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GLOBE

NO.
2/2022

Beauty & science

What unites them, what divides them – and how they complement one another 12

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EDITORIAL

BEAUTY AND KNOWLEDGE

At its core, science is about knowledge, not beauty. Yet there are myriad examples of the ties that bind beauty and science: researchers seeking brilliant solutions and devising elegant structures, forms and colours, or scientists playfully engaging with the aesthetics of space and drawing inspiration from the beauty of nature. This issue of *Globe* reflects on this complex relationship, highlighting both the beauty of science and the science of beauty.

Architects and engineers, for example, spend much of their time seeking a balance between aesthetics and functionality, which raises questions about beauty as an end in itself. Not all beauty is visible, however. Genomes, the blueprint of life, remain hidden to the human eye – and the mathematical formulae we use to describe scientific theories have a simple aesthetic all of their own. In fact, the ability to represent scientific data in a visual form plays a vital role in every discipline, both as a means of gaining scientific knowledge in the first place and as a method of communicating it to the public. Yet, however seductive beautiful images may be, we must always be sure to maintain a critical distance.

This issue of *Globe* is the last with Martina Märki at the editorial helm. Having spent a remarkable 29 years setting the course of our ETH magazine, she is now ready to enjoy a well-deserved retirement. I wish you all the very best for the future, Martina. And I hope all our readers enjoy this issue of *Globe*!

Joël Mesot,
President of ETH Zurich

Globe, the magazine for ETH Zurich and ETH Alumni

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Images: Daniel Winkler (2)

NEW + NOTED

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NEW + NOTED

Image: ETH Zurich

The male of the tropical butterfly species *Cynandra opis* served as the model for the 3D-printed structural colours.

Structural colours from a 3D printer

The wings of the butterfly species *Cynandra opis*, native to tropical Africa, shimmer with brilliant colours. This is a phenomenon known as structural coloration, whereby very finely structured surfaces scatter visible light. This differs from the effect of "everyday" colours, which are the result of light-absorbing pigments. A research group led by ETH professor Andrew deMello has now succeeded in reproducing the nanostructures that make up the surface of a butterfly wing. Their work, which makes use of a 3D printer, has created an easily applicable principle for replicating the textured surfaces that produce structural colours.

In the case of *Cynandra opis*, the structured surface consists of two superimposed lattices positioned at right angles to one another. Geometric patterns like these lend themselves particularly well to replication by means of 3D printing. By varying the spacing between the lattices and the height of the lattice rods, researchers were able to vary the colours produced. They succeeded in generating structured surfaces with a range of materials, including a transparent polymer. This is the first time that structural coloration across all the colours of the visible spectrum has been achieved with a translucent material.

As part of the study, the scientists created a minuscule image measuring 2 by 2 micrometres and made up of structural-colour pixels of different hues. Such mini images could one day be used as a security feature on banknotes. This process could also be used to produce nanostructures over a larger surface area, making it suitable for the manufacture of high-resolution colour displays. Conceivably, structural colours could even replace the pigments used in printing and painting. After all, they do not fade when exposed to light and, as a rule, have a better environmental footprint. ○

A new dimension in organelle transplantation

Mitochondria are the tiny powerhouses responsible for energy production in cells. A research group led by ETH Professor Julia Vorholt has now developed a new method for transplanting these organelles from one living cell to another with an unmatched survival rate.

Using a nanosyringe developed for another project, the team removed mitochondria from a living cell and transplanted them into a recipient cell. The position of the nanosyringe is controlled by laser light from a converted atomic force microscope. A pressure regulator controls the flow rate, enabling the injection of incredibly small volumes of liquid in the femtolitre range – a millionth of a millionth of a millilitre – during organelle transplantation. Over 80 percent of the transplanted mitochondria survive the procedure and are accepted by the host cell.

This new technique will give rise to applications in various areas of research. Conceivably, it could be used to rejuvenate stem cells, which exhibit a decline in metabolic activity with increasing age. The research team, however, is pursuing other plans. They hope to understand the processes that control how different cell compartments cooperate – and to unravel how cell organelles have developed as a result of evolution. ○

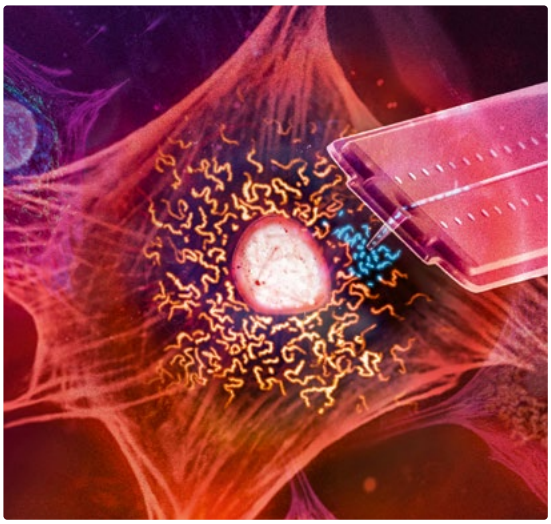


Illustration: Sean Kilian

Using a nanosyringe, mitochondria (blue) are removed from a cell.

Helping robots feel more human

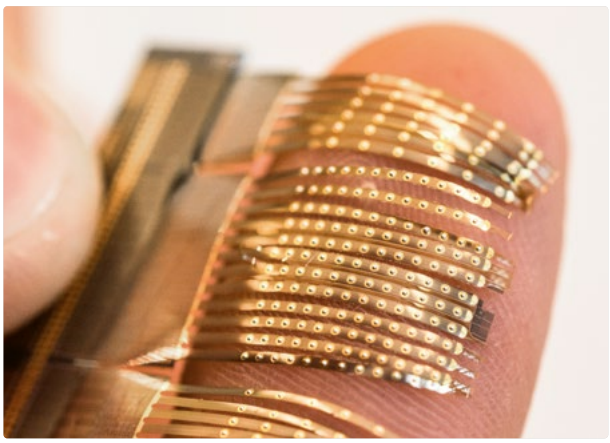


Image: ETH Zurich / Johannes Weichart

The pliable skin can be mounted onto any surface.

Doctoral student Johannes Weichart is developing an artificial skin that emulates the tactile sense in a human finger. If all goes to plan, this could soon be endowing robots with the ability to touch and feel. Much like its human equivalent, Weichart's robot skin is equipped with an array of sensors. Each of these sensors consists of two conductive layers and a small bead. When pressure is applied to the bead, the gap between the two layers changes – and, with it, the signal measured by the sensor at this particular point.

Half of the beads are equipped with three electrodes rather than one. This means they can measure not only the amount of force applied to the bead at a precise point but also the angle of application. The result is a much more nuanced sense of touch. On the strength of his promising project, Weichart was among the nominees for this year's Spark Award. ○

Filter and block cookies automatically

Image: Adobe Stock

The new extension identifies, categorises and filters cookies automatically.

Studies have revealed that cookie-consent banners can give users a false sense of control over their data. Websites employ various tricks, such as designing banners that encourage users to unwittingly accept all cookies, or failing to give a proper explanation of what cookies are and how they work – or to declare their use at all. To counter this problem, an ETH research group led by Professor David Basin has developed a browser extension that automatically categorises and deletes cookies. Cookieblock uses machine learning to classify cookies into four data-protection categories: essential, functional, analytics and advertising. After installing the browser extension, users can simply state which types of cookies they wish to allow. Cookieblock will then take charge of deleting all other cookies, irrespective of any cookie-consent banners. Cookieblock is available for the following browsers: Chrome, Firefox, Edge and Opera. ○

Simulation of foam formation

Image: ETH Zurich / Harvard University / CSCS

Realistic simulation of foam forming in rapids.

Whether atop a cappuccino or at the foot of a waterfall, foam is something we're all familiar with. Yet creating a realistic simulation of foams has proved almost impossible, even with the help of supercomputers. Now, however, a research group under the leadership of Petros Koumoutsakos, professor at ETH and Harvard, has shown how this can be done. With the existing method, the requisite computing power increases proportionally to the number of bubbles in the simulation, meaning that even today's supercomputers soon run out of steam. Thanks to the incorporation of a smart new algorithm, however, it is now possible to model foam with thousands of bubbles – i.e., on a scale that is relevant for industrial applications. With the help of Piz Daint, the supercomputer at the Swiss National Supercomputing Centre (CSCS), researchers have been able to create a realistic simulation involving an unprecedented total of 20,000 bubbles, all interacting – but not coalescing – with one another. ○

Image: Marco Tranzatto

Guest of honour

ANYMAL ○ Following two pandemic-related rain checks, Zurich's Sechseläuten spring holiday was once again on the calendar this year. Highlight of the traditional celebrations is the guilds' parade to Sechseläutenplatz, the city's largest square, where the Böögg – an effigy of a snowman prepared with firecrackers – is ceremonially burned at 6 p.m. According to modern legend, the faster the Böögg's head explodes, the better the weather will be in the coming summer months. Among an illustrious roll call, which included Swiss President Ignazio Cassis and Mayor of Zurich Corine Mauch, this year's guest list also featured – to the delight of assembled crowds – a large robotic dog named ANYmal. Developed by ETH Zurich's Robotic Systems Lab, ANYmal moves autonomously on one or two pairs of wheels and can even negotiate off-road terrain. On the other hand – despite featuring an impressive array of technology – ANYmal has absolutely no influence on this summer's weather! ○

A video from the Robotic Systems Lab can be viewed at: youtu.be/f4ThgxAN6Uw

→ rsl.ethz.ch

Safe and sustainable

To be more sustainable, the construction industry needs reliable service-life predictions for civil engineering structures, says Ueli Angst. He explains why it's time for a paradigm shift.

UELI ANGST is Professor of Durability of Engineering Materials in the Department of Civil, Environmental and Geomatic Engineering at ETH Zurich.

One of the inherent problems with civil engineering structures is their extremely long service life. Reliable long-term predictions are therefore essential – without them, current and future structures are at risk of succumbing to premature deterioration. The trouble is, however, that the techniques used to predict the service life of civil engineering structures are still in their infancy.

The concrete industry offers a prime example. Concrete is the most widely used man-made material and a massive emitter of CO_2, producing around three times the emissions of aviation. The concrete industry has set the goal of reducing carbon emissions to net zero by 2050, and the hunt is now on to find climate-friendly alternatives such as low-carbon cements and materials recycled from demolition sites. But which of these are actually the most sustainable in the long term?

The chief enemy of reinforced concrete structures is corrosion of the embedded steel. This is often caused by road salt that penetrates the porous concrete and attacks the reinforcement.

Corrosion is a gradual process that often remains unnoticed until it's too late. This image shows the degraded substructure of a steel-reinforced concrete bridge.

The steel then rusts, and the concrete crumbles. Corrosion is the most common form of deterioration in civil engineering structures, and one that incurs huge costs – in Switzerland, some 1,000 Swiss francs a minute in road infrastructure alone. Predictions as to the condition and safety of civil engineering structures are therefore crucial. Unfortunately, however, current models are limited in their ability to determine how reinforcing steel will corrode over time.

WRONG FOCUS In collaboration with researchers from North America and Europe, I recently published a historical review of the development of scientific methods used to predict corrosion

damage. What we found was that all existing prediction models are based on a single theoretical concept that represents the service life of reinforced concrete as a simplified two-stage process: in the first stage, corrosion-inducing agents penetrate the concrete cover; in the second stage, the reinforcing steel corrodes.

Current prediction models focus on the first phase. These models largely draw on empirical experience with earlier building materials and therefore have limited relevance to new materials. What's more, current regulations and testing methods are also based on the traditional paradigm, which means they too apply to new building materials only to a limited extent. Worse still – and most regrettably of all – these regulations often put modern, low-emission building materials at a disadvantage when it comes to real-world use.

For these reasons, I believe we urgently need a paradigm shift in how we predict corrosion. Science and engineering must focus on the corrosion itself. We need sound models that can reliably predict the actual corrosion damage and its effects on the load-bearing behaviour of a structure – models that are equally valid for both old and new building materials.

The use of better predictive models would yield great benefits. By helping us determine the right time for repairs – neither too late, nor too soon – they would enable more proactive maintenance of our increasingly ageing infrastructure.

Precise corrosion predictions also hold the key to making civil engineering more sustainable. It stands to reason that a structure's ecological footprint should be based not just on its construction but on its entire life cycle – yet it's difficult to conduct a life-cycle analysis without an accurate idea of the structure's service life.

Efforts to rapidly decarbonise the construction industry are to be welcomed. But, for all our enthusiasm for net zero, we shouldn't lose sight of the long-term outlook beyond 2050. What we build today must also be safe and durable for generations to come. Sound prediction models are essential if we are to make the right decisions for the future; with their help, we can identify which of today's promising building materials and processes are truly sustainable. ○

Read more blogposts at:
—〉 ethz.ch/zukunftsblog-en

Image: Wirestock / Adobe Stock

European-wide seismic risk analysis

Illustration: EFEHR

Updated seismic hazard map

An international team of European seismologists, geologists and engineers – led by the Swiss Seismological Service and the Group of Seismology and Geodynamics at ETH Zurich – has revised the current seismic hazard model, which has been in place since in 2013, and created the first ever seismic risk model for Europe as a whole.

