

# GLOBE

NO.  
1/2021

## Disruptions

How they affect us  
How we deal with them 14



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to detail.

Tuana Savrim,  
DevOps Engineer

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## EDITORIAL

# DEALING WITH THE CHALLENGE OF DISRUPTION



GLOBE – the magazine for ETH Zurich  
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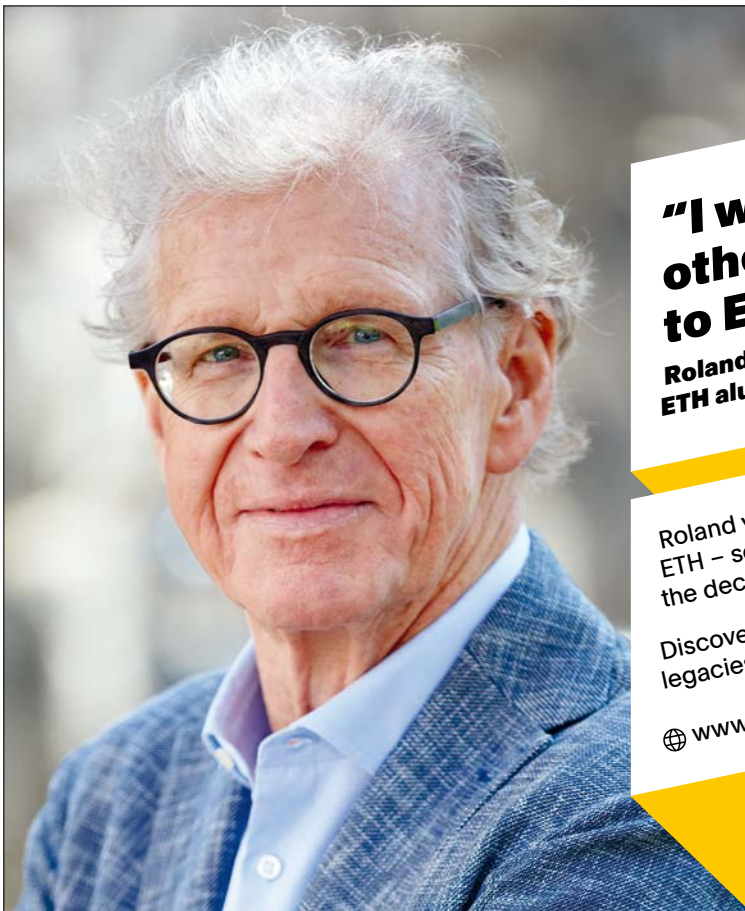
Whether it's an ill-timed phone call, a local power cut or a low-pressure weather system spoiling our plans for the weekend, disruptions to our regular routines can be irritating. In extreme cases, their consequences can be devastating. The coronavirus pandemic we're currently living through is perhaps the greatest disruption our generation has ever faced – and one that throws into sharp relief the vulnerabilities of our highly technological and connected society. But there's another side to disruption. It forces us to question our assumptions and abandon what we thought we knew; it pushes us to be more creative. In fact, it's often the most unwelcome upsets that have the power to lift us out of a rut, forcing us to consider things from a different perspective.

Disruption plays an important role in evolutionary biology and is a key driver of personal, societal and technical development. As such, it's a complex and ambiguous concept that deserves to be explored in more detail. This is what the current issue of *Globe* sets out to do. As well as highlighting the importance of disruptions in our daily lives, it explains how researchers at ETH are helping us deal with them better and how they can be put to productive use.

You may have noticed that *Globe* has also put the past few months to productive use and now features a brand-new look.

I hope you enjoy this issue of *Globe* and wish you a pleasant – and undisrupted – reading experience!

