciplines such as life and environmental sciences," says Krause.

Questions such as those presented by Buchmann are addressed with an interdisciplinary approach, so that researchers from all disciplines are able to access the latest techniques in data management and data analysis. In turn, research questions inspired by real-life applications drive forward the development of new techniques in data science.

In his research, Krause tests algorithms that can be used for efficient, interactive data analysis. One example is a concept known as active learning. The learning process usually requires large quantities of training examples, which is often costly. Active learning takes a different approach, since it is the learning algorithm itself that selects the data that data analysts must consider. This accelerates learning and cuts costs. Similar issues arise when scientists look to apply learning techniques in extremely large data sets – for example, identifying representative use cases.

Active learning is also applicable to networks in which people and computers collect data together – for instance, data on earthquakes or air quality. These scenarios afford the opportunity to compensate for less reliable data and still use it to build up an overall picture. "How can humans and machines work together to achieve what neither of them could on their own?" wonders Krause, while Buchmann adds: "Maybe machine learning will open up a whole new perspective that we have never considered before."

DATA SCIENCE CENTER:
datascience.ch

Measurement station at Chamau

NINA BUCHMANN has held the post of Professor of Grassland Sciences in the Institute of Agricultural Sciences at ETH Zurich since April 2003. Her research focuses on the biogeochemistry of terrestrial ecosystems, namely forest, grassland and cropland.
›www.gl.ethz.ch

ANDREAS KRAUSE has held the post of Associate Professor in Computer Science at ETH Zurich since 2009. He is a specialist in machine learning and artificial intelligence, and a prominent figure in the Swiss Data Science Initiative.
›las.inf.ethz.ch

Image: Giulia Marthaler

Image: Grassland Sciences Group; Giulia Marthaler (2)

COMMUNITY

ETH has led the support programme for space technology start-ups since 2016.

ESA BIC: Second round

CONDUCTING RESEARCH FROM SPACE

ESA BIC Switzerland, a start-up support programme, is entering its second round with seven young start-ups. This time, five of them are from ETH Zurich. The jury was won over by ETH spin-offs like IRsweep, a start-up that aims to make environmental analysis from space more precise by using a spectrometer that works with infrared laser radiation. The other ETH spin-offs being supported in the second round are Embotech, Diramics, Fixposition and Anybotics. In the first phase, the start-ups each receive funding to the tune of 50,000 euros.

New MAS programme

SCIENCE, TECHNOLOGY, POLICY

Energy policy, decisions about urban design and development, and the transition to a digital society – policies on complex topics such as these increasingly require a sound scientific basis. Yet at the same time, if scientific findings regarding such multifaceted issues are to be successfully translated into practice, they must be compatible with political structures and processes as well as social realities.

ETH Zurich is offering a new interdisciplinary postgraduate programme dedicated specifically to this interface between science, technology and policy. The course is based at the Institute of Science, Technology and Policy (ISTP). Admission is subject to the applicant having completed a Master's degree in the natural sciences, engineering or a related discipline such as mathematics, architecture, medicine or life sciences.

The programme, which is completed over two semesters, equips students with the skills they need to apply their scientific and technical knowledge to a wider social, economic and political context. They learn how to analyse policy processes and institutions, evaluate decision options, support the implementation of policies and assess their impact. Skills such as these are in high demand from many employers, including government authorities, technology companies, international organisations and civil society organisations.

ETH Alumni

WELCOME TO THE CLUB

The ETH Alumni Association is pleased to welcome two new member organisations. In early March, ETH alumnus Thomas Hug co-founded the REIS Alumni group for Spatial Development and Infrastructure Systems graduates. Hug established the group along with three of his former coursemates from the REIS Master's degree programme.

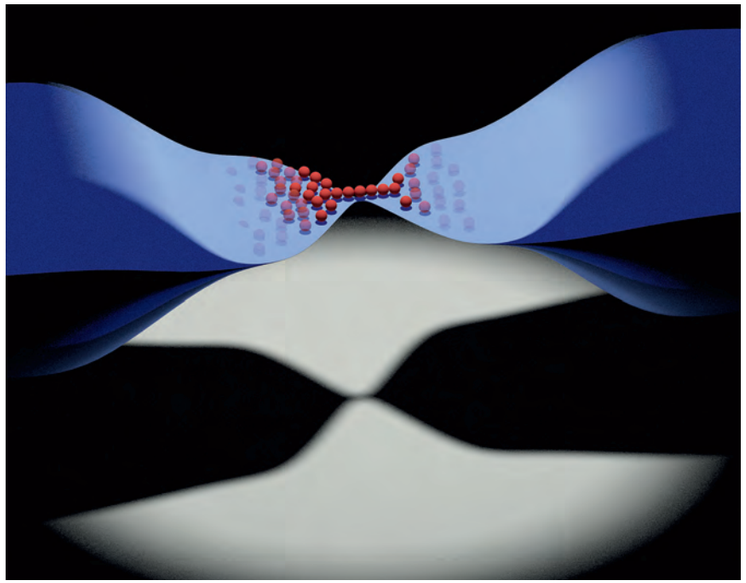
The second new organisation is an alumni chapter in Vienna. Alumni Chapter Wien offers former ETH students living in and around or visiting the Austrian capital the opportunity to meet up and network.