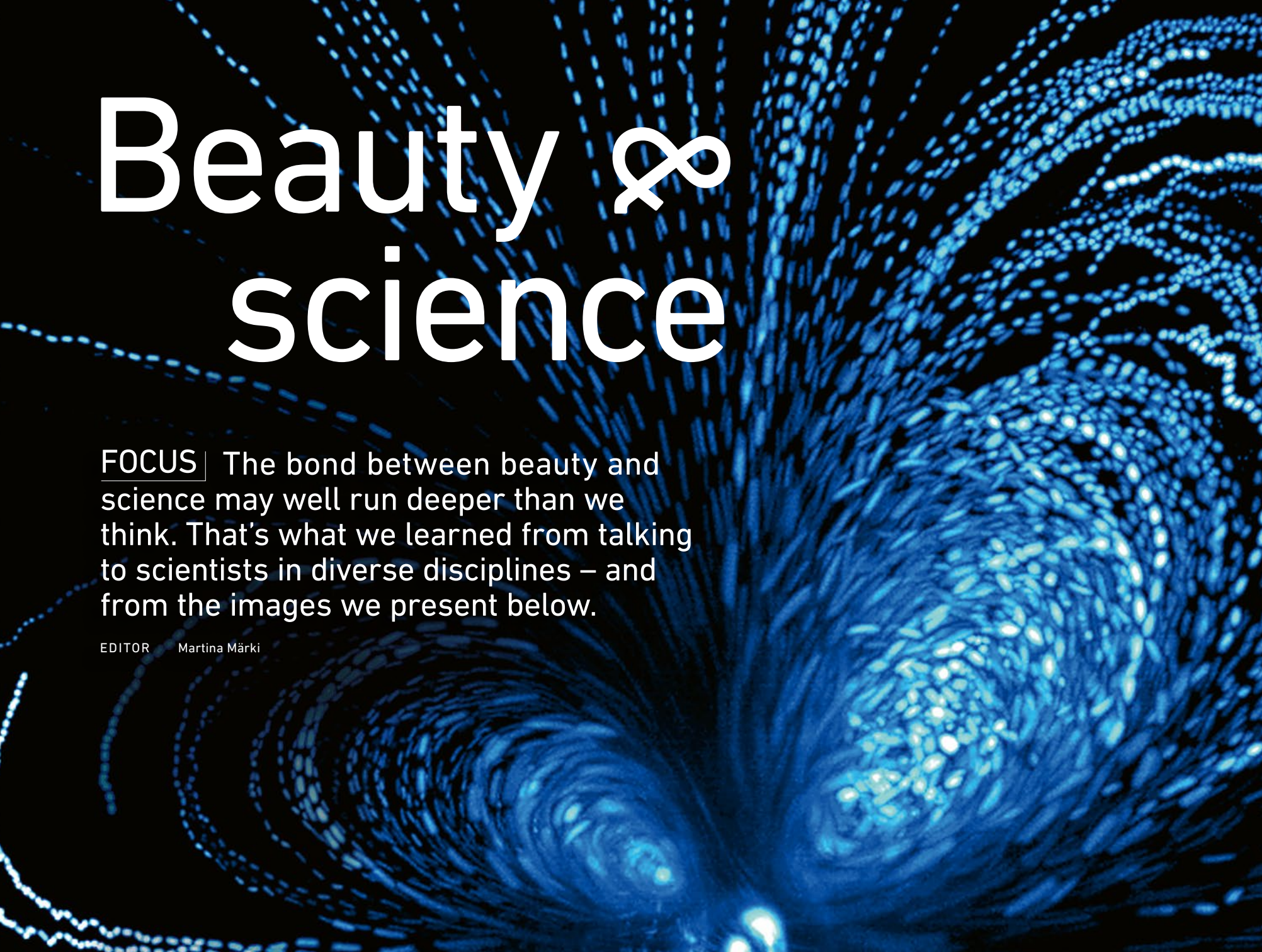
Researchers have updated and harmonised all the datasets underpinning the seismic hazard model – a complex undertaking given the huge amount of data and highly diverse tectonic settings in Europe. Larger datasets have been incorporated in the revised version of the model, thereby facilitating a new and more extensive assessment of earthquake hazards across the continent. Compared to the 2013 model, estimates of seismic activity have been dialled down for most parts of Europe – with the exception of areas in western Turkey, Greece, Albania, Romania, southern Spain and southern Portugal, where estimates have increased.

The updated model confirms Turkey, Greece, Albania, Italy and Romania as the countries most exposed to seismic hazards in Europe. ○

Beauty & science

FOCUS | The bond between beauty and science may well run deeper than we think. That's what we learned from talking to scientists in diverse disciplines – and from the images we present below.

EDITOR Martina Märki



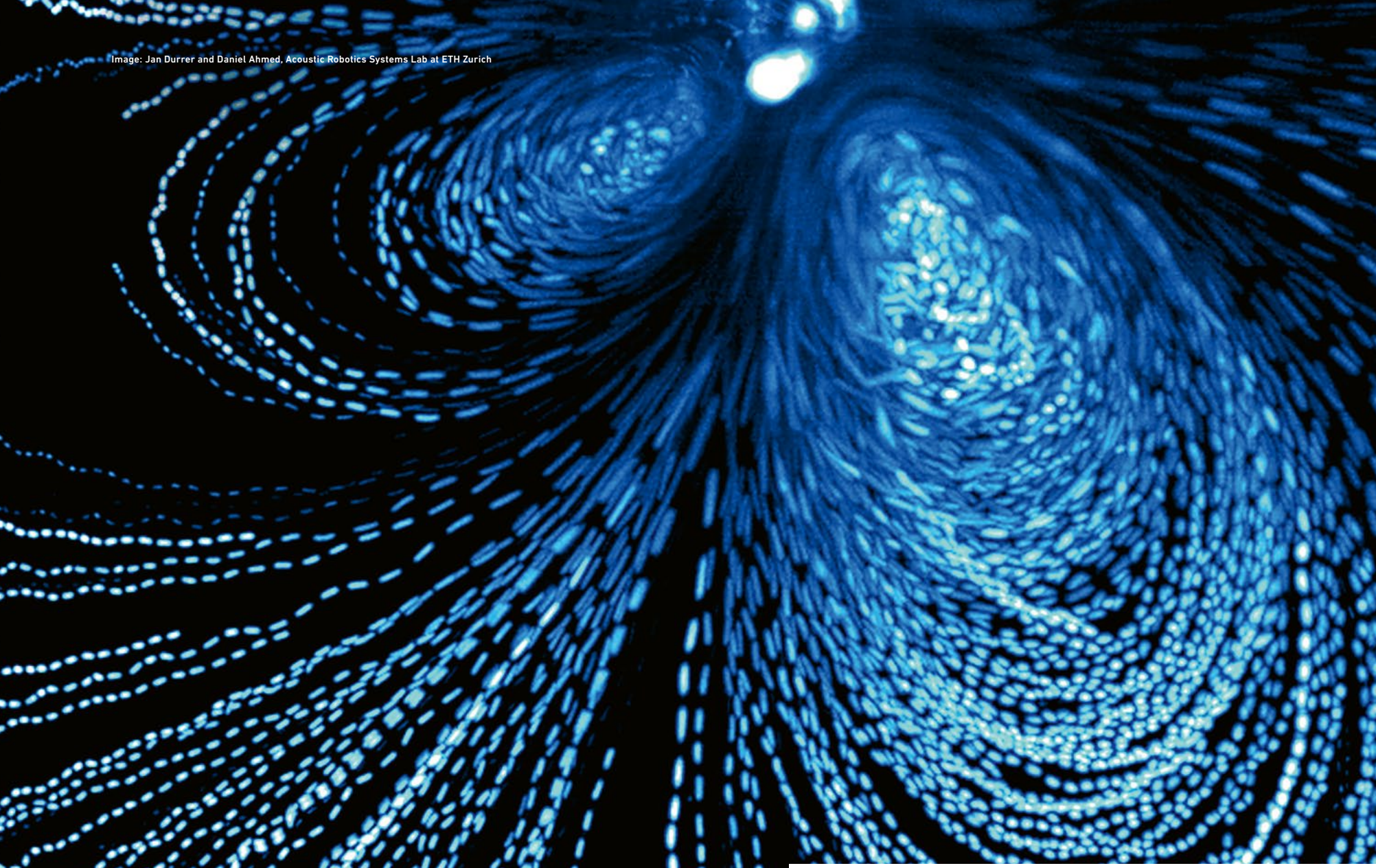


Image: Jan Durrer and Daniel Ahmed, Acoustic Robotics Systems Lab at ETH Zurich

PICTURING SCIENCE Research into waves and fluid dynamics can produce pictures of immense beauty. This butterfly pattern, for example, shows tiny tracer particles in water right after they have been shocked into motion by a pulse of ultrasound. ETH researcher Jan Durrer submitted the photo to the SNSF Scientific Image Competition of 2021. Two researchers from the Collegium Helveticum take a closer look at the role of the visual in science. Page 27

ARCHITECTURE AT THE CROSSROADS? Consolidation is the new buzzword in urban planning. But can this still give rise to beautiful design? And what do architects and city dwellers make of the conflict between densification and aesthetics? *Globe* accompanied two ETH architects on a stroll to the Grünau estate in Zurich's Altstetten neighbourhood. Page 18

Image: Marcel Rickli

Image: Stocksy

BIODIVERSITY The beauty of the world's coral reefs never fails to amaze. Yet behind such splendour, there lies much more – namely, a diverse habitat for a host of marine life. With complex ecosystems under acute threat from environmental pressures, ETH researchers are taking a closer look at the manifold purposes of biodiversity. Page 22

THE MAGIC OF FORMULAE Nature proffers many examples of symmetry, including the perfect helix of a snail's shell. Mathematics has the tools to describe this form of beauty but also possesses an elegance of its own.
Page 30

Image: gettyimages

Image: Giulia Marthaler

THE SECRET OF COLOUR ETH researchers have imprinted the surface of pralines with a specific pattern that splits incident light into the spectral colours. This makes the chocolate shimmer in beautiful rainbow hues – without the addition of any chemical substances. Yet there is more to colour than just a beautiful appearance. Page 25

Calculate or

FOCUS | Beauty may be in the eye of the beholder – yet how do we find consensus on a shared amenity such as a neighbourhood? We took a stroll with two ETH architects to discover how they see their role as mediators between the conflicting priorities of urban consolidation, functionalism and aesthetics.

TEXT Stéphanie Hegelbach
IMAGES Marcel Rickli

A huge map is spread out on the floor in front of us, populated by neat paper models connected by coloured threads and arrows. It's a new world in the making – and a whole new imagining of Zurich's Altstetten district. We're standing in the Design in Dialogue Lab at the NEWROPE Chair of Architecture and Urban Transformation, where Professor Freek Persyn and his students are seeking to gain a better understanding of Altstetten and the dynamics of urban densification. "The Lab is a place where we can engage with stakeholders who are actively involved in the transformation of this district – from neighbourhood associations, residents and developers to allotment holders and architects with alternative ideas. That helps us see Altstetten from different angles," says course leader Lukas Fink. The city of Zurich's urban development plan argues that Altstetten offers significant potential for densification – and Freek Persyn agrees: "I wouldn't describe Altstetten as metropolitan yet, but that's definitely where it's heading." One of the priorities in his studio is to build up a common understanding of the district and discuss what development makes sense in this context. "Densification isn't just about the numbers; it's also about how we create new connections and tie new developments to what's already there," says Persyn.

For Sibylle Wälty, however, numbers are key: the ETH doctorate holder has come up with an empirical formula for the most effective degree of densification. She determined what a compact urban area would need to look like to enable people to fulfil most of their daily needs within a short distance of their homes. The result of her work is the "10-minute neighbourhood", a district with good public transport links that increases the likelihood of people not having to walk more than 10 minutes between their home, their workplace and local amenities. "It's about curbing urban sprawl, giving residents the freedom to reduce their dependency on cars, and finding ways to sidestep many of our current infrastructure and traffic problems," says Wälty.

But what are the key things to bear in mind when it comes to densification? And what role do aesthetics play? With the two architects by our side, we set off to explore Altstetten and Brupbacherplatz – Zurich's only 10-minute neighbourhood.

co-create?

Sibylle Wälty and Freek Persyn under the Europa Bridge

Our first stop is the Europa Bridge. This is the kind of infrastructure that forges important links in the urban landscape, but it also represents a headache for urban planners. Often constructed out of concrete in a brutalist style, such connecting infrastructure challenges traditional concepts of beauty and provokes heated debate, particularly in regard to the inhospitable "non-places" it often creates.

SIBYLLE WÄLTY: A key issue with any bridge is what you put underneath it. Often, the best idea is to find a practical use, like the parking spaces and fenced-in storage area you see here.

FREEK PERSYN: The area under this bridge is also popular with joggers. Some people treat it like a park leading to the Limmat river. It's not simply a non-place – it can actually be really important to local residents.

WÄLTY: Absolutely. Locals sometimes see things quite differently to visitors. People from the outside often dismiss brutalist structures as ugly.