Joël Mesot  
President of ETH Zurich



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ETH alumnus and ETH Foundation donor

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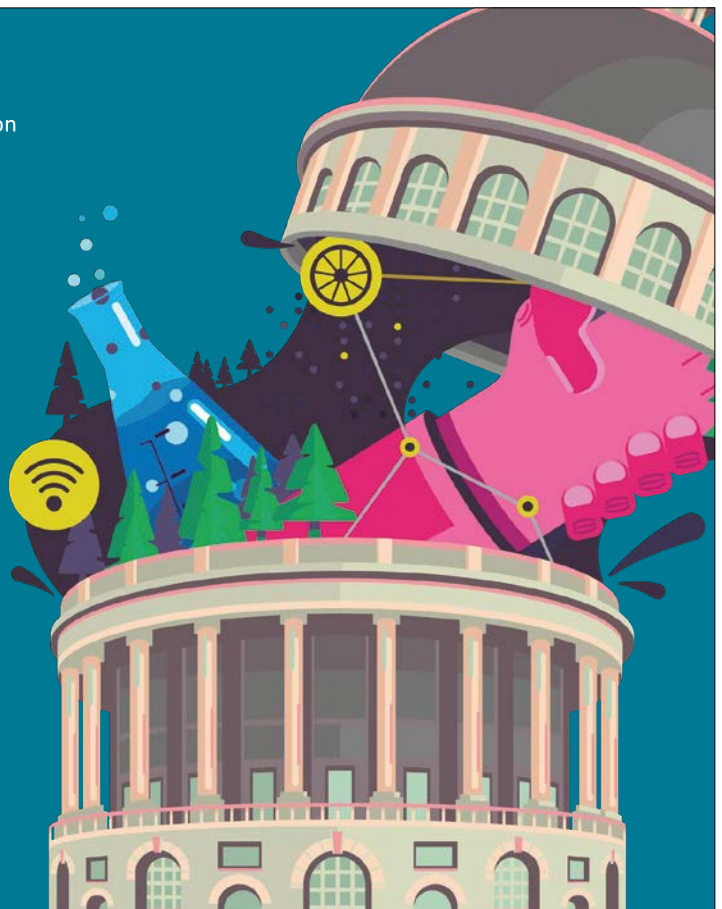
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Images: Daniel Winkler

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# NEW + NOTED



Illustration: Fruzsina Korondi

ETH researchers analysed one of Switzerland's largest hiring platforms to discover how recruiters make their decisions.

## Discrimination in the hiring process

Education, professional skills and experience should be the key criteria when recruiting to fill a vacancy. But the reality is often different, as numerous studies have shown. This was confirmed by a recent ETH study conducted by Dominik Hangartner from the Public Policy Group and Daniel Kopp and Michael Siegenthaler from KOF. Working in collaboration with the State Secretariat for Economic Affairs (SECO), the research group analysed data from Job-Room, one of Switzerland's largest recruitment platforms. Recruiters on Job-Room first specify the criteria that job candidates must fulfil for a specific post. They then receive a list of suitable candidates together with their profiles. This includes information on professional skills and expertise, gender, nationality and language skills.

If recruiters are interested in specific candidates, they can then contact them with just one click and invite them for a job interview.

Over a period of around ten months, the researchers analysed which candidates were contacted for interviews and how recruiters made their selection. The team discovered that, on average, migrant jobseekers were 6.5 percent less likely to be contacted than Swiss jobseekers with otherwise identical qualifications. This discrimination was particularly pronounced for migrants from the Balkans, Africa, the Middle East and Asia, all of whom face prejudice in everyday life. The researchers also showed that both men and women face discrimination. Given equal qualifications, women are primarily discriminated against in male-dominated professions and men in female-dominated professions. ○

## Detailed tumour profiling

Researchers from the university hospitals in Zurich and Basel, ETH Zurich, the University of Zurich and pharmaceutical company Roche have set out to improve cancer diagnostics with Tumor Profiler, a suite of state-of-the-art molecular biology methods. The profiler determines the molecular makeup of tumours in cancer patients. Based on this profile, which is a key factor in the efficacy of many new cancer drugs, physicians will then be able to recommend improved and personalised therapy options.