Image: ESA/ATG medialab

Ten years of ERC grants

Confidence in basic research

ERC grants? ERC grants! There's simply no way around it: any mention of the value and quality of basic research in Europe today simply must include the European Research Council (ERC).



Tilman Esslinger studies elementary transport mechanisms in a system that obeys the laws of quantum physics.

Anyone doing basic research is working at the frontiers of knowledge, where what comes next is no longer a matter of course. At these frontiers, researchers must examine their approaches and their research subjects, and scrutinise, refine or revise their definitions, theories and methods. They often have to develop new measurement, analysis or evaluation techniques, and depending on the situation, the existing research infrastructure, too, may be inadequate.

But even in the perfect research setting, basic researchers need to have a lot of stamina. No one can predict when there will be a new or groundbreaking finding and what it might bring about – it's like embarking on a journey with an unknown destination or an endurance run without a finish line. The European Research Council has been supporting this kind of research at the frontiers of knowledge for ten years. "The ERC funding programme is quite special in Europe, as it reflects precisely how basic research generates new findings," says Detlef Günther, ETH Vice President for Research and Corporate Relations. "The ERC is unique in the world in the consistent way it funds individual basic research, with substantial financing and in a reasonable time frame."

When the Council began its work on 27 February 2007, it was already clear to many that the ERC wasn't going to be just one programme among many others. As the German Research Foundation wrote in a press release at the time: "The founding of the ERC marks the beginning of a new era for the funding of basic research in Europe." Today, its financial support – the ERC grants – have become an international seal of quality for cutting-edge research and a benchmark in fostering talent. For ETH Professor Emeritus Helga Nowotny, who was President of the ERC from 2010 to 2013, the ERC has set the "gold standard for basic research" with its grants.

More than success factors

One success factor is the funding principle: the ERC doesn't fund predefined topics, but rather awards its grants based on the scientific excellence of the submitted projects. Only the quality of a research idea matters, regardless of the discipline it represents. "ERC funding is characterised by outstanding selection, well-endowed grants, time, and confidence that the researchers will conduct superior basic research in their projects," says Günther.

Another success factor is the career aspect: the Starting Grants (1.5 million euros each) go to talented scholars in an early stage of their career. The Consolidator Grants (2 million euros each) are directed at young researchers looking to become more independent, and the Advanced Grants (2.5 million euros each) at established top researchers who have already demonstrated outstanding scientific performance. All grants run for a period of five years.

"ERC grants are proof of performance. Generally speaking, anyone who succeeds in the international competition for an ERC grant can expect to go on to top academic positions," Günther says. Since the ERC awards the grants through the same process throughout the European Research Area, they provide a way to assess research quality and identify strong scientific performance in an international comparison.

ETH researchers have received 134 ERC grants since 2007 (242.1 million euros): 47 Starting Grants, 8 Consolidator Grants and 67 Advanced Grants. Nearly 30 percent of all ETH applications were rewarded with a grant (European average: 11.4 percent). Two ETH researchers who received their second Advanced Grants in March 2017 are Frédéric Merkt, Professor of Physical Chemistry, and Tilman Esslinger, Professor of Quantum Optics.

"ERC grants pave the way for taking a group's research in a new direction," Merkt says. "The exceptional financial support and minimal administrative effort make you feel like the ERC has great confidence in you, which is very liberating and compelling. The ERC's support also spurred a surge of innovation in my group."

"Applying for an ERC grant is an intellectual challenge, since you have to summarise your own research plans and ideas succinctly and win over many critical colleagues," Esslinger adds. "With an ERC grant, you can pursue a major scientific question for five years in exactly the way you deem fit. This gives you great freedom, but also great responsibility." – Florian Meyer

European Research Council (ERC):
→ erc.europa.eu

Philanthropy

SUPPORT FOR BRIGHT MINDS

Thanks to the generosity of the over 3,500 donors to the Excellence Scholarship & Opportunity Programme (ESOP), 57 new Excellence Scholars from 21 countries will begin their Master's courses at ETH Zurich this autumn.

Mauro Salazar Villalon was also an Excellence Scholar, earning his Master's degree in mechanical engineering in 2015. Today he is an enthusiastic supporter of the ESOP: "I am very grateful to the ETH Zurich Foundation and am happy to give it my financial support. It constantly offered me exciting experiences and remarkable opportunities to learn new things and meet interesting people."

The ESOP supports the top two to three percent of Master's students at ETH Zurich – talented people whose personalities and intellectual prowess promise to deliver outstanding achievements. The programme is financed entirely through donations to the ETH Zurich Foundation.

Further information:
→ www.ethz-foundation.ch/en/excellence-scholarships

Image: Tilman Esslinger

Image: ETH Zurich Foundation

Timm Schroeder wants to further strengthen relations with research partners in Basel.