PERSYN: I think that's because it can be hard to recognise the beauty of infrastructure. These are complex places, and learning to appreciate them takes time. One of the questions we ask in our studio is how infrastructure can be transformed into a collective space. There's a project in Belgium that opens up infrastructure for other uses on Sundays. Those kinds of temporary projects can really benefit a neighbourhood.

WÄLTY: What I find counter-productive is the current trend of simply eliminating parking spaces. Cars bring people into a neighbourhood; shops and service providers depend on that for their survival. Parking spaces should only be turned into green zones in neighbourhoods that already have a sufficient number of residents to sustain them.

We stroll across anonymous green spaces sandwiched between main roads and flyovers, which will soon be home to Altstetten's new school. Behind a row of trees, a group is practising archery. We also spot a disc golf basket which, set against ⟶

the massive dimensions of the infrastructure, illustrates the conflicting scales in Altstetten. In the background – wedged between the motorway, the Limmat river and the Europa bridge – are the high-rise buildings of the Grünau estate, which form a microcosm of their own.

WÄLTY: Grünau is a typical 1970s housing estate. It has a restaurant and a kiosk on the ground floor, but the 1,200 residents of Grünau don't generate enough demand for there to be a wide range of choice.

PERSYN: The problem is that these services don't lie on the routes people take. If you always drive into the underground car park, you'll never even pass this spot!

WÄLTY: You need to have an adequate flow of people, and that requires the population and employment density of a 10-minute neighbourhood. Grünau simply isn't dense enough, whatever impression the high-rise buildings might give.

PERSYN: Personally, I think the Grünau estate is lovely – a really spacious world of its own. We mustn't fall for the kind of prejudices that might lead us to tear down places like this. They have qualities of their own that challenge our preconceived ideas. Another thing we do in our studio is to analyse residential areas and the routes pedestrians take; that tells us where people meet and how public spaces function.

WÄLTY: If we fail to densify underused locations with good public transport links like Grünau, the result will be even greater urban sprawl. The city of Zurich recently adopted a net-zero target for 2040 that includes making more efficient use of land. This calls for at least 10,000 inhabitants within a 500-metre radius, plus a 2:1 ratio of local residents to full-time workers. With 10,450 employees working within a 500- metre radius and just 3,300 local residents, Grünau is a long way off meeting the minimum requirement; this has a negative impact on traffic, land usage, CO_2 emissions, property prices and segregation.

PERSYN: To me, those figures feel like an over-simplification. We need to ask ourselves what qualities we want to preserve and strengthen. When we talked to residents on the Grünau estate, they said they like how it feels like an island; they appreciate that sense of community.

WÄLTY: Spatial planning is about more than just the people who live on an estate; it's also about society, the economy and the environment beyond. It's a false assumption to say that transforming a neighbourhood will necessarily make it worse.

Densification projects have a big impact on residents' lives, yet most of them involve zero dialogue between the developers and local people. We continue walking until we reach Lindenplatz, which is a meeting point for several social subgroups.

High-rise buildings on the Grünau estate

"Grünau simply isn't dense enough, whatever impression the high-rise buildings might give."

Sibylle Wälty

These are at risk of being displaced by the nearby development projects.

PERSYN: I remember a student saying that a clean Lindenplatz isn't a real Lindenplatz! Some places defy our conventional understanding of beauty; by doing so, they provide a niche for certain user groups.

WÄLTY: If the Rosengarten tunnel project had been approved, for example, noise levels would have plummeted, and the housing would have attracted a whole different clientele.

PERSYN: When conditions change, we always need to ask who stands to benefit. Paradoxically, when we invest less and embrace reuse, we sometimes end up benefiting a marginal group.

WÄLTY: Reuse is the key for all resources, including land. We can't let spatial planners ignore the option of densification in central locations. Housing that is close to jobs, leisure facilities and good public transport is in short supply, and that's why property prices are going up. Urban planners need to take a long-term perspective by analysing and calculating socio-economic factors.

PERSYN: It's not easy to frame this kind of problem. This is the reason why we developed the design-in-dialogue method. We want to examine our role in the process, channel conflict into productive dialogue, and learn together as we go, because everyone – especially local residents – has something to contribute.

WÄLTY: I believe in making the calculations and discussing things before putting anything into practice. And if the discussion prompts new ideas, then I run the calculations again! That way you end up with a framework for a long-term vision that has everyone's support.

The figures add up in the Brupbacherplatz neighbourhood, says Wälty, where 16,000 people live and 9,300 work within a 500-metre radius. This is the only location in the greater Zurich area that meets the minimum requirements for a 10-minute neighbourhood. We arrive to see people already queuing at the Gelateria di Berna. This is a typical Zurich family neighbourhood for the well-heeled: colourful flags fluttering in the breeze, Danish designer bicycles and a mother with a pram and dog. So could this be considered the ideal neighbourhood?

PERSYN: I think the 10-minute neighbourhood is an interesting idea that can make people think. But it's not a one-size-fits-all solution, because urban spaces are simply too diverse. What's more, proximity – i.e., the distance we're happy to move on a weekly or monthly basis – means different things to different people.

WÄLTY: Local amenities still don't get the consideration they deserve; we should be tailoring spatial-planning measures to each individual location. What's missing is a genuine understanding of how spatial planning is connected to traffic, land use, segregation and property prices. I run an association called WALK10min, which seeks to raise awareness of this issue. Neighbourhoods should be designed in ways that enable us to carry out all our everyday activities on foot. As well as making us healthier and reducing our medical insurance bills, that would also cut down the need for infrastructure.

PERSYN: I agree. And the way to get people walking is by creating a pleasant and stimulating environment.

WÄLTY: Right. For example, you can use ground-floor premises in more diverse ways to increase pedestrian footfall and make the neighbourhood livelier. That makes places more appealing.

PERSYN: That's exactly the kind of thing we should be scrutinising more closely. Ground-floor premises don't have to be commercial – they can also be social. It's the same with our idea of beauty: in reality, it's just one among many values. We should also be thinking about criteria such as orientation, suitability and climate – and we should be making those values just as explicit as the solution. The 10-minute neighbourhood represents a certain set of values that we need to communicate to people. And we need a new culture of spatial planning that is able to weigh up and connect these values.

Calculate or co-create? The two architects agree that both are necessary for designing dense neighbourhoods that people actually enjoy living in. But Persyn is quick to point out a Swiss trait that often gets in the way: "It's the fear of conflict that leads to micromanagement – yet conflict can teach us so many valuable lessons." ○

FREEK PERSYN is Professor of Architecture and Urban Transformation and Head of the Institute of Landscape and Urban Studies. He is co-owner and founding partner of the architecture firm 51N4E in Brussels.
⟶ lus.arch.ethz.ch

SIBYLLE WÄLTY researches and teaches at ETH Wohnforum - ETH CASE. Her teaching on the MAS | CAS Future Mobility programme focuses on 10-minute neighbourhoods.
⟶ wohnforum.arch.ethz.ch/en

Both are part of the FCL Global project Dense & Green Cities, led by Sacha Menz, where they investigate the transformation and densification of Altstetten.

The beauty and

Image: FiBL, Véronique Chevillat

Natural meadows exhibit high levels of diversity.

benefits of biodiversity

Biodiversity is beautiful, but it's also vitally important. ETH researchers are getting to the heart of how species diversity and genetic diversity evolve – and why we must fight to preserve them.

TEXT Peter Rüegg

Spring is synonymous with bright yellow dandelions, lush green fields and cloudless blue skies, a captivating combination of colours that sends many people into raptures of delight. Yet biodiversity researchers such as Alex Widmer, Professor of Plant Ecological Genetics in the Department of Environmental Systems Science, take a rather different view: "I know too much about ecosystems to take any pleasure in something so monotonous," he says. His notion of beauty tends more towards dry grasslands and natural meadows rich in different species. "A far cry," he says, "from the picture-postcard idyll." He argues that such areas are beautiful in much less obvious ways. Unfertilised, minimally cultivated meadows and dry grasslands are incredibly diverse, he says, which makes them not just beautiful, but essential. "Species diversity makes ecosystems resilient," says Widmer, "and at the core of that resilience is genetic diversity." Without genetic diversity, he explains, species and organisms cannot adapt to existing and evolving environmental conditions. And it's this adaptability that lies at the very heart of speciation.

Loïc Pellissier, Professor of Ecosystems and Landscape Evolution in the Department of Environmental Systems Science, agrees that much of the beauty of biodiversity is hidden from view. One of the most beautiful aspects of biodiversity, he says, is how species co-evolve and exist together. "All organisms have evolved to interact with each other, as anyone who works in species diversity will tell you. To me, ecosystems are like huge jigsaw puzzles, in which all the pieces fit together more or less perfectly." His research focuses on how species diversity arises and evolves. Because this occurs over the course of millions of years, Pellissier relies on computer models to simulate geological processes and the evolutionary forces that lead to the formation of new species.

GENETIC DIVERSITY Pellissier also conducts numerous field projects to unlock the secrets of species diversity. He favours a new and increasingly popular method that enables ecologists to detect species and organisms from the DNA they leave ⟶

behind in the environment – known for short as environmental DNA, or eDNA. Researchers simply collect water and soil samples and analyse them to see what genetic material they contain. They then match whatever DNA they find to the corresponding organisms, provided a reference is available for this. This method provides a relatively quick way to determine whether a species is present in an ecosystem or not – and it works for a wide variety of organisms. "eDNA gives us a new insight into an ecosystem's diversity," he says.

Recently, Pellissier co-authored a study on the diversity of reef fish worldwide. Researchers collected over 200 seawater samples from various tropical coral reefs and then "fished out" whatever fish DNA they could find. Using the eDNA method, it took the researchers less than two years to confirm the presence of more fish species and families than experts had managed to identify during 13 years of reef dives.

Yet species diversity is only one aspect of biodiversity, the others being habitat diversity and genetic diversity. "Of the three, genetic diversity is the one that has been most neglected," says Widmer. "Studying and monitoring genetic diversity is much more difficult and time-consuming than monitoring habitats or species numbers." Hence the numerous inventories of Swiss plants, animals and habitats – from forests and wetlands to dry grasslands. "Yet there isn't a single monitoring project in Switzerland that focuses on the genetic diversity of living things," says Widmer, "This is despite the fact that genetic diversity is fundamental for species diversity and adaptability."

To fill this gap, Widmer has joined forces with the Swiss Federal Institute for Forest, Snow and Landscape Research WSL on a project that aims to add this crucial element to Switzerland's existing biodiversity monitoring systems. With the support of the Swiss Federal Office for the Environment (FOEN), Widmer and his colleagues have already launched a pilot study of five different species, including two plant species, a butterfly and a toad. The fifth species in their study is the yellowhammer, a songbird commonly found in cultivated areas of Switzerland. The researchers have already sequenced the genomes of one hundred individual yellowhammers from right across the country.

As well as working with living organisms, the researchers also study the genetic material of specimens held in collections. "This tells us whether populations from over 100 years ago were as diverse as today's, or whether some of that genetic diversity has been lost," says Widmer. Research into biodiversity in Switzerland has already revealed a sharp decline in species diversity, he notes: "We'd like to find out whether the same applies to genetic diversity." Once the pilot study is complete, Widmer's goal is to set up a large-scale monitoring project encompassing up to 50 species. These would be examined at regular intervals to detect changes in their genetic diversity. However, it is still unclear whether this complex and ambitious project will receive the necessary funding.

FRAGILE AND ENDANGERED BEAUTY Time is of the essence, because biodiversity is under threat and declining rapidly. It is only by firmly fitting together the many different pieces of the biodiversity puzzle that we can slow the extinction of individual species. Reduce this network by half, and species will die out a thousand times faster – and when external pressures such as climate change are factored in, species extinction will occur a thousand times faster again.

"Biodiversity is essential to our lives," says Widmer. "It impacts everything from our mental well-being to whether we have food on the table." Diverse ecosystems are much more stable and better geared for the future than monotonous, species-poor habitats. Pellissier nods in agreement: "Biodiversity is like classical art in the sense that it can't be replaced. If the earth loses its biological riches, it will lose its magic." ○

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ALEX WIDMER is Professor of Plant Ecological Genetics in the Department of Environmental Systems Science. He conducts research into evolutionary processes and biodiversity.
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Colour vision

Colours can be created in surprisingly different ways. And in addition to being pleasing to the eye, colour can also serve a useful purpose.

TEXT Corinne Johannssen

"Asking why chocolate is brown is like asking why the sky is blue," says Ralph Spolenak, Professor of Nanometallurgy in the Department of Materials at ETH Zurich. In both cases, particles scatter the light in such a way that only a certain part of it reaches our eyes: particles of cocoa powder make chocolate appear brown, while air molecules make the sky look blue. Particles are also responsible for a colour's intensity: the higher the cocoa content, the more the cocoa particles will influence how the light scatters, and the darker the chocolate will appear.

Henning Galinski, a physicist in Spolenak's research group, has been delving into the science of chocolate. "We were focusing on the optical properties of chocolate and wanted to find out if we could change the colour of chocolate without adding any extra ingredients," he explains. To answer this question, Galinski worked closely with ETH research groups in Complex Materials and Food Process Engineering and with the University of Applied Sciences and Arts Northwestern Switzerland.