The Tumor Profiler study breaks new ground by harnessing a suite of complementary methods for the investigation of tumours. It therefore goes significantly beyond today's limited use of molecular biology methods as practised in leading hospitals. The scope of testing covers the DNA, RNA and proteins of the cancer cells. An investigation at the level of single cells enables researchers to understand the cellular diversity of an individual tumour, which comprises not only cancer cells but also cells from the immune system. The analysis also includes lab tests in which biopsies of the tumour are treated with drugs in order to determine their efficacy. This also takes into account medical imaging and other patient data. The data is processed and analysed using data science methods and then provided to doctors. ○

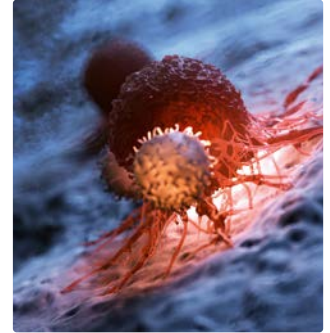


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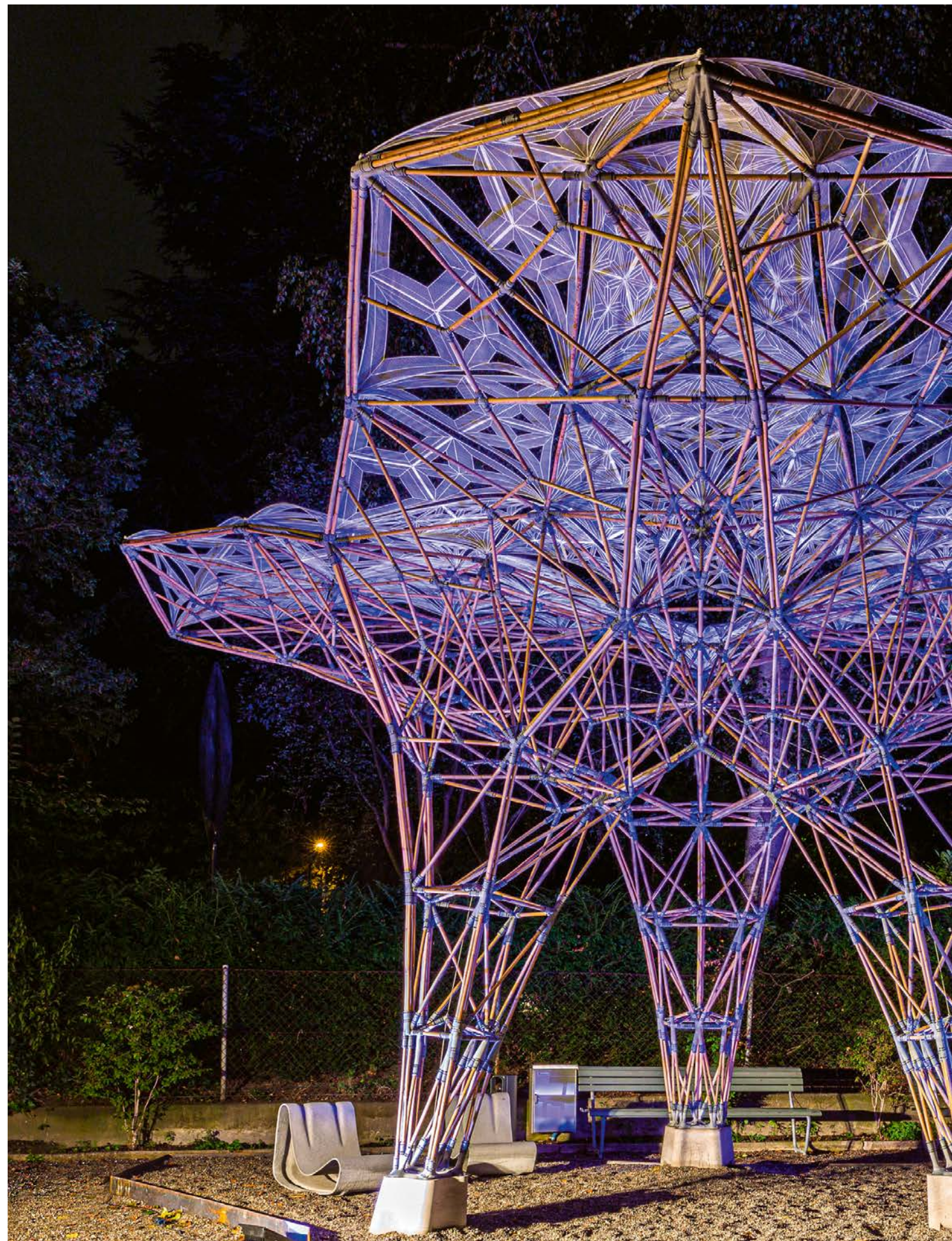