Ten years of the D-BSSE

WELL ESTABLISHED IN BASEL

Ten years ago, ETH Zurich established its first and only department outside Zurich: the Department of Biosystems Science and Engineering in Basel. Since it was founded, the D-BSSE has focused on three areas: biology, engineering sciences and theory. The D-BSSE began with 7 professors and 150 employees. Today there are 19 professors with over 300 employees in total. In the ten years since it was established, the department has produced nine start-ups.

With its focus on synthetic and systems biology, the department has been perfectly suited to Basel from the start. "ETH Zurich was able to establish itself here at one of the world's largest life sciences clusters, with first-class researchers and the giants of the pharmaceutical industry. We benefit greatly from being part of this community. Working in such an environment is extremely valuable and inspiring for our own research," says Professor Timm Schroeder, head of the Basel-based ETH department.

Now, a new department building will be built on the Schällemätteli campus in central Basel. The new building will be a modern research centre that – thanks to its location on the University of Basel campus – will offer excellent conditions for collaborations in biomedicine between ETH Zurich, University Hospital Basel and the University of Basel. The building is expected to be ready for use in 2021.

ETH Zurich Foundation

GENEROUS DONORS

In its annual report, the ETH Zurich Foundation has an impressive year to look back on. In 2016, it added 500 new donors to its existing count of 4,400. Together, they supported ETH Zurich's unique projects with donations amounting to 48 million Swiss francs.

Donors ranged in age from 22 years old to an impressive 105. Private individuals were inspired to donate primarily by a desire to promote talent. Their donations also helped support innovations in teaching. Foundations and organisations supported ETH Week and the Cybathlon, amongst other projects. Large business partners were involved mainly in the new ETH strategic initiatives: media technology and information security. They also supported long-term ETH priorities, such as personalised medicine, sustainable construction and global nutrition.

Unrestricted donations, an important funding instrument, accounted for a pleasing four percent of donations. These provide ETH with funds that it can use freely and according to the urgency of current research topics.

→ www.ethz-foundation.ch

Image: Pino Covino

Column

With borrowed plumes?

Academic authorship is a highly competitive business because it generates visibility and attracts attention. Both are a must for anyone pursuing a career in academia; they are a way for authors to "shamelessly market themselves and their projects."* For the sake of their own careers, it is not unusual for prominent academics to have some borrowed plumes in their hats. False advertising or an investment for the future? In *The Bourbaki Gambit,* a novel by Carl Djerassi, Max, in his capacity as a mentor, teaches his young academic protégé that "there is one character trait which is an intrinsic part of the scientist's culture … his extreme egocentricity, expressed chiefly in his overmastering desire for recognition by his peers." Max continues: "No other recognition matters. And that recognition comes in only one way … through your publications."

The Bourbaki Gambit takes its inspiration from the story of Nicolas Bourbaki, the collective pseudonym under which a group of mainly French 20th-century mathematicians published a series of important articles and textbooks, which began to appear in the thirties. They helped establish set theory as a foundation for mathematical education in schools, attracting significant media attention (tick!) and even fuelling debates in the German Parliament. On the basis of today's academic publications and career practices (see above), Nicolas Bourbaki would have seemed set to fail. After all, you couldn't even invite him to give a keynote lecture.

Why, then, were renowned individuals willing to play the Bourbaki game? Does mathematics boast a different career model? A wise person once gave me an insightful example. Among the especially prominent works in the field of combinatorics are those of Endre Szemerédi. One publication contains the following concluding remark: "My indebtedness to my friends R.L. Graham and A. Hajnal is extremely great. In fact, they wrote the whole paper after listening to my rough oral exposition." It seems that group size plays a key role in the choice to hide behind a "trade name" like Bourbaki. With small groups, the members are still likely to be recognised. The result is an ironic interplay between author and pseudo author, between authenticity and emulation in the style of commedia dell'arte. Too bad this magazine doesn't permit such a game. The confidence to subordinate oneself and retreat behind a fictional character would be evidence of "critical thinking" indeed. Regrettably, that's off limits for me here. Do away with some of the rules and all will be good.

Gerd Folkers heads the ETH Critical Thinking initiative. He is also President of the Swiss Science and Innovation Council. Prior to that, he spent many years as President of the Collegium Helveticum.

*Leandra Bias, *NZZ: Bildung*, 5 April 2017. Page 10.

Illustration: Benedikt Rugar; Image: Giulia Marthaler

Researching the cities of the future

A visit to ETH Zurich's Future Cities Laboratory in Singapore, where researchers are working on sustainable solutions for urban development. They want to make tropical cities cooler, more liveable and more environmentally friendly.

TEXT Andrea Schmits IMAGE Lina Meisen

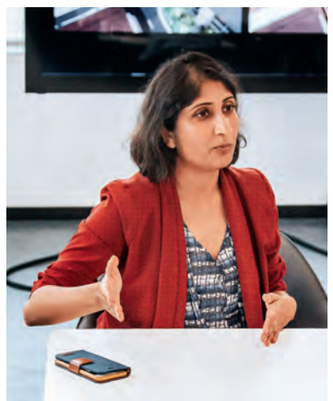
Project leader Alexander Erath on a virtual bike tour through Singapore.