The team started by studying the effects of both scattered and reflected light. Unlike scattering, reflection occurs when a ray of light is reflected at a fixed angle after striking a surface such as a piece of metal or a mirror. "We imprinted a specific pattern on the surface of the chocolate to create a diffraction grating, which bends the reflected light," says Galinski. The nanostructured pattern splits the incident light into its spectral components, causing the chocolate to shimmer in beautiful rainbow hues without any coatings or chemical modifications.

VISIBLE TO THE NAKED EYE "Beauty is in the eye of the beholder, but I think the iridescent chocolate looks great!" says Spolenak. Yet colours are more than just easy on the eye. They can also be used ⟶

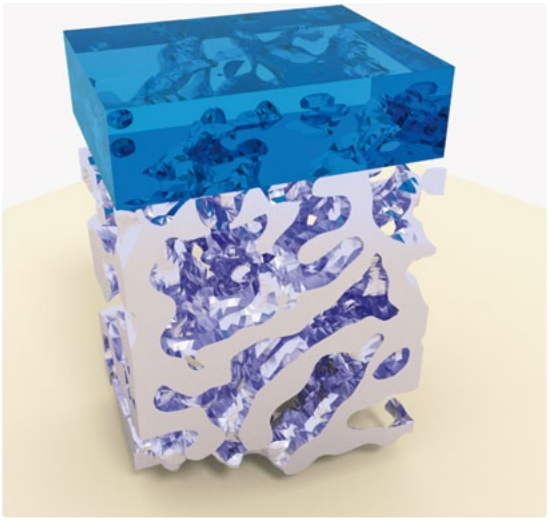

Image: Galinski et al. 2016, digitally modified

The colour of the material is determined by the thickness of the upper layer.

to make objective observations. "We wondered whether we could use colours to gauge a material's properties," Galinski explains. For example, could they serve to signal how the hardness of an alloy changes when it gets hot?

Galinski offers the example of a wind turbine. If the turbine overheats, this could damage the material and make it unstable. But using helicopters to monitor turbines in offshore wind farms is a costly and time-consuming business. "We developed a system to continuously monitor changes in a material's properties using a simple optical measurement," says Galinski. "We were able to use changes in colour to directly indicate changes in a material's hardness or its electrical resistance."

Galinski cites a further example. In a joint project with Empa, ETH researchers applied the same sensor concept to textiles. "We gave the textile fibres a thermochromic coating that changes colour when the material is damaged by heat," he explains. This kind of visual warning could mean the difference between life and death for people who are regularly exposed to hazardous situations, such as firefighters. When materials such as ropes or garments overheat due to fire or friction, this impairs their function. The change in colour warns users that the item is damaged and should no longer be used.

These examples show how colour can be harnessed as a sensor system to monitor functionality. "After all, we humans constantly use colour to assess our surroundings. When we see a red traffic light, for example, we know it means 'stop'," says Galinski. The researchers are building on the same principle, as Spolenak explains: "In reality, the damage to the material is microscopically small, but our colour-coating system amplifies the effects, making them visible to the naked eye." The system used on the textile fibres consists of multiple coatings. However, only the uppermost layer – which is just 20 nanometres thick – reacts to temperature by crystallising and changing colour.

LESS MATERIAL, MORE LIGHT "We're also interested in how light interacts with larger surfaces, specifically in relation to thin coatings," says Spolenak. Developments in this area could be a game-changer: if scientists could find a way to capture lots of light in a small amount of material until the light is completely absorbed, this could have huge benefits for solar cells and other materials used in the energy industry. "If we can take the same method of concentrating light that we use to create colour and make it work in a small volume of material, then the efficiency will be very high," says Galinski.

Recently, Spolenak's group developed a principle for using nanoscale networks to capture light efficiently. These networks, which are made of a special alloy, enable the absorption of up to 99 percent of the light – at practically any angle of incidence.

A few years ago, the group collaborated with an international team of researchers. Together, they successfully developed a principle for producing metal coatings in different colours. The coating consists of a special microstructure made up of two different layers. The bottom layer comprises a network of metals permeated by tiny pores, while the upper part of the coating is a thin oxide layer. The colour is produced primarily through the interaction of light with the disordered interface between the two materials. The thickness of this interface region determines the colour; for example, 12 nanometres gives the material a green tone, 24 nanometres makes it yellow, and 48 nanometres makes it blue.

Claudiadele Polinari from Rämibühl secondary school also produced structural colours as part of her baccalaureate paper. Rather than creating just a few individual colours, she set out to obtain the broadest possible palette. The green tones pushed the young researcher's dual-layer principle to its limits. Nonetheless – or perhaps as a consequence – she learned a great deal during her short research visit at ETH. Some of her many successful colour specimens were framed and now hang on the wall above the meeting table – a striking example of how research results can provide a real visual treat! ○

RALPH SPOLENAK is Professor of Nanometallurgy in the Department of Materials at ETH Zurich.

HENNING GALINSKI is a Senior Scientist in Ralph Spolenak's research group.
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The fascination of images

Images play an important role in science and science communication. They have always held a powerful appeal, but the means of producing them – and the notion of how they should reflect reality – continue to evolve over time.

TEXT Martina Märki

Asked about the role that beauty plays in image-based science communication, Sarine Waltenspül and her research partner, Mario Schulze, confess a reluctance to use this term. Instead, the two image experts prefer to talk about the "desire for images" or the more general concept of aesthetics. "The term 'beauty' can easily come across as a universalising category," they say. "Yet images are produced in a variety of contexts and are perceived and interpreted by different audiences." In other words, they explain, we always need to ask who is looking at what, and in which timeframe and context. The duo are currently applying this question to a film about fluid dynamics as part of their project "Film, Research, Fluidity", which focuses on the epistemological implications, aesthetics and politics of moving images in the sciences. The project forms part of their fellowship at the Collegium Helveticum, an institution of ETH, the University of Zurich and Zurich University of the Arts, which encourages researchers to explore transdisciplinarity. Starting point of the project is a 1927 film entitled *Entstehung von Wirbeln bei in Wasser bewegten Körpern* (Production of vortices by bodies travelling in water) by Ludwig Prandtl, a German scientist who made several key contributions to fluid mechanics.

FROM LECTURE HALL TO FILM FESTIVAL "He harnessed the power of images and of moving images to show phenomena that could not be derived from the fluid dynamics model of the time," says Schulze. "But he was also trying to make his lectures more interesting!" And he certainly succeeded. Prandtl screened his film at conferences all over the world, and its popularity continued to grow. Under National Socialism, the film was adapted into an educational film for university students; during the Cold War, it even made its way into school classrooms. By the 2000s, Prandtl's film had shed its academic gown altogether and was appearing at film festivals celebrating experimental film and visual music. ⟶

Screenshot from the film *Entstehung von Wirbeln bei Wasserströmungen* (Formation of vortices in water currents) by Ludwig Prandtl and Oskar Tietjens, 1927.

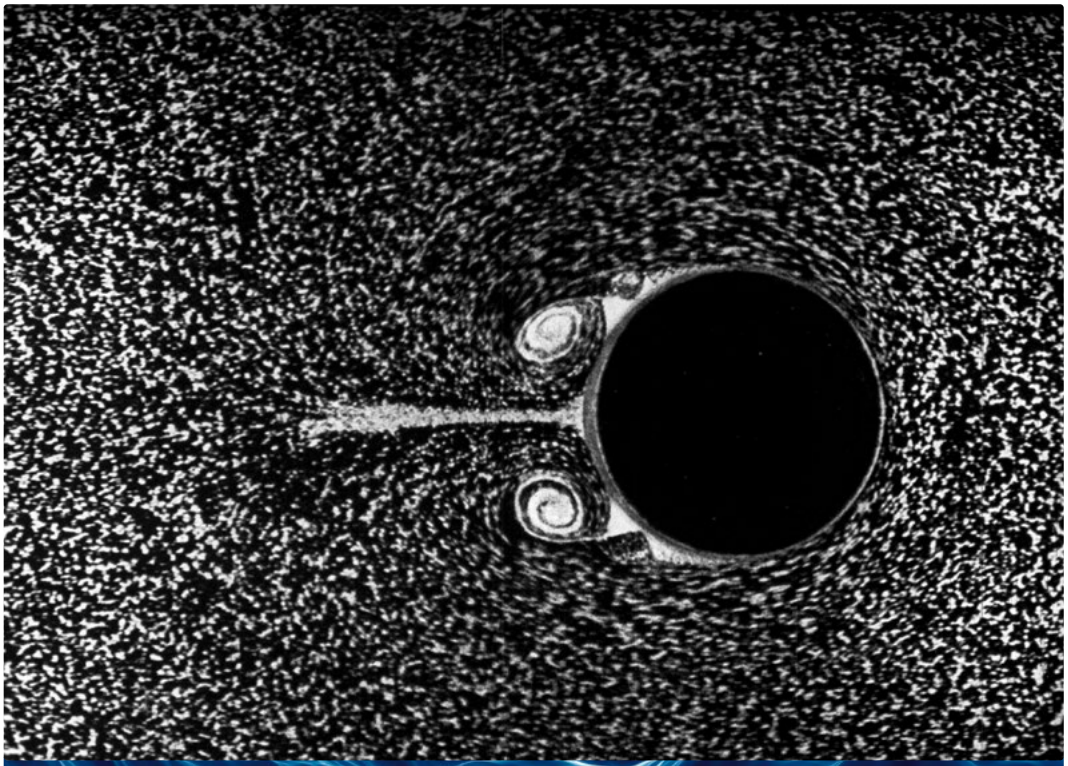


Image: Archives of the Max Planck Society, Berlin, Signature: F 152

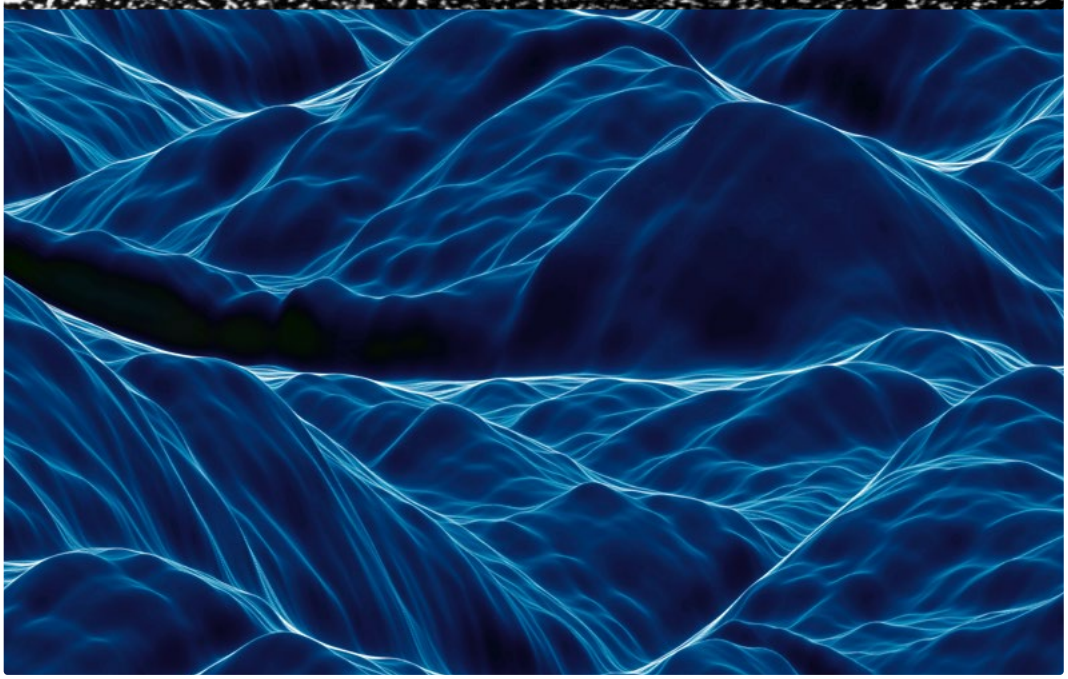


Image: Thibault Roch, EPFL

Entitled "Mountains of friction", this image creates a virtual world from a computer simulation of earthquakes. It was awarded a distinction in the SNSF Scientific Image Competition 2022.

Image: ETH Library Zurich, Rar 3384

Plant illustration drawn by botanical artist Georg Dionysius Ehret and included in the *Hortus Cliffortianus* (1738) by Carl von Linné. Ehret was initially reluctant to include the details Linné wanted because he felt they spoiled the overall aesthetic effect.

"What we see again and again is how these moving images not only present scientific knowledge but also create moments of pure fascination," says Waltenspül. Prandtl's film offers an aesthetic all of its own. Employing a powerful light-dark contrast, it shows glittering particles set against a dark background and flowing around simple geometric bodies such as cylinders and pyramids. "The images are very abstract and clear, but they also have a kind of rhythm to them, almost a musicality," she says. "They are precise and, in many cases, apply the golden ratio, which ties in with certain ideals of beauty." This high degree of abstraction stems from the desire to achieve scientific objectivity, says Schulze, but it also helped the film connect with a variety of audiences.