Image: Dyatlov Memorial Foundation

The group en route to Kholat Syakhl.

## A new take on an old mystery

Researchers from EPFL and ETH Zurich have come up with a plausible explanation for the mysterious death in 1959 of nine hikers at Dyatlov Pass in the Ural Mountains in the former Soviet Union. It seems likely that an avalanche took the Russian group by surprise as they lay sleeping in their tent. Russian-born Alexander Puzrin, from ETH Zurich, and Frenchman Johan Gaume, from EPFL and currently a visiting fellow at the WSL Institute for Snow and Avalanche Research SLF, sifted through documents on the mysterious incident. On this basis, they then developed an analytical model with which to reconstruct the deadly avalanche. Their theory is that an avalanche occurred in the middle of the night, some 9.5 to 13.5 hours after the mountaineers had dug a cut into the snow-covered slope to shelter their tent from the wind. ○







## Bamboo meets 3D printing

DIGITAL BAMBOO ○ Students of the MAS Digital Fabrication programme had 12 weeks to design and fabricate this filigree pavilion. The ultralight structure spans more than 40 square metres but weighs just 200 kilograms. Comprising over 900 bamboo poles and some 400 3D-printed nylon connectors, the five-metre-high “Digital Bamboo” pavilion explores the potential of 3D printing technology combined with a sustainable building material. The shading panels were also produced through 3D printing a recyclable plastic filament, which reinforces and forms the textile mesh. The “Digital Bamboo” project is part of the one-year Master of Advanced Studies programme to help students apply and extend their knowledge of digital design, robot-assisted fabrication and 3D printing. The project, which was developed in collaboration with the Chair of Digital Building Technologies, shows how digital fabrication can be used to optimise the use of time and resources and to promote a more sustainable culture of building. ○

→ [dbt.arch.ethz.ch/  
project/digital-bamboo](https://dbt.arch.ethz.ch/project/digital-bamboo)