Alexander Erath cycles past the Tiong Bahru market and turns into Kim Cheng Street, past rows of palm trees, shops, pedestrians and other cyclists. He turns two more times to ride around the block, never once leaving the clearly marked cycle path. If he wanted, he could dismount now and treat himself to a Tiger beer in the market – or head further down to trendy Yong Siak Street for an espresso. Except he can't, because Erath is simply taking a tour in a virtual environment. In reality, he is a transport planner wearing a virtual reality headset and sitting on a red bicycle in the meeting room at the Singapore-ETH Centre (SEC).

Here on the huge campus of the National University of Singapore (NUS), ETH Zurich's presence is easy to spot: it has been active in Singapore for seven years now, the last five of which have been spent in offices spread over two floors of the CREATE Tower. Researchers from other renowned universities – including the Massachusetts Institute of Technology (MIT), the Technical University of Munich (TUM) and Cambridge University – also work in the tower's lush, verdant spaces.

Singapore's National Research Foundation invited ETH Zurich to come here and research sustainable solutions for global challenges. "There is an urgent need for this kind of research in a region that is urbanising rapidly," says Professor Peter Edwards, who heads the Singapore-ETH Centre. Population growth has been fastest in Asia, he explains, pointing to a couple of graphs on the giant screen that fills a whole wall of the room. Cities are developing very quickly – and that development is anything but sustainable. "We need to find ways to bring this growth back within the resource limits of our planet; otherwise, the future will be bleak."

Urban planner Tanvi Maheshwari finds virtual reality an extremely useful tool.



The Singapore-ETH Centre's projects are grouped into two research programmes. The first of these was the Future Cities Laboratory, launched in 2010 and extended in 2015 for another five years; this has the mission of producing the knowledge and ideas needed for a sustainable urban future. In 2014 it was joined by the Future Resilient Systems programme (see box).

On your bike

One of the Future Cities Laboratory's projects aims to get Singaporeans to cycle – which brings us back to the red bike standing in the middle of the meeting room.

It's an old-fashioned ladies' bike, something of a rarity in Singapore. Cyclists are generally found only in recreational areas. For now, Singapore is the first tropical city in Asia to actively promote cycling. But this is a tricky proposal in an urban environment that often obliges you to cross a six- or even eight-lane road just to get to the next bus stop. The infrastructure has to improve. "We want to understand what it would take to get Singaporeans to use their bikes more often," says project leader Erath.

In order to test this infrastructure before building it, Professor Kay Axhausen and his team on the Engaging Mobility project developed a virtual-reality cycling simulator. This enables test subjects to cycle along three streets in Singapore's Tiong Bahru district that have been made bike-friendly. The locals have welcomed the project with open arms: in September 2016, under the heading of Bike to the Future, the team set up the simulator in the Tiong Bahru neighbourhood. They invited passers-by to test the virtual cycle paths of the future for themselves and provide feedback. "People's willingness to cycle shot up dramatically," says transport planner Michael Van Eggermond. However, he also admits that "it isn't yet clear whether people's behaviour in virtual reality is different from their behaviour in real life – in other words, to what extent the tool is valid for behavioural research." One possible problem is the lack of eye contact with car drivers and pedestrians, which is not accounted for. Nonetheless, virtual reality is an extremely powerful tool in the planner's arsenal, says urban planner and architect Tanvi Maheshwari.

The team is in regular dialogue with the Singaporean transport planning and urban planning author- ›

ities. This helps to keep the research grounded in reality – and it means that when the findings are ready, they could help the government make better-informed decisions.

A cooler Singapore

It's good that Erath currently tests the cycle paths only virtually, because outside the sun is beating down. The air is so humid on campus that sweat gathers on your brow as soon as you set foot outside. That's how it is all year round in Singapore. The Cooling Singapore project, which was launched in January 2017, aims to tackle this problem. Cities are often warmer than the rural areas around them. Singapore, with an average temperature of 27 degrees and humidity of 84 percent, is hotter than it should be. "Take the Orchard Road shopping area, for example," says Edwards, who heads the project with Heiko Aydt. "In the evening, the temperature there is seven degrees hotter than it should be." The reasons for this include the loss of vegetation, the absorption of heat by buildings and roads, and high energy consumption.

Not only does this heat bring discomfort, but it encourages Singapore's 5.6 million inhabitants to use their air-conditioned cars – which themselves give off heat – rather than walking or cycling. What's more, the warm exhaust air from close to a million air-conditioning units leads to increased rainfall. The incidence of major storms has doubled over the past 30 years. This also poses a problem for the drainage system: only yesterday evening, parts of the city centre were flooded following a rainstorm.

By January 2019 the project aims to be in a position to propose measures for long-term mitigation of the urban heat island effect in Singapore. In addition, the team wants to set up a working group of researchers and government representatives to promote knowledge exchange and ensure that the proposals are practically relevant. To this end, the Singapore-ETH Centre is collaborating with other top universities. A total of ten researchers from ETH Zurich, NUS, TUM and MIT are involved in the project. Experts in areas ranging from energy to construction and transport are considering the problem from all angles.