TECHNOLOGY, OBJECTIVITY AND AESTHETICS

The functional aesthetics of Prandtl's film corresponded to the scientific expectations of the age. As the techniques of photography and film began to emerge, there was a steady shift in the definition of scientific objectivity, says Schulze, referring to work by science historians Loraine Daston and Peter Galison. The goal of earlier scientific representations such as drawings and engravings was to offer a true depiction of nature and of natural beauty, with beauty and truth seen as inseparable companions. Artists and engravers allowed their aesthetic, artistic vision to colour their work. By contrast, the advent of photography and film showed how nature could be depicted in a true-to-life manner with an almost mechanical objectivity. "The question of how technology influences scientific thinking is one that arises in image production, too – and it's one that we are currently exploring in regard to image-based virtual worlds," says Waltenspül.

The emergence of new image technologies also increased the ways in which science could be made accessible to a wider audience. "Communication with images is more direct than communication with words," says Schulze. Images are part of the basic toolkit for popularising science; and, increasingly, aesthetic strategies such as attraction, beauty, novelty and surprise are deployed to capture people's attention. Hence the enthusiasm of science organisations such as the Swiss National Science Foundation and Germany's Max Planck Society for competitions to find the best science images and for exhibitions to show the winning entries. Using images to popularise science may not be new, says Waltenspül, but it is becoming more common: "Today's scientists rely more than ever on their ability to communicate and attract attention, not just within their own discipline but also across fields and with the general public." Images are an excellent tool to achieve this, as Ludwig Prandtl was one of the first to appreciate. ○

SARINE WALTENSPÜL is a Junior Fellow at the Collegium Helveticum. In 2021–22, she held the Chair of Media Aesthetics at the University of Basel on an interim basis. Prior to that, she co-led an SNSF project at Zurich University of the Arts (ZHdK), where she also lectured.

MARIO SCHULZE is a Junior Fellow at the Collegium Helveticum. For the past year, he held the Chair of Media Aesthetics at the University of Basel on an interim basis. Prior to that, he was a postdoc at Zurich University of the Arts and Humboldt University of Berlin.
—〉 collegium.ethz.ch/en

… as they search

At its heart, is mathematics an aesthetic discipline? Or what does it mean if someone finds a proof "beautiful"? And what does mathematical beauty say about physical connections?

TEXT Florian Meyer

To this day, mathematics includes beautiful facts that are also familiar to us in everyday life. The golden ratio, for example, has been revered since antiquity as representing the most aesthetically pleasing proportions. Some mathematicians claim that mathematical discoveries would be virtually impossible without an aesthetic sense. "Beauty certainly touches mathematicians' souls," says Ana Cannas da Silva, ETH Professor for Mathematics, whose main field of research is geometry. For her, mathematical and aesthetic curiosity go hand in hand. In Portugal, for example, pavements are often laid in complex symmetrical patterns which visualise mathematical phenomena. She has also authored an illustrated book on this topic, entitled "Symmetry step by step".

When asked about the meaning of beauty in mathematics, the professor says it's not just about the visuals, but also about language. She shares the view of the pioneer of modern physics, Galileo Galilei (1564 – 1642), that the universe is written in the language of mathematics.

AN INTENSE EXPERIENCE There is no fixed rule as to what constitutes mathematical beauty: "For me, the abstract quality of mathematics is the source of its beauty," says Emmanuel Kowalski, who researches analytic number theory, a branch of pure mathematics. He concedes: "Not all mathematicians see identical things as beautiful in the same way, but most personally experience the intense beauty of mathematics." Ana Cannas da Silva adds: "Perceptions of simplicity, clarity, elegance and symmetry are often associated with mathematical beauty." Even without a consensus as to what beauty actually means, mathematicians within a subcommunity tend to agree on which theorems, proofs, formulas or constructions are most beautiful in their field.

The gateway to truth in mathematics lies in the proof. Proofs are considered beautiful, or rather "elegant", if they derive their statements as directly as possible from proven, true statements, deal sparingly with additional assumptions, solve multiple problems and allow for new results. "A beautiful proof is usually concise and involves surprising new ideas. Although there are impressive results with long, technical proofs, we usually find shorter and more elegant proofs once we understand them," explains Benny Sudakov, a mathematician specialising in combinatorics.

More controversial is what makes a theory or equation beautiful. There is currently no generally accepted mathematical rule or criterion for it, and it does not come about automatically. Conversely, mathematicians often speak of beauty when a result or proof creates a new connection between two areas or statements of mathematics that at first glance have nothing to do with each other. These interconnections constitute deep relationships. Kowalski says: "My strongest aesthetic reactions in mathematics are where completely different approaches happen to meet in a

for beauty.

profound way." In such moments he experiences how closely the individual parts of mathematics are interconnected.

BEAUTIFUL EQUATIONS Because of the deep connections it shows, many consider Euler's identity to be one of the most beautiful and profound mathematical equations. It is named after the Swiss mathematician Leonhard Euler (1707 – 1783). The profound beauty of the equation $e^{i\pi}+1=0$ is due to the fact that three basic arithmetic operations occur exactly once each (addition, multiplication and exponentiation), and that it also creates a simple connection between five of the most fundamental mathematical constants: Euler's number e, the imaginary number i, the circle constant Pi, the number 1, and zero.

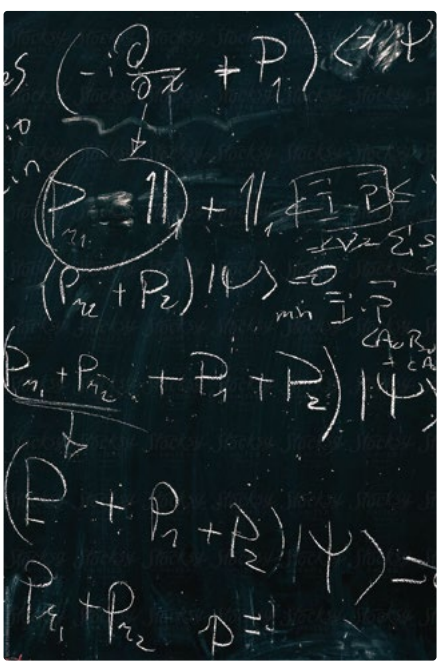


Image: ETH Zurich / D-MATH

"For me, the abstract quality of mathematics is the source of its beauty." Emmanuel Kowalski

"In mathematics, beauty can be a pointer to what is likely true," says Ana Cannas da Silva. For Emmanuel Kowalski, beauty provides an underlying principle leading to truth: "A beautiful equation allows greater confidence to take a certain approach to solving a problem. But you can be wrong, especially if you don't understand the facts well enough." Benny Sudakov points out: "Theorems with unattractive proofs are also accepted."

The question of the beauty of elegant theories and formulas is also discussed in branches of the natural sciences influenced by mathematics, such as theoretical physics. Here the path to truth is through experiments. The general relativity theory of Albert Einstein (1879 – 1955) is considered beautiful because its mathematical statements can be repeatedly measured and empirically proven. In physics, however, there are some entities that can be postulated mathematically but have not yet been measured – even using large research facilities such as particle accelerators or space telescopes. The physicist Sabine Hossenfelder has therefore challenged the assumption that the best physical theories are beautiful, and beautiful theories must be true.

Eugene Demler, Professor for Theoretical Physics at ETH, sees it like this: "My experience in physics is that when one discovers something about nature that is true, it can be described in an elegant and beautiful way. Our biggest aspiration is to find a fundamental equation with a few letters. That really is beautiful."

As an example of a beautiful, fundamental equation, he cites Albert Einstein's law $E = mc^2$. This states that when energy changes, mass changes as well – and vice versa. Many experiments have proven this equation's legitimacy. But Demler does not conclude from this that beautiful mathematical statements are true. "Theoretical physicists are often divided into truth seekers and beauty seekers. The great ones achieve both." ○

Orca is Climeworks' largest carbon-capture plant to date.

Image: Climeworks

Climeworks raises 600 million Swiss francs

ETH spin-off Climeworks successfully closed its latest financing round with a total of 600 million Swiss francs. The company's direct-air-capture technology, which was developed at ETH, filters CO_2 out of the air, permanently removing it from the atmosphere. "We set up Climeworks with the vision of providing the world with a technology that has the potential to reverse climate change," says Climeworks CEO Jan Wurzbacher, explaining the mission behind the company he helped found.

Most of the latest funding will go towards building new large-scale facilities worldwide and hiring additional employees, significantly boosting capacity to remove CO_2 from the atmosphere. "We hope our filtration technology will play a major role in keeping global warming below 1.5 degrees Celsius," says Wurzbacher. Investors include Swiss Re, Swiss asset management company Partners Group and Singapore's sovereign wealth fund GIC.

The recent success of Climeworks underscores the major market potential of green technology, as does the rapid growth of ETH spin-off Synhelion, which uses a solar reactor to convert CO_2 filtered from the air into climate-neutral fuels. Together with its partners, Synhelion is now planning to build Germany's first industrial-scale plant for the production of environmentally friendly kerosene.

ETH President Joël Mesot is delighted to see venture capitalists putting more money into ETH spin-offs: "ETH is determined to play its part in addressing the big global challenges of our time. That's why I'm so pleased to see spin-offs from our university getting more and more successful at bringing their solutions to market."

Climeworks is part of a growing family of ETH unicorns – that is, start-ups with a market valuation of over one billion Swiss francs. Software company and ETH spin-off Scandit, which was founded in 2009, recently acquired unicorn ⟶

status after successfully raising 150 million US dollars of fresh funding. AutoForm, an ETH spin-off founded in 1995, passed into new hands in November 2021, when it was acquired by US investment group Carlyle, which reportedly paid around 2 billion US dollars for the company. GetYourGuide – an online travel and leisure platform founded by ETH doctoral students in 2009 – hit the headlines in 2019 when it successfully closed a financing round of some 500 million Swiss francs, which also propelled it to unicorn status. ○

Solutions for the future of mobility

The Center for Sustainable Future Mobility (CSFM) launched its activities in May with a kick-off symposium at ETH Zurich. The new ETH Zurich centre of excellence, which was founded in 2021, will conduct interdisciplinary research into the fundamental principles of sustainable and environmentally friendly transport systems. The CSFM – a network of some 40 ETH chairs from eight academic departments – is based at the Departments of Civil, Environmental and Geomatic Engineering (D-BAUG) and of Mechanical and Process Engineering (D-MAVT). The strategic partnership was established by ETH Zurich in 2018 with SBB, Siemens Mobility and AMAG and brought under the umbrella of the CSFM in 2021. Set up as part of the Mobility Initiative, this partnership covers many of the same topics as the CSFM and also receives support from the ETH Zurich Foundation. The initiative also receives support from other donors of the ETH Zurich Foundation. ○

→ ethz-foundation.ch/en/mobility

Image: Colourbox

PHILANTHROPY

BY
Donald Tillman

Alma mater triggers strong emotions

As a university of science and technology, ETH Zurich is often regarded as the domain of sober-minded intellectuals obsessed with crunching figures. That's why I'm always so touched to see the strong emotional ties so many alumnae and alumni have to ETH. The donor Stefano Musso, who I recently met at an ETH Foundation event, is an excellent example. "Whenever I read or see something related to ETH," he told me, "I get goosebumps!" It's this emotional attachment that is prompting more and more people to support their old university by making donations. Many of them really do see their alma mater as a "nurturing mother" who nourished them with knowledge. "I owe so much to ETH" is a sentence we hear a lot. Of course, our donors are still meticulous about checking what their donation will be used for and how it will affect the big picture – after all, their capacity for analytical thinking is still very much alive and well! The result is a commitment to ETH that is both emotional and intellectual in equal measure.

→ ethz-foundation.ch/en

Image: Eline Keller-Sørensen

Emerging continent seeks skilled workers

ETH lecturers have teamed up with colleagues at Ashesi University in Ghana to offer a Master's programme in mechatronics. Their goal is to educate a new generation of top-level engineers.

TEXT Samuel Schlaefli

When Alexander Caspar and his assistant Robert Crowell checked in at Zurich airport on January 15, 2022, Caspar still had only the haziest notion of what Ghana would be like. It was an 11-hour flight from Zurich, where the temperature was a chilly -3 degrees Celsius. In Ghana's capital, Accra, where it was 30 degrees and humid, he was initially overwhelmed by the unfamiliar climate, heavy traffic and crowds of people. "I'm not much of a traveller; in fact, it was the first time I had ever left Europe!" says Caspar, a Senior Scientist in the Department of Mathematics at ETH Zurich. "But when the offer came through a few months earlier to teach a two-week block course in Ghana, I realised it was a once-in-a-lifetime opportunity."

IMPRESSED BY ASHESI UNIVERSITY The joint Ashesi-ETH Master in Mechatronics Engineering was set in motion by ETH for Development (ETH4D), an interdisciplinary initiative that seeks to educate future leaders in sustainable global development. "Africa is a tremendously dynamic continent, with high economic growth rates and a very young population," says Maximilian Grau, programme manager at ETH4D. "Our goal is to help nurture this trend and also give ETH teaching staff the chance to see for themselves the challenges and opportunities that Africa offers."