# The empire strikes back

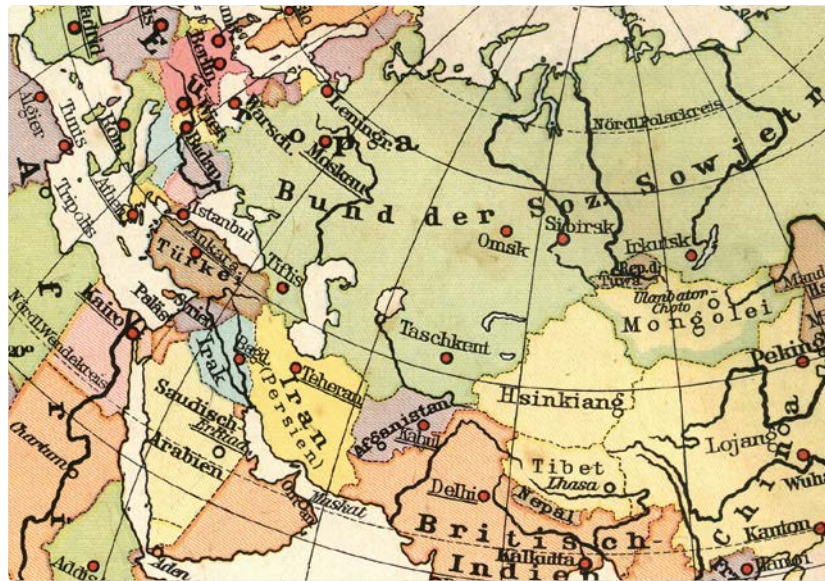
Revanchist nationalism poses a threat to geopolitical stability, says Lars-Erik Cederman in the Zukunftsblog.

Imperialism is thought to be a thing of the past. Yet in recent years, populist nationalists have increasingly expressed a strong sense of longing for their states' imperial past. Vladimir Putin has demanded the return of Crimea; Recep Tayyip Erdogan has shown an interest in Syrian border regions; and, as a reflection of a deep identity crisis following the loss of the British Empire, the Brexit process may ultimately rekindle the conflict in Northern Ireland.

## THE EMPIRE IS DEAD – LONG LIVE THE EMPIRE!

Formal empires may be dead, but in the playbook of aggrieved nationalists who want to make their countries "great again", the temptations of revisionism loom large. As vividly demonstrated by Putin's land grab in the Crimea, the norms of peaceful border change have come under pressure in recent years. Leading states have shown little regard for international law, as reflected in the Trump Administration's recognition of Israel's occupied territories.

To a large degree, the aforementioned tensions are the result of ethnic nationalism, an ideology that holds that political borders must coincide with ethno-national ones. Nationalist tensions frequently emerge where multiple ethnic nations inhabit the same state or where members of the same nation remain divided by borders.



The Soviet Union: a "golden age" from the perspective of neo-imperialists.

**YEARNING FOR A GOLDEN AGE** Together with my team, I have produced an analysis showing that the geopolitical fragmentation of ethnic groups is an important driver of civil conflict. Moreover, we emphasise that ethnic nationalists do not merely react to current injustices, but also often refer to a past "golden age" in their rhetoric.

In Putin's case, the reference point is the USSR, and in the case of Erdogan, the Ottoman Empire. Thus, what counts is not just a lack of unity, but

also a comparison with a real or mythical point in history. Using geocoded data on state boundaries and ethnic groups since the late 19th century, we can show that violent rebellions against established states are more likely to occur when ethnic groups are fragmented by borders and when this ethnic fragmentation increases.

In the ongoing ERC project on Nationalist State Transformation and Conflict (NASTAC), my team and I are currently extending this research by going even further back in time to study the historical roots of modern states and ethnic nationalism.

**WARS OF TERRITORIAL EXPANSION** So far, we have been able to confirm the great sociologist Charles Tilly's thesis that warfare drove state formation and territorial expansion of great powers in early modern Europe. We have also shown that the rise of ethnic nationalism has reversed this trend toward larger states. In fact, since the early 20th century, states have been shrinking steadily due to the collapse of multi-ethnic empires.

Thus, our research confirms that nationalism continues to threaten geopolitical stability. I believe that the coming years will reveal whether the forces of liberal democracy and power sharing regain their momentum or whether we are entering a much darker era characterised by ethno-nationalist domination and violent conflict. Much will hinge on developments in the West: in particular the power struggles inside the US and the EU, where currently democracy, the rule of law, and multi-ethnic tolerance are challenged by vocal illiberal forces. Ultimately, belief in the liberal world order rests on a successful track record of delivering wealth and security to the masses. In my view, failure in these crucial respects will create even more demand for populist nationalism and neo-imperialism. ○

Read more blog posts at:  
 —> [ethz.ch/zukunftsblog-en](https://ethz.ch/zukunftsblog-en)

**LARS-ERIK CEDERMAN** Professor of International Conflict Research at ETH Zurich. Seraina Rügger and Guy Schvitz contributed to this blog post.