Real lab: Adam Rysanek indicates the building in which "3for2" is being implemented.

More space, less energy

Unlike outside, the temperature in the Singapore-ETH Centre's high-ceilinged rooms is just right. To feel comfortable in spite of the heat and humidity, Singapore's residents spend a considerable amount of their time in air-conditioned spaces. Whether in apartments, offices, restaurants, shopping centres or cars, the AC is almost always turned on. But cooling and dehumidifying the air demands not only plenty of energy but also large volumes of space. Professor Arno Schlüter and project manager Adam Rysanek want to solve this problem. "Sixty percent of energy use in Singapore's buildings goes to cooling, dehumidification and ventilation," says Rysanek. But there's more. The pipes and ducts required by these systems take up as much as a third of the space – to a height of some 1 to 1.5 metres – in the rooms on each floor. Rysanek looks up to the ceiling of the meeting room, where huge air ducts can be seen. They're not pretty, but they help to make the indoor climate pleasant. The 3for2 Beyond Efficiency project team is aiming to cut the energy consumption of air-conditioning systems while also reducing the amount of space needed for all the various piping and ducting systems. This should allow three floors to be built in future in the space taken up by two floors today – hence the project name "3for2".

There are three major components to the concept. First, it separates the cooling of the indoor air from the dehumidification of fresh, outdoor air that is fed into the building. Doing so significantly reduces the amount of very cold water – nearly 7 degrees C – needed to drive the air-conditioning process, which saves energy. Second, heat is transported through the building using water rather than air, since a given volume of water can carry more heat than the same volume of air. This means that the air-conditioning system can be more compact and consume less energy for the distribution of cooling. Finally, rather than having one central air-conditioning unit, this approach uses multiple small, distributed units that bring air directly from the façade into the room. This eliminates the need to distribute air throughout the building, which makes the associated ducting redundant – and saves space and energy.

> "In the evenings, the temperature is seven degrees hotter than it should be."
> PETER EDWARDS

The concept functions well: the Singapore-ETH Centre installed the suite of air-conditioning technologies on one floor of a building belonging to the United World College of South East Asia. The 550 square metres of office space is just a short stroll from the CREATE Tower – a happy coincidence. The rooms are used by administrative staff at the school, and their rather dated furnishings give no clue as to the modernity of the technology employed here. Just in the first month, the rooms consumed less energy than some of the most energy-efficient buildings in the entire city-state. One thousand sensors continuously provide the researchers with data on variables such as temperature, air circulation, humidity and CO_2 concentration. "By the time the research project ends in December 2018," says Rysanek, "we're hoping these will be the most energy-efficient offices in the whole of Singapore."

Touring on a bicycle

The red bike with the virtual-reality simulator has since been moved out of the meeting room. It was so popular in Tiong Bahru that the Engaging Mobility team have had enquiries from event organisers across Singapore. "We could do plenty of road shows," laughs Van Eggermond. But the priority is to make the virtual experience as realistic as possible, so that it is possible to translate the findings to reality. ○

SINGAPORE-ETH CENTRE

The Singapore-ETH Centre is home to two major research programmes. The Future Cities Laboratory (FCL) is developing knowledge and ideas for sustainable cities of the future. The CREATE Tower is also where researchers from the second SEC research programme, Future Resilient Systems (FRS), work. They are developing methods and tools to make critical infrastructure systems more robust and resilient. These include energy supply, transport, communication, financial systems and emergency services.
→ www.sec.ethz.ch

Peter Edwards (r) and his team in Singapore appreciate having lots of space for ideas.

CONNECTED

1 *Alain Berset at ETH*

FEDERAL COUNCILLOR VISITS DISNEY LAB

ETH President Lino Guzzella (bottom right) invited Swiss Federal Councillor Alain Berset (left) to visit the Disney Research laboratory. Berset, who is Head of the Federal Department of Home Affairs, was keenly interested in and impressed by the work of the ETH researchers. He gave a speech in which he stated that the rapid development in areas such as artificial intelligence and robotics not only opens up fascinating new opportunities, but also raises the question of how politics and society should handle these developments. All those present agreed that such new technologies can offer enormous benefits when used responsibly.

2 *L'Oréal–UNESCO award*

NICOLA SPALDIN'S WORK HONOURED

ETH Professor Nicola Spaldin (3rd from right) has been honoured for her revolutionary research in the field of material sciences. At a ceremony in Paris, she received the L'Oréal–UNESCO For Women in Science award for Europe, a prize endowed with 100,000 euros. The awards aim to recognise and support outstanding female researchers from all around the world. Spaldin has also received numerous other prestigious scientific honours.