In 2018, an ETH4D team visited universities in several countries in Sub-Saharan Africa to discuss the possibility of developing a joint Master's degree programme. The team eventually decided on Ashesi University near Accra. Founded 20 years ago by a former Microsoft engineer, Patrick Awuah, Ashesi is now one of the top African universities in international rankings – and it has set the goal of educating a new generation of highly skilled and socially responsible engineers. "We were impressed by their level of commitment," says Grau. Ghana also had the advantage of being politically stable and economically vibrant, two conditions that favour long-term cooperation.

On 17 January, after a day spent settling into his new surroundings at the teaching staff residence on campus, Caspar began teaching a block course on the foundations of mathematics to the first cohort of 26 students. Hailing from seven African countries, this group had been selected for the Master's programme from a total of around 250 applicants. Some of the cohort were fresh from their Bachelor's degree, while others had already embarked on a career. "It was the same mix of students you might get at ETH: some brilliant minds, others struggling to stay on top of the material," says Caspar.

Caspar taught from 8 a.m. to 5 p.m. for ten days straight. "That's obviously very different to the semester courses we do at ETH," he says. Despite working in tandem with a local colleague, he admits that spending so much time in the classroom made the whole experience very intense. Caspar found his students to be motivated, eager to learn and keen to debate; they were also pragmatic in the face

of less-than-ideal conditions: "The quality of the projector left a lot to be desired, so some people struggled to read the presentation. But because we were also streaming the lecture via Zoom for the students who were in quarantine, many of the ones who were actually in the room simply followed the presentation on their laptop instead of complaining about the the projector!"

TIME TO BUILD UP EXPERTISE The collaborative programme with ETH Zurich has given Ashesi University the chance to educate engineers to a Master's degree level for the very first time. "We don't yet have enough experience and lecturers to run this kind of programme independently," says Nathan Amanquah, Acting Dean of the Engineering Department. "But this collaboration is helping us build up the knowledge and teaching staff we need." A total of five cohorts will be educated using the ETH-Ashesi tandem model between now and 2028. Graduates of the programme will receive two degrees: a Master of Science (MSc) from Ashesi and a Master of Advanced Studies (MAS) from ETH Zurich. After 2028, the programme will continue as an independent, two-year MSc from Ashesi University. Its realisation has only been made possible by the generous support received from the Swiss State Secretariat for Economic Affairs as well as private donors and foundations (such as the Arthur Waser Foundation and Louis Dreyfus Foundation).

The Master's programme is supported by seven industry partners – ABB, Barry Callebaut, Bühler, HPW, Holcim, Nestlé and Tetra Pak – all of whom hope to gain access to skilled talent to help bolster their activities on the African continent. As well as funding 20 scholarships for talented students, the companies are providing internships, which form an integral part of the degree course. Amanquah is quick to allay concerns that students might take the first well-paid job they are offered in Europe or the US after completing the course: "During the application process, we look for candidates who are determined to give something back to their African homeland."

Caspar will be returning to Accra next January. Each of the ETH lecturers involved in the programme will teach their respective block several times. "Preparing lectures takes time, so this is the most sensible approach," he says. Caspar is confident that this experience will also benefit his teaching at ETH. On his first visit, he says, he was too busy teaching to pay much attention to anything else; on his next trip, he hopes to travel more and get to know the country better. "But what really motivates me is that I'm helping a new generation of aspiring engineers to get one step closer to achieving their personal goals." ○

Caspar values the pragmatism of his African students – and their enjoyment of a good debate.

Image: Nicolas Mertens

Biochemical process wins Spark Award

Along with Jörn Piel, ETH Professor of Microbial Interactions, the two microbiologists Daniel Richter and Edgars Lakis have been presented with the 2022 Spark Award. Their novel biochemical process has a broad spectrum of uses. For example, it can be used to load proteins with an active ingredient, which is then transported to the right place in the body. This is the 11th time that ETH transfer – ETH Zurich's technology transfer office – has hosted the award for the university's most promising innovation. In particular, the jury was impressed by the method's wide range of potential applications, which include not only the treatment of disease but also diagnostics and pharmaceutical research. ○

About the Spark Award:
⟶ ethz.ch/sparkaward

Image: Oliver Bartenschlager

The winners of the 2022 Spark Award (from left): Edgars Lakis, Jörn Piel and Daniel Richter, together with Vanessa Wood, Vice President for Knowledge Transfer and Corporate Relations.

Image: Stefan Weiss

Zuzana Sediva, Pioneer Fellow 2019 and founder of Groam, an ETH spin-off that received funding.

Financial boost for ETH

Buoyed by over 3,200 legacies, donations and bequests from private individuals, foundations and companies, ETH Zurich was once again able to invest additional funds into teaching and research in 2021. All in all, this extra money helped finance over 150 research and teaching projects, scholarships for brilliant students, sponsorship for young entrepreneurs, and start-up funding for professorships. In its 2021 annual report, the ETH Foundation takes a closer look at some of the projects and people that benefited from the generous support of donors. ○

The annual report of the ETH Foundation:
⟶ report21.ethz-foundation.ch/en

Improving dental hygiene with artificial intelligence

Brushing your teeth properly is trickier than it sounds, and dentists spend a surprising amount of time telling patients that their dental hygiene is not up to scratch. To help tackle this problem, ETH spin-off Zaamigo has launched a new device that lets anyone check how clean their teeth are – and tells them when it's time to visit the dentist. The device, which looks rather like an electric toothbrush, features a miniature camera that takes microscopic images of your teeth and gums. The images are then processed in an app by means of artificial intelligence. As well as providing useful indications of tartar build-up, discolouration and gum inflammation, the software also offers tips on exactly how and where you could be brushing better and whether you need to visit your dentist. The dental camera is easy to use, which makes it a good choice for kids, too. In future, Zaamigo plans to add additional features to the system to help diagnose tooth decay and nocturnal teeth grinding. ○

→ zaamigo.com

PRODUCT:
Camera and app for assessing dental hygiene

DEVELOPED BY:
ETH spin-off Zaamigo

BENEFITS:

- Examine your teeth in your own bathroom
- Early detection and prevention of dental problems
- Tips on improving dental hygiene

Illustration: Carolin Eitel

Image: Oliver Bartenschlager

ETH Rector Günther Dissertori presents the Kite Award to Andreas Eggenberger.

Physics experiments at home

ETH Zurich's Kite Award is presented in recognition of especially innovative teaching projects. This year's award goes to a course that brought physics experiments to students in lockdown. One of the experiments was based on a tube of potato crisps. Using the tube, a CD, a smartphone and two razor blades mounted to form a narrow slot, students working from home were able to measure the wavelength of light from different sources. The experiment was just one of many devised by Andreas Eggenberger, who is in charge of physics lab courses, and his team back in March 2020, when labs were forced to shut on account of the pandemic, and the only shops open were those selling essential goods. All the experiments could be conducted safely at home and generally had equivalent or better teaching outcomes than those usually performed in the laboratory. ○

AI partnership with Bulgaria

This spring saw the launch of the Institute for Computer Science, Artificial Intelligence and Technology (INSAIT) in Sofia, which has been established in collaboration with ETH and the Federal Institute of Technology in Lausanne (EPFL). INSAIT is aiming to become a leading scientific institute for computer science, artificial intelligence (AI) and computer technology. By establishing itself as a world-class research centre, it will also generate fresh impetus for digital transformation and the creation of a competitive economy in Bulgaria and eastern Europe. Alongside support from professors at Switzerland's top two technical universities, INSAIT will also profit from the expert assistance and advice of scientists from other leading research institutions such as the Institute of Science and Technology Austria (ISTA), Massachusetts Institute of Technology (MIT), UC Berkeley, Yale, Princeton and Technion – Israel Institute of Technology. ○

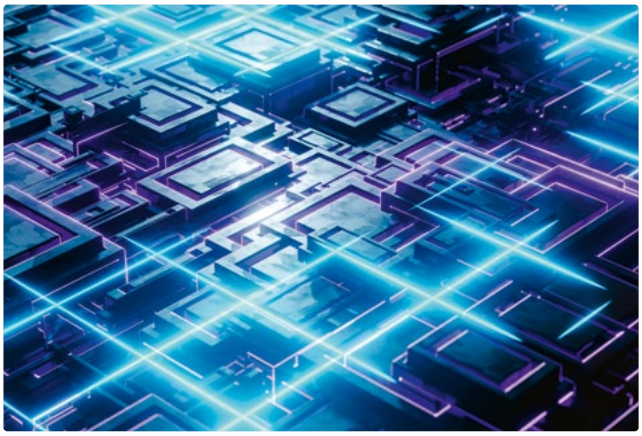


Image: Colourbox

IN PERSON

LINDA MADUZ has great faith in people's – and society's – resilience and in their capacity for positive development, even in politically turbulent times.

TEXT Karin Köchle

LINDA MADUZ is Senior Researcher in the Global Security Team at the ETH Zurich Center for Security Studies (CSS).
⟶ css.ethz.ch/en/

Your research focuses on Asia. Do you have any personal connection to the region?

Well, my mother comes from South Korea. And that's given me a natural interest and sympathy for the region. But the fact I ended up specialising in Asian affairs as a political scientist came about almost by chance. Demand for people with knowledge of Asia had shot up, so it was the ideal time to get funding for research positions in this field. I benefited from that.

What's the biggest challenge right now for relations between Asia and Europe?

There's growing pressure on countries in Asia and Europe to decide on their position towards an increasingly assertive and authoritarian China, as well as within the escalating strategic competition between the US and China. In my view, holding China accountable internationally – without isolating it – is the key challenge for all involved.

What's your advice to Switzerland in the current geopolitical situation?

The strategic environment is changing rapidly. With the return of geopolitics, we're seeing once again that a country's international position depends more heavily on its geographic location. To extend its room for manoeuvre in foreign policy, Switzerland needs to resolve and strengthen relations with key countries, starting with its European neighbours.

The pandemic probably has a natural origin, but the Ukraine war is most definitely caused by humans. Do we perceive each of these threats in a different way?

Unlike naturally occurring events, threats of a social nature challenge us to reflect on how much responsibility we bear and how much power we have to act. They also make us question whether we could have prevented them. Could the war in Ukraine have been avoided? And, if so, how?

What's your recipe for staying positive in these challenging times?

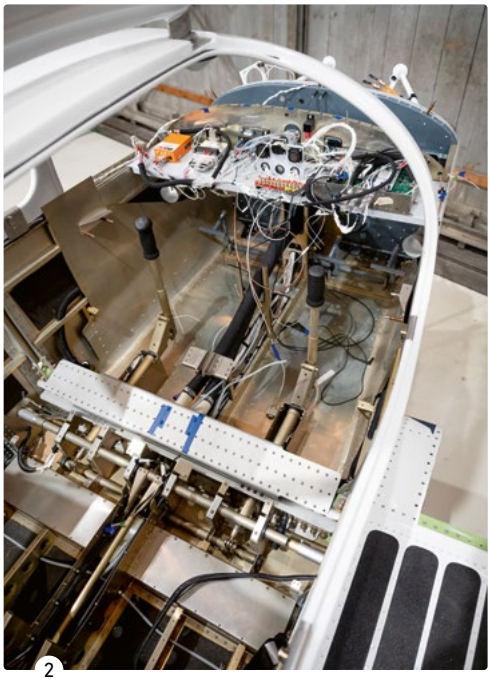
I have great faith in people's – and society's – resilience and in their ability to develop and progress. The pandemic and Russia's attack on Ukraine have both shown us how supposedly safe goods, such as stability, security and travel, can very rapidly come under threat. But, on the other hand, we've also seen how policy can shift direction very quickly – and that can decisively change things for the better. ○

Image: Daniel Winkler

GETTING INTO THE AIR

TEXT Christoph Elhardt
IMAGES Daniel Winkler

REPORT | Eight ETH students are working on battery and hydrogen versions of an electric aircraft as part of the e-Sling focus project. For the past year, their lives have revolved around Hangar 3 at the Innovation Park Zurich in Dübendorf.



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The students still have a lot of work to do before the electric plane takes off this summer.

2
Screens, displays and switches still need to be installed in the cockpit.

The midday sun casts a warm summery light on Hangar 3 next to the Dübendorf military airfield, evoking a holiday mood as it softly illuminates the runway and the landscape beyond. But holidays are the last thing on the minds of the eight ETH students who have been here since autumn 2021. The team of one woman and seven men – all aged between 20 and 24 – spends up to six days a week working on a small electric aircraft and its battery and hydrogen propulsion systems. Built from a kit supplied by South African aircraft manufacturer Sling, the small airplane – which stands proudly amid workbenches and various pieces of equipment – has become the main focus of many of these students' lives.

The e-Sling has a wingspan of 10.5 metres, a maximum take-off weight of 950 kilograms, a cruising speed of 160 kilometres an hour and an estimated range of 250 kilometres. Instead of running on fossil fuels, it will eventually be powered by a 240-kilogram battery consisting of almost 3,000 individual cells. Right now, however, the section of the plane where you would expect to find an engine and propeller is nothing but a mass of loose connections. What will eventually be a four-person cockpit with screens, displays and switches is currently just a tangle of cables – and there are gaping holes in both wings where the batteries should be. In other words, it doesn't look like this aircraft will be taking off any time soon.