Image: courtesy of L. Cederman



Image: iStock / troyek

## Breathing easier with a better stent

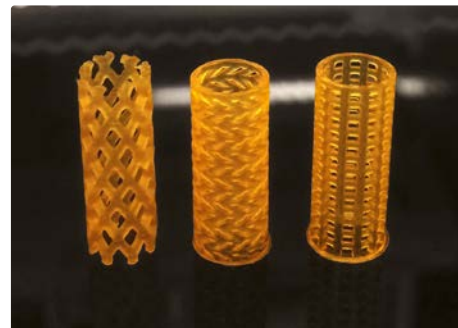


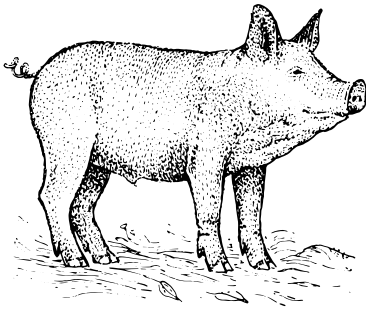
Image: Paunovic N., et al. ScieAdv, 2020

Prototypes of the airway stents.

Patients who suffer a sudden constriction of the trachea, whether due to illness or injury, often require rapid medical attention. As a rule, this involves a surgeon inserting a stent – a tubular implant made of medical silicone or metal. This procedure brings swift relief but has some drawbacks: metal stents often have to be surgically removed afterwards, which places an additional burden on patients, while silicone stents can migrate from the site of insertion. This is because implants are not specifically adapted to a patient's anatomy.

An ETH Zurich research team made up of members of the Complex Materials and the Drug Formulation and Delivery groups, and working in partnership with researchers from University Hospital Zurich and the University of Zurich, has now come up with a new type of airway stent that is tailored to the patient's anatomy and made of bioresorbable materials – i.e. it gradually dissolves after implantation. These stents are fabricated using a 3D printing process known as digital light processing (DLP) together with photosensitive resins specially adapted for this purpose. Until recently, the only objects producible with the DLP method and biodegradable materials were stiff and brittle. However, the ETH research team has now developed a special resin that becomes elastic upon exposure to light. ○

# Mutation causes defective boar sperm



In order to artificially inseminate sows, veterinarians must first obtain boar ejaculate. In the course of routine screenings of this ejaculate, vets spotted an anomaly with the sperm of five breeding boars from the Swiss Edelschwein race: the sperm lacked the requisite mobility because the individual sperm cells had crooked and shortened tails, thus rendering the sperm unusable. Such defects occur sporadically in livestock and also in humans; they are often

the result of genetic mutations. In collaboration with colleagues from the Vetsuisse Faculty at the University of Zurich, ETH researchers led by livestock genomicist Hubert Pausch sequenced the entire genome of the five boars and compared it with that of healthy animals. In this way, the researchers were able to track down the mutation underlying the sperm defect. This affects a gene that provides the blueprint for a protein involved in the formation of the sperm tail. The mutation leads to a defect in the production of the protein in question, resulting in a protein that is too short and therefore not functional. As a consequence, the tail of the sperm does not form properly.


Thanks to these new findings, pig farmers can now have their breeding boars specifically tested for this mutation. Furthermore, this genetic defect can also be detected even when it is not manifested in the sperm, but is present in just one of the two sets of chromosomes. ○

# Bigger synapses, stronger signals

Nerve cells communicate with one another via synapses. Researchers working under Kevan Martin at the Institute of Neuroinformatics at the University of Zurich and ETH Zurich have shown for the first time that the size of the synapse determines the strength of information transmission. Larger synapses result in stronger electrical impulses. The team was also able to resolve another long-standing question in neuroscience. Contrary to the conventional school of thought, researchers found that upon activation, neocortical synapses release several vesicles filled with neurotransmitters simultaneously. This means that synapses are more complex and can regulate their signal strength more dynamically than was once thought. In turn, the computational power and storage capacity of the entire neocortex is probably much greater than was previously believed. ○



Illustration of nerve cell connections of different sizes.