1 *Alain Berset at ETH*

2 *L'Oréal–UNESCO award*

Image: Manuel Lopez (2); L'Oréal Foundation

3 *Spark Award 2017*

4 *Book launch*

5 *Meet the Talent*

Image: Oliver Bartenschlager; Nicola Pitaro; Eline Keller-Sørensen (2)

3 *Spark Award 2017*

AWARD-WINNING VIRUS RESEARCH

ETH Professor Sabine Werner (2nd from left) and her colleagues Michael Meyer (1st from left) and Luigi Maddaluno (1st from right) have received this year's Spark Award for their groundbreaking new antiviral defence strategy. The award was presented by ETH Vice President for Research and Corporate Relations Detlef Günther (2nd from right). At the ceremony, he emphasised the importance of basic research for supporting advancements in medicine.

4 *Book launch*

SPARKING AN INTEREST IN SCIENCE

Globi, who is probably Switzerland's most famous comic book hero, paid a visit to ETH Zurich. The launch of the latest Globi book, *Globi and the Crazy Machine,* which is set at ETH Zurich, sparked keen interest from all the attendees, especially the little ones.

5 *Meet the Talent*

SUPPORTING THE BEST

At Meet the Talent 2017, an ETH Zurich Foundation event, sponsors of the Excellence Scholarship and Opportunity Programme (ESOP) had a chance to meet the scholarship recipients. The latter presented their research projects and discussed their studies, motivation and plans for the future. Rector Sarah Springman (right), official patron of the ESOP programme, offered her thanks to all supporters, partners and alumni who have helped support and develop ETH's most promising talent.

Agenda

EVENTS

27 June 2017 / 6.30 – 9 p.m.
The rise of the robot
At the Alumni Focus Event, ETH Professor and robotics expert Roland Siegwart will be speaking about robots rolling off the production lines.
ETH Main Building, Dozentenfoyer
→ www.alumni.ethz.ch/events

29 August 2017
Industry Day 2017
Visitors to Industry Day can get the lowdown on the research underway at ETH. They will also have the opportunity to speak with researchers, discuss ideas and make contacts.
ETH Hönggerberg campus
→ www.ethz.ch/industryday

29 August 2017 / 5.30 p.m.
Health is hereditary
This public lecture, part of the Latsis Symposium, will address health in terms of development and hereditary traits. Science writer Peter Spork will give a talk entitled "Erbe, Umwelt und Vergangenheit: Warum die Epigenetik den Blick auf die Gesundheit verändert" (Heredity, environmental influences and past experiences: How epigenetics is changing our view on health).
ETH Main Building, Audimax
→ www.latsis2017.ethz.ch

Sisyphus: The robot is caught in an endless cycle of creation and destruction.

Museum of Digital Art

WHERE ART MEETS SCIENCE

1 April – 16 July 2017 The work of ETH architects Fabio Gramazio and Matthias Kohler is on show at the Museum of Digital Art in Zurich. With their architectural structures built using algorithms, sensors and robots, the two professors have attracted international acclaim. At the exhibition, put together in collaboration with ETH Zurich, Gramazio and Kohler are showcasing a selection of their past creations and two new robotic installations, including one named Sisyphus. Developed especially for this exhibition, the installation features a hanging vacuum device that continuously moves grains of sand to create – and destroy – ever-shifting landscapes.

→ muda.co

Alumni trips

FOUR CITIES IN FOUR DAYS

12–15 October 2017 The ETH Alumni Association are taking a four-day trip to the Netherlands. The plan is to visit attractions and points of interest in four different cities: innovative urban development projects in Amsterdam; Museumpark, Erasmus Bridge and the new Market Hall in Rotterdam; the Gemeentemuseum in The Hague, which holds the world's greatest collection of Piet Mondrian works; and the University of Technology in Delft.

Sign up here:
→ www.alumni.ethz.ch/events

Image: Nicola Pitaro; Digital Arts Association

GUIDED TOURS

4 July 2017 / 6.15 – 7.15 p.m.
Hallo Albert
"Hallo Albert" is an evening tour at ETH's Main Building. During the tour, visitors can take a look at a collection of exciting original documents written by Albert Einstein. Einstein studied at ETH Zurich back when it known as the "Polytechnikum", and later became a professor there.
The tour is given in German.
ETH Main Building
→ www.tours.ethz.ch

12 September 2017 / 6.15 – 7.15 p.m.
Modern art in a historic building
There's much more to ETH's historic Main Building than commemorative busts and plaques. The evening tour "Art at ETH since 1955" offers visitors the chance to view modern artwork at the University. In the car park, for example, are numerous pieces of graffiti by artist Harald Naegeli from the 1970s.
ETH Main Building
→ www.tours.ethz.ch

EXHIBITIONS

11 April – 14 July 2017
Shaping the cityscape
Teppichbeet und Promenade – die Zürcher Kunst- und Handelsgärtner Froebel (Carpet bedding and promenades – the Froebels: Zurich's landscape and commercial gardeners) is a joint exhibition of ETH and the City of Zurich. It features a collection of valuable material from landscape gardener Froebel's estate, which is kept at ETH in the archives of the Institute for the History and Theory of Architecture (gta). Theodor Froebel and his son Otto were among the leading Swiss landscape and commercial gardeners of the 19th century. The Old Botanic Garden is one of the most important projects to have shaped the Zurich cityscape.
Haus zum Rech, Neumarkt 4, Zurich
→ www.stadt-zuerich.ch/agenda