PROJECT FLATSHARE Stairs at the back of the hangar lead up to a steel platform where the project team are sitting at a round table, finishing off their lunch break with coffee and biscuits. The platform feels rather like a student flat: it has a compact kitchen with a dishwasher, coffee machine and microwave, plus a sofa, lockers and six computer workstations. Everything you need for a comfortable flatshare!

Colin, Elsa, Jan, Joël, Patrick, Rafael, Robin and Sander clearly feel very much at home here, and the relaxed atmosphere suggests that these eight students have already spent a lot of time together. They all study mechanical or electrical engineering, but their bond goes far deeper than that: each of them has agreed to dedicate a year of their lives to a focus project, which requires them to develop a realistic product, taking it from the design phase right through to production and potential commercialisation. The e-Sling project was ⟶

3

launched in September 2020. The first team spent 12 months developing all the components required for the battery-powered version of the plane. However, they didn't have time to finish testing the aircraft's new propulsion system and to obtain the necessary approval for its maiden flight.

So this task has now fallen to the current team, which comprises Elsa Wrenger and her fellow students: "We're expecting to get the plane developed by the first team up in the air by the summer," says the 21-year-old, who comes from Munich. But that's a lot harder than it sounds.

BATTERY LAB IN A CONTAINER A shipping container sits rather forlornly in front of the hangar. Inside these cramped quarters, the airplane's engine and propeller have been jacked up and are connected to a computer by a mass of cables. The two battery modules are on the floor, plugged into the charger. They take three hours to reach full charge, which will be enough to keep the plane in the air for about an hour.

"This is our battery lab," says 23-year-old Jan Wallimann, the team member responsible for the aircraft's battery system. "It's where we test battery performance and check they work properly with the engine and the control system." To do this, the students developed their own software, which collects data from 150 sensors. "We even came up with an app that lets us check the temperature and voltage of the individual battery modules on a smartphone while we're sitting at home on the sofa," says Patrick Benito, who programmed the software. The students clearly take pride in understanding every last inch of their airplane.

FOCUS PROJECT = PROBLEM-SOLVING Being part of a focus project means tackling a constant stream of surprises, and that's certainly true of e-Sling. It was the previous team who first noticed that every time they started the propeller, the cockpit electronics would shut down and take the rest of the control system with them. Once this happened, the engine could no longer be operated

3
The team developed their own software to enable them to monitor key parameters around the clock.

4
Jan, Elsa and Joël examine the wing tip. The plane has a wingspan of 10.5 metres.

via the control lever – a situation that obviously has to be avoided at all costs once the plane is airborne. Unfortunately, the original team ran out of time before they could fix the problem.

That left Jan, Elsa and the other members of the current team to come up with a solution. After puzzling over it for two months and performing numerous tests and measurements, they finally figured it out: "We realised that the engine and all the cables that run to the batteries via the cockpit were producing an electromagnetic field that interfered with the electric signals in the cockpit," says Jan. The solution was to prevent that field from forming.

Deciding how to do that was very much a mechanical problem, so much of the work fell to Joël Meyer: "After countless attempts, we finally managed to solve the problem by making various modifications, including re-routing the cables and mounting a cover plate on the engine."

A FORMATIVE EXPERIENCE This is what makes focus projects so exciting: the experience of encountering new problems and solving them as a team. To find a solution, the students cannot simply rely on their textbooks and lecture materials; they also need to apply scientific and technical principles to get the job done, just like real engineers. As well as doing research and asking experts from industry and academia, they also have to put their heads together and improvise, because it's rare to find an off-the-shelf solution that ticks every box.

The aspiring engineers are keenly aware that they are likely to face a barrage of further obstacles, both big and small, before their aircraft finally takes off this summer. Yet they still seem remarkably undeterred. So what motivates them to plough so much time into this project?

"There's no way anyone would do it just for the ECTS credits, because you only get 14 for the entire year!" says Sander Metting with a grin. The 23-year-old mechanical engineer, who moved into a shared flat in Dübendorf for the duration of the project, argues that the biggest benefit is the huge amount of practical experience it offers to students who are still doing their Bachelor's degree. Being able to apply the knowledge you gain from lectures and seminars to develop something from scratch is ⟶

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a unique opportunity, he says. That's why applications for focus projects always outstrip the number of places available, so students need to show tremendous commitment before they even get through the selection process.

Most of the group also have a passion for aviation and are keen to experience the process of building an aircraft first-hand. Some are even considering a career in the aircraft industry after they graduate. Yet they are motivated by other reasons, too. "We want to show that there are alternatives to fossil fuels in the aviation sector," says Elsa. Personally, she hopes her participation will contribute in some small way to making air travel more sustainable.

NEXT STEP: HYDROGEN PROPULSION Back in the hangar, a few of the team members have gathered around a big table to work on the second part of the project: developing a hydrogen powertrain for a small aircraft. Their aim is to make this sufficiently lightweight and powerful to keep the plane airborne for as long as possible. But hydrogen propulsion alone cannot provide all the power required: "You need a lot of power on take-off and landing and when you encounter turbulence in the air. That means you need batteries as a backup to make sure all those power requirements are met," says Sander.

So far, they have only made sketches of the hydrogen-electric aircraft and put together a few parts. "Our goal is to get the core of the propulsion system – the fuel cell – up and running by October, which would at least lay the technical foundations for the next team," says Robin Feuz. "We benefited so much from the previous group's work and expertise, so we want to leave things in the best shape we can for whoever's up next!"

Like most of their teammates, Sander and Robin are in the third year of their mechanical engineering course. They have already acquired a theoretical understanding of how fuel cells work from a lecture on thermodynamics. But this knowledge falls far short of what they would need to install a fuel cell in an aircraft, because all the elements have to be defined from scratch. That means not only selecting the right fuel cell but also configuring the cooling system and the hydrogen and air supply. "The biggest challenge is getting all those components to work together smoothly so you end up with a lightweight and inexpensive propulsion system that not only complies with all the regulations but is also airworthy," says Sander.

At the start of the project, this topic was completely new to the team, but over the past few weeks and months they have delved deeper into the key issues, spoken to experts and even visited the Hydrogen Technology Expo Europe in Bremen. They have now acquired enough expertise to order individual parts, including the compressor that Sander pulls out of a large box to show us. Yet it's likely to be some time before this compressor will be supplying the fuel cell with air and, together with all the other components, getting the hydrogen-powered plane off the ground. By then, it will be a new team of students making their mark in Hanger 3 at the Innovation Park Zurich in Dübendorf. ○

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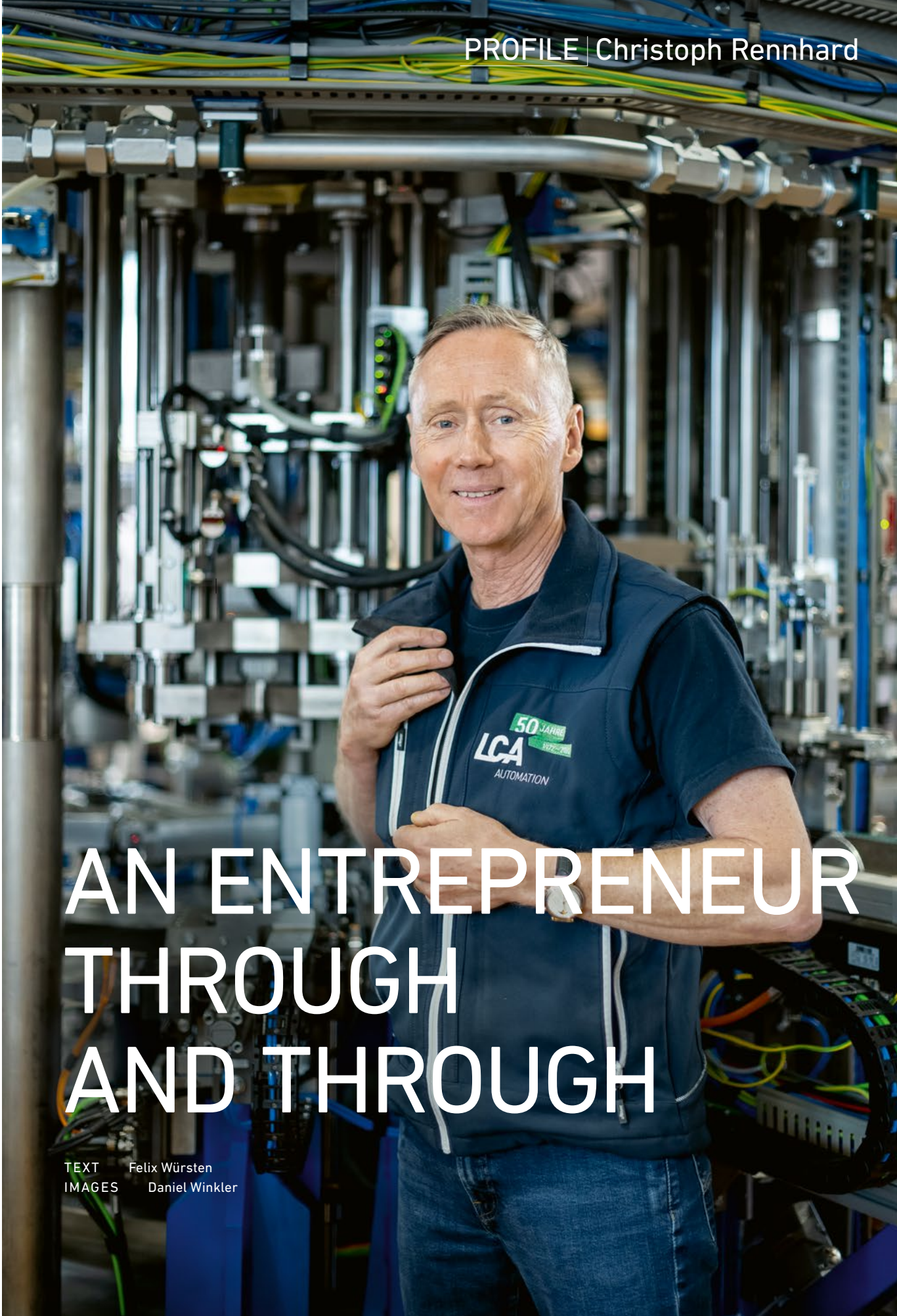
The prominent logo on the tail fin.

The aircraft was still on the ground at the time of the editorial deadline. You can find out about the project's current status at:
⟶ e-sling.com/news/



AN ENTREPRENEUR THROUGH AND THROUGH

TEXT Felix Würsten
IMAGES Daniel Winkler

PROFILE | ETH alumnus Christoph Rennhard runs a company that develops precision machines for the global market. The keys to his success are technical expertise, customer orientation and talented staff – plus the ability of his SME to respond faster than big corporations.

We are in an unremarkable industrial estate on the outskirts of the Swiss village of Küssnacht am Rigi. Intersected by a busy main road, the site consists of a series of functional industrial buildings, with the first farmhouses visible just a stone's throw away. There is little to suggest that these doorways lead to the headquarters of a company that supplies the global market with highly specialised machinery.

"I'm Chris," says our host Christoph Rennhard, greeting his guests with a firm handshake. He immediately launches into a description of his company, telling us about his employees in China who are currently in lockdown in Shanghai, showing us a series of oddly shaped concrete parts fabricated by a 3D printer gantry system his company designed and built, and pointing out the yellow floors that make it easy to spot dirt and the wide corridors that keep everything moving at a brisk pace.

It's been 12 years since Rennhard took over LCA Automation, which now has around 80 employees. Almost 70 of them work here in Küssnacht; the others are located in Puebla, Mexico, and in the Chinese city of Shanghai. LCA produces sophisticated, custom-made manufacturing and testing systems that fabricate and test parts fully automatically – at high speed and with maximum precision. When Rennhard and his team design a new machine, they typically combine a whole series of engineering challenges. Their goal is to create a machine that can perform specified tasks, such as positioning objects with pinpoint precision, processing materials, assembling components, processing information or monitoring steps in a production process.

During the presentation, which by now has taken us to Rennhard's office, we spot the logos of well-known automotive companies that use LCA machines. "Big corporations enjoy working with SMEs like us because we're agile and good at what we do," he says. The key to a successful SME, he explains, is to get everyone pulling in the same direction and make sure that each team member's performance is visible to everyone else: "That maximises efficiency and offers a refreshing contrast to the complex development and procurement processes you typically see in big companies." He acknowledges that it can sometimes be challenging for employees, because a small team means that each individual's performance counts for a whole lot more. "You need to know you can rely on everyone in your team," he says.

EQUIPMENT AND EXPERIENCE Originally from Appenzell, Rennhard acquired his professional skills at ETH Zurich after completing his matriculation exam with a focus on classical languages in nearby St. Gallen. "I'm still glad I opted for humanities," he says. Yet mechanical engineering and materials technology were the subjects he chose to study at university. "I was just fascinated by these subjects," he says. "Though I wasn't exactly a model student! I spent a lot of time in the military, plus I had a job on the side." He shrugs off the question of whether he financed his studies himself: "Of course, an ETH degree course doesn't cost that much."