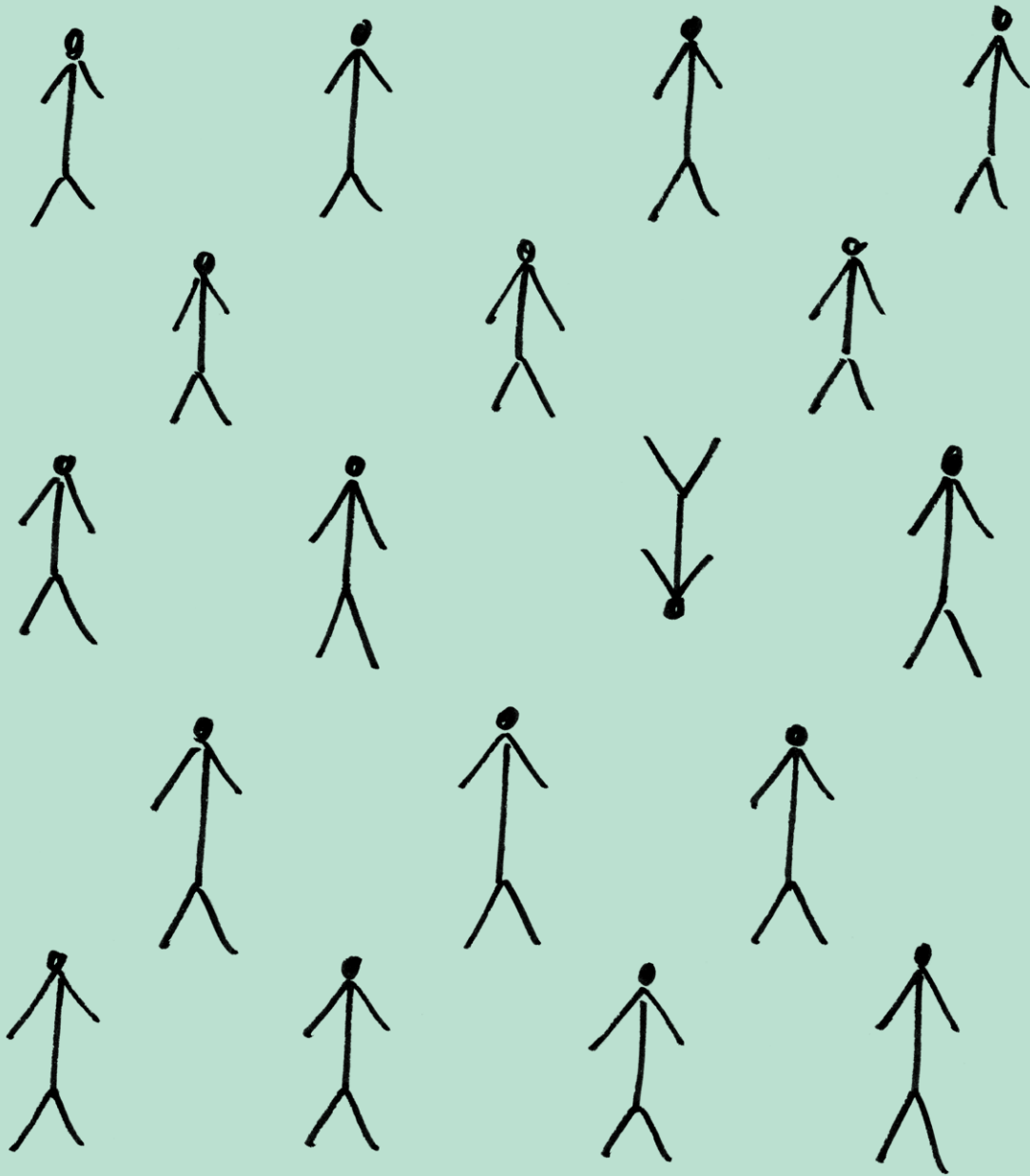
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# DISRUPTION – A TROUBLESOME TEACHER

FOCUS | Disruption disrupts: at best, it's a nuisance; at worst, it poses a real threat. Our intricately connected, high-tech society is particularly vulnerable. Yet disruption is more useful than we might think: it compels us to reconsider and search for new solutions.

ILLUSTRATIONS Beni Bischof



Image: courtesy of L. Wingert

**LUTZ WINGERT** is Professor of Philosophy at the Department of Humanities, Social and Political Sciences of ETH Zurich.

#### PHILOSOPHICAL ESSAY

by Lutz Wingert

A disruption is mostly irritating or annoying, though it can also be unsettling. It makes you stop and think, and may grow into something bigger. For example, a pneumatic drill hammering beneath the office window might disturb your concentration. Or the announcement of a disruption to rail services might make you feel angry. Being diagnosed with cardiac arrhythmia is disquieting and stops you in your tracks. And, on a larger scale, the growing disturbance to the world's ecological systems now threatens to destroy our own ecological niche.

A disruption is a deviation from a normal state, process, practice or attitude that serves to fulfil certain functions or norms – or that is considered to fulfil such functions and norms. A heart murmur may sound romantic to someone with a poetic nature, but actually refers to cardiac arrhythmia, a serious condition also known as ventricular fibrillation, in which ventricular excitation deviates from normal. This hinders or even prevents the heart chambers from filling and emptying effectively, thus disrupting the heart's proper functioning, namely to pump blood. Similarly, an excessive influx of phosphorus or nitrogen into bodies of water and oceans, e.g. as a result of intensive

farming, disrupts the dynamic balance between the formation and breakdown of phytoplankton. This equilibrium is vital for biodiversity and thus for an ecological system's resilience to changing environmental conditions. (For example, algal bloom reduces water oxygenation levels at greater depths. This kills fish eggs, asphyxiates small organisms such as worms and crustaceans, and drives away other forms of aquatic life.)<sup>1</sup>

Disruption, which is not the same as destruction, can be remedied. Algal bloom can be broken down to some degree, and with the help of a defibrillator a doctor can correct cardiac arrhythmia. Moreover, some forms of disruption can be anticipated and thereby prevented. For example, roadblocks and no-go zones around the seat of government help keep disruptive demonstrators away from centres of power. Other forms of disruption can be similarly neutralised.

The hammering of a pneumatic drill can disrupt someone trying to solve a mathematical problem. Similarly, if a sensor's reliability is reduced due to extreme temperatures or vibrations, this can disrupt the algorithm used by an autopilot to calculate an aircraft's flight path. But like a person with robust powers of concentration, an algorithm can also be robust in the face of disruptions and neutralise them as they occur.<sup>2</sup> This quality of robustness, incidentally, is also a key characteristic of someone who possesses knowledge about a specific topic. Such a person does not allow herself to be irritated by circumstances that do not in any way alter the truth of her opinion on the matter at hand. Knowledge is a disruption-proof belief in what is true, what should be done, or even what is morally necessary.

Whenever we register a disruption, we experience this as a deviation from our expectations. We often experience this deviation as a moment of uncertainty or frustrated expectations. Does this mean that disruptions are always a bad thing? Not necessarily. Take fine art. Beyond its depiction of religious themes and courtly scenes of historical events and figures, it occasionally aims artfully to



disrupt the stereotypes that guide our perception of