11 May – 29 September 2017
Artists and friends
Over a number of decades, Max Frisch formed a close friendship with Zurich artist Gottfried Honegger (1917–2016). The current exhibition at the Max Frisch Archive traces the ups and downs of this impressive relationship between writer and artist.
ETH Main Building, Max Frisch-Archive
→ www.mfa.ethz.ch

Recommended reading

WALTER MITTELHOLZER REVISITED

Aviation pioneer, co-founder of Swissair, spectacular aerial photographer of the Swiss Alps – things many would associate with the name Walter Mittelholzer (1894–1937). But Mittelholzer is not as well remembered for his flying expeditions abroad, during which he proved himself to be a shrewd media entrepreneur. A new illustrated book, *Walter Mittelholzer Revisited,* by historian and journalist Kaspar Surber covers some of the less well-known aspects of Mittelholzer's life. Photographs of his adventurous expeditions to Africa and what is today Iran provide insights into lives of foreign cultures. The work is the sixth volume in the series *Pictorial Worlds. Photographs from the ETH-Bibliothek's Image Archive.*

ISBN 978-3-85881-543-9
Publisher: Scheidegger & Spiess AG, Zurich
Price: CHF 59.–

Image: ETH Bibliothek, art inventory; Zurich city archives; Scheidegger & Spiess

A sustainable economy

Sabine Döbeli is convinced: we need to improve sustainability in our economy. Now the ETH alumna is focusing her efforts on achieving this objective in the financial world.

TEXT Felix Würsten IMAGE Annick Ramp

Sabine Döbeli developed a keen interest in nature and the environment from an early age. At the cantonal school she attended in Switzerland, her geography teacher would often bring up ecological topics, piquing Döbeli's curiosity in environmental matters. When she found out that ETH Zurich offered a new degree programme in environmental sciences, the choice was obvious: that was what she wanted to study.

Back then, to think she would end up working in the financial sector seemed highly unlikely. And initially she followed the typical route for graduates of her degree programme. She wrote her thesis at the Federal Institute for Forest, Snow and Landscape Research in Birmensdorf on "the ecological importance of forest edges". The associated field work involved making detailed maps of the vegetation along forest borders and asking walkers how much value they attached to forest edges as features of the landscape.

The transition from being a student to working in the field wasn't easy, she recalls. "The job market back in 1994 was pretty bleak," she explains. "What's more, nobody really knew what graduates of this new degree programme were actually capable of, except ETH, of course." Following a short stint at an environmental agency where she wrote a study on the landscape of Lago Bianco, she arrived at a fork in her career path. Her first option was to continue down the traditional route and work on another project, this time mapping plants. Alternatively, she could take a step into the unknown with a six-month internship at Zürcher Kantonalbank (ZKB), Switzerland's third-largest bank. Her task was to come up with a concept for an environmental fund. "It just seemed like a more exciting job, even if I didn't know much about banking back then," she says.

Learning on the job

A job that was initially supposed to be for 6 months ended up being 11 years, during which Döbeli established herself as a sustainability expert at ZBK. During this time, she formed an internal research team specialising in sustainability matters: "Our main task was to establish the extent to which businesses were being run in an environmentally friendly and sustainable manner, and whether these companies were a viable option for potential investors looking to make sustainable investments." Step by step, she built up her knowledge of the financial world, of which she had little at the start. She attended various training courses and a few years later completed a postgraduate degree in marketing and business administration at the University of Basel.

"I worked hard to lay the groundwork," she says, thinking back to her time at ZKB. The same was true for her next position at Vontobel. At the time, the private bank still had little to do with the area, but it was a segment in which it wanted to gain a foothold with products for interested private customers. "If a bank wants to offer this kind of product, it needs to act sustainably itself," explains Döbeli. "In addition to developing new investment approaches in my role as sustainability manager, I was also responsible for things like clarifying how we were handling the topic in-house."

Regarding the decision to expand their sustainability activities, Döbeli's former employers are in good company. Numerous >

"In my role as sustainability manager, I worked hard to lay the groundwork."

PROFILE

Sabine Döbeli

completed her studies in environmental sciences at ETH Zurich in 1994. She went on to establish an internal sustainability research team at Zürcher Kantonalbank, where she also worked on the launch of sustainable investment products. She joined Vontobel, another Swiss bank, in 2006. In her role there as sustainability manager, her responsibilities included coordinating the group-wide sustainability management system. Since 2014, she has been the CEO of Swiss Sustainable Finance.

financial institutions have meanwhile identified this field as a promising business area. "The Swiss financial sector is almost certain to take a leading position here," says Döbeli. "After all, Switzerland manages almost one third of all development investments worldwide; in other words, the money allocated specifically for investment to help develop poorer countries."

"My solid training in the natural sciences benefits me time and again."

Just like a start-up

It is thanks not least to Döbeli's initiative that Swiss Sustainable Finance (SSF) was founded in 2014. She has been head of the networking organisation from the outset. At the start, Döbeli reduced her workload at Vontobel by 50 percent and threw herself wholeheartedly into her new venture. "It was just like launching a start-up," she says to sum up her role over the last few years. As CEO, she now devotes all her working hours to the organisation. She manages quite a remarkable network at SSF, which already comprises 95 institutions across Switzerland, she explains. Among SSF's members – alongside banks, asset management organisations, pension funds and federal offices – is ETH Sustainability, the unit responsible for coordinating sustainability activities at ETH Zurich.

For Döbeli, it's clear how a networking platform makes itself heard: "Firstly, we have to provide interesting materials for our members," she says. Picking up an example from the top box in a pile in her office, she continues: "We've just finished our latest publication." Döbeli and her team also organise regular events for members to compare notes on current topics. The sustainability specialists from the financial sector really are an appreciative audience. "For many of them, the drive comes from within. They take a personal interest in the matter, which means they are more willing to work with others," she says. Stepping up sustainability in the Swiss financial sector is something Döbeli feels very strongly about. "A functioning economy is the key to our unprecedented level of prosperity," she says to summarise her perspective. "But if we don't manage to realign our economy, sooner or later it will find itself in jeopardy."

Döbeli sees education as an area with special need for improvement. "Sustainability is still given far too little attention in economics-based degree programmes," she explains. "It's perfectly feasible to study finance today without having to even touch on the topic." For this reason, she is all the more pleased that ETH Zurich now has David Bresch, a prominent expert from the reinsurance industry, on board as Professor for Weather and Climate Risk. Bresch's appointment will help strengthen networking and dialogue among environmental researchers and finance experts.

It doesn't bother Döbeli that ecological issues are in a pretty poor state again at present. "Of course, I'm not very happy about the direction political and social development is heading at the moment," she says. "But if I compare where we are now to when I was a student, I can see that actually a lot of positive changes have been made over the last few years."

Up until a few years ago, she had followed the development of this discussion very closely indeed. As a member of the advisory board for the Department of Environmental Systems Science, she found out firsthand how research and teaching at ETH was progressing in this area. Although she no longer has any direct contact with her alma mater, she still has indirect links with ETH. "The solid training I received in the natural sciences benefits me time and again in my current position," she says. "When working with sustainability experts from the finance industry, you always notice the big difference it makes if they're approaching sustainability from a purely financial perspective, or if at some point they've also tackled the physical and chemical realities of climate change." ○

SWISS SUSTAINABLE FINANCE

Swiss Sustainable Finance (SSF) strengthens the position of Switzerland in the global marketplace for sustainable finance. The association, founded in 2014, is represented in Zurich, Geneva and Lugano. Currently SSF unites 95 members and network partners, including financial service providers, institutional investors, universities and business schools, public sector entities and other interested organisations. SSF publishes studies, organises events and contributes to education and training.

5 QUESTIONS

Frank Schimmelfennig gains new insights from "constructive failure": *"Fortunately, failing is recognised as part of the scientific process."*

1 *What do you especially enjoy about this field of research?*

European integration is a process of political organisation unprecedented in history; a unique political experiment, the outcome of which is still undecided. I'm fascinated by the various tensions in this process: between democracy and technocracy, sovereignty and supranationality, national identity and European solidarity. And I am deliberately speaking not only about the EU, but also about "European integration", which Switzerland is closely involved in as well.

2 *Are there any areas in which your work hasn't been a success?*

Almost all of them, and multiple times! Applications, research proposals, publications, keeping appointments, providing persuasive answers to research questions, understanding theories and methods, realising teaching goals – and probably answering this question, too. The great thing about my career is that failure is a recognised part of the scientific process, and that new insights and opportunities emerge from "constructive failure" time and time again.

3 *What would you change about today's world of academic research if you had the chance?*

Frank Schimmelfennig is Professor of European Politics at the Center for Comparative and International Studies.
→ www.eup.ethz.ch

It wasn't necessarily any better before. But what bothers me is seeing a good idea evolve into something else. One example is large academic conferences. I think the time and effort put into them is no longer proportionate, when all you get out of it is full tills for the organisers and tourism experiences for the participants. I get my most helpful feedback in smaller workshops.

4 *How would you characterise a "modern" scientist?*

One who works in a team with flat hierarchies and mutual support, or in a research group rich in diversity with an international dimension; one who has freedom and accountability early in the process of selecting and carrying out projects. In other words, no "premodern" authoritarian relationships, as I myself experienced as a doctoral student, but also no "postmodern" randomness. Research groups at ETH tend to be "premodern" in their formal structures, and it is up to the professors to interpret them in a "modern" way.

5 *If you could swap jobs with someone for one week, who would you choose?*

I would love to get a different perspective by going from academic political observer to active participant in political decision-making processes. If I were the foreign minister of a small EU member state, I could see how realistic my ideas about European politics are, maybe suggest a couple of ideas – all without causing too much damage.

– Interview conducted by Corinne Johannssen

Image: Giulia Marthaler