Working with industry partners, he completed his doctoral thesis on powder-metallurgy processes, which also gave him his first experience of being abroad. His next port of call was South Africa, where he worked as head of new product development at a steelworks, developing new materials and the corresponding process technology. It was an exciting time, not just professionally, but also because of South Africa's radical transformation after the end of apartheid. Rennhard was impressed by how much bolder South African managers were than their European colleagues. "As a young engineer, I was able to carry out some fairly intrepid experiments that would never have been permitted in

CHRISTOPH RENNHARD studied Mechanical Engineering and Materials Technology at ETH Zurich and completed his doctorate in 1993. After working for three companies, including posts in South Africa and the US, he took over ownership of the company LCA Automation in Küssnacht am Rigi in 2010. He also sits on the advisory board of Inspire, the ETH centre of excellence for technology transfer.

Europe, where the risk of damaging the plant would have been seen as too high." South Africa was also where he met his wife, who came to Switzerland with him in 1996 and now also works for LCA.

"The opportunity came up to do my General Staff training," he says, explaining why he decided to return to Switzerland. He attended Grenadier school in Isone in the canton of Ticino on four occasions, gaining a different rank each time. "At first, I saw my military training as a kind of sporting challenge, but I ended up advancing all the way to the strategic planning level." Much of what he learned is still useful today, he says: "Many aspects of military decision-making can also be applied in a modified form in business." The military also taught him how to lead and motivate people, he says, and it showed him how important it is for managers to give their staff the appreciation they deserve. Many of those working in Rennhard's team are still young, but he insists on giving them leadership tasks and plenty of leeway to make their own decisions.

"My biggest challenge is finding talented and loyal employees," says Rennhard. He would like to recruit more ETH graduates. "But a lot of them prefer the option of a bigger company, because we're not exactly a household name," he says. "They also tend to underestimate how challenging our business is. We don't offer the kind of in-house workshops where people can unwind and relax," he says with a twinkle in his eye. Nonetheless, he feels it would be a mistake for Switzerland to produce even more graduates. "It's not mediocre academics we need, but as many skilled professionals as possible, plus a smaller number of high-calibre graduates."

Away from work, Rennhard is a keen motorcyclist and an amateur pilot – two areas where he can apply his technical skills. On the job, he is an entrepreneur through and through, combining a global outlook with solid Swiss pragmatism. He regularly comes out with phrases that he learned as a boy in Appenzell: "Always be who you are" and "Be careful who you trust". He also emphasises his close ties to his native land: "I'm a patriot and proud of Switzerland's culture of hard work." And he is quick to highlight the importance of honesty and loyalty: "Leaving a company and taking the customers with me is not the kind of thing I would do."

ACTIVE IN MANY INDUSTRIES After returning from South Africa, he worked for two Swiss companies – and stills serves on the board of directors at one of them. As the new head of LCA, he immediately realised they needed to beef up the software department. "The control units for our machines are highly sophisticated," he explains. The company's efforts have clearly paid off. "Breakdowns are few and far between," says Rennhard proudly. The company can access customer machines via the internet, but supporting customers on site and in person continues to be important. "When our customers call us, they expect to speak to a trained professional as fast as possible. We achieve that in nine out of ten cases."

LCA works in many different industries, as shown by the variety of parts in Rennhard's office. But how do they keep so many balls in the air at once? "The basic focus of what we do is clearly defined," says Rennhard. "We combine different technologies to build a single automated system." He recently gained insight into a new sector as part of a project involving the construction materials manufacturer Sika and the construction company Affentranger. The three partners developed a gantry system that fabricates customised components from special concrete. As a member of the advisory board of Inspire, the ETH centre of excellence for technology transfer, Rennhard also has a gateway to the latest research. "It's important for us to have access to ETH expertise so that we can keep pace with our competitors," he says.

At the end of our tour, Rennhard shows us the automated marble run in the foyer that a team of apprentices developed for the local trade fair. "The visitors absolutely loved it," says Rennhard. "We think it's important to have a local presence, because this is where we find the young people who do vocational training at our company." Eventually, some of them will even end up working as his employees as far away as Mexico or China. ○

DISCOVER

○ 8 June – 2 September 2022

Max Frisch and Helmut Schmidt – Wherefore utopia?

This exhibition traces the seminal encounters between Helmut Schmidt and Max Frisch, examining the events of the time from both a German and Swiss perspective. After opening in Hamburg, the exhibition will then travel to Zurich.

ETH Zurich, Zentrum campus, Max Frisch Archive

Find out more:
⟶ mfa.ethz.ch/en/

Image: Nicola Pitaro, ETH

○ 12 July 2022, 6.15 – 7.15 p.m.

Earthquakes made at ETH

Deep within the Hönggerberg is one of the world's largest geotechnical centrifuges. Nine metres in length, its rotating arm weighs 25 tonnes and develops an acceleration 250 times the force of gravity. The tour (in English) offers an introduction to the simulation of earthquakes, tsunamis and riverbed erosion.

ETH Zurich Hönggerberg, Campus Info

Sign up for this and other tours:
⟶ tours.ethz.ch/en

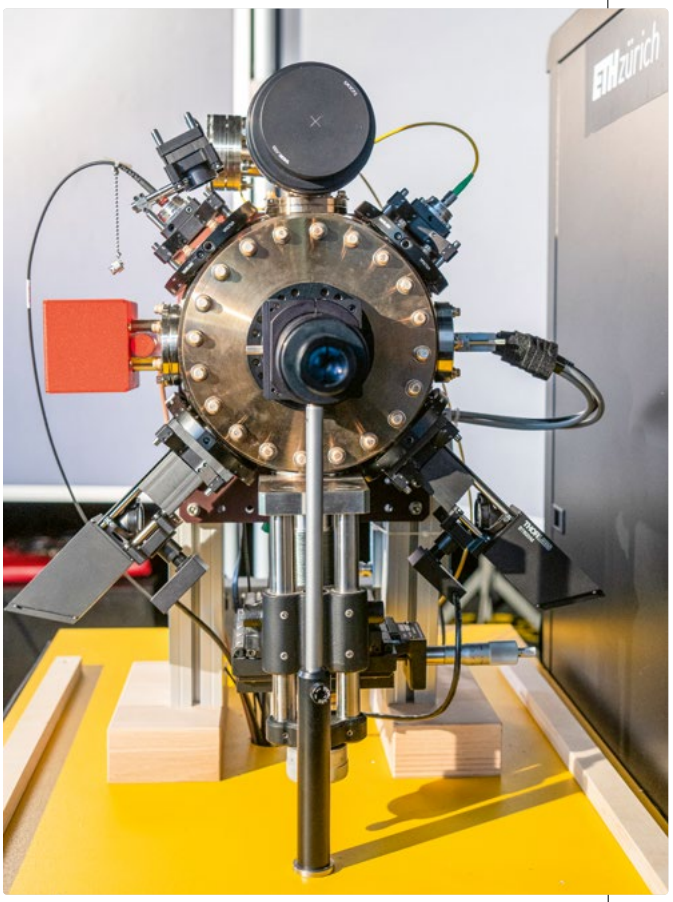


Image: Heidi Hostettler, ETH

Insights into the quantum world

○ From September 2022

Ion trap

A new exhibit at Technorama makes it possible to see individual atoms with the naked eye. The ion trap was created in collaboration with researchers from ETH Zurich. Visitors will have a unique opportunity to interact with atoms and explore the quantum world.

Swiss Science Center Technorama, Winterthur

For tickets and further information:
⟶ technorama.ch/en

Image: CreativeLabZ

○ 15 – 19 August 2022

Rock your Future.

The morning will be devoted to recycling and upcyling projects with the CreativeLabZ team. In the afternoon, dive into the world of music and write your own song – no previous musical knowledge required! Just bring along a love of music, and a team of professional musicians and producers will help you take care of the rest. For female or non-binary participants aged 12 to 17.

Verein ReCreaZZZ, Zurich

Find out more and sign up:
⟶ sportamt.ch/kurse

AUDIO

○ ETH podcast

Equal opportunities

Two new podcasts are devoted to the topic of equal opportunities. One takes a closer look at the facts and figures on gender equality at ETH, while the other discusses why it is so important for Swiss researchers to be admitted to the Horizon Europe funding programme.

The podcast is available on all major platforms. It can also be found, along with other podcasts, at:
⟶ ethz.ch/podcast (in English)

BOOKS

The benefits of anise and other plants

Health tips from the garden

During the pandemic, more attention than usual has been devoted to plants and flowers. Many people have rediscovered the green spaces on their own doorstep. Whether gardening, walking in the countryside or simply spending time in the fresh air, we have regained an appreciation for the beneficial influence such activities have on our otherwise tech-driven lives.

For some time now, interest has also been focused on medicinal plants and garden therapy. The "Garden and Health" series published by vdf Hochschulverlag explores a wide array of nature-therapy topics from the realms of medicine, botany, cultural history and society.

The Swiss Society for Garden Culture (SGGK) advocates the preservation and expansion of private and public gardens, parks and other landscaped spaces. Its activities help promote a greater awareness of the art of the garden, past and present.

vdf Hochschulverlag AG
ISBN: 978-3-7281-4104-0

Image: vdf Hochschulverlag AG

OUT OF FOCUS

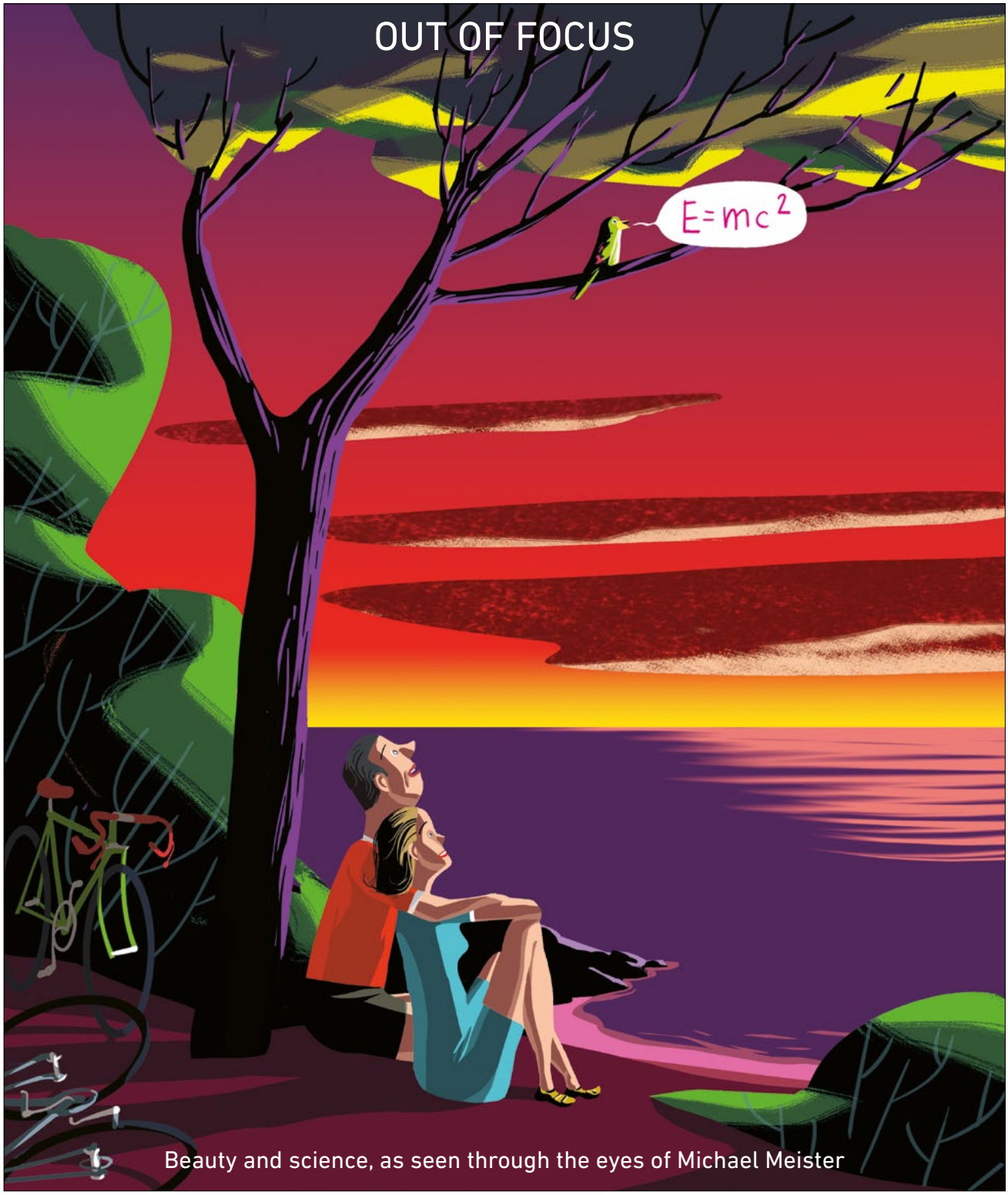


Illustration: Michael Meister

Beauty and science, as seen through the eyes of Michael Meister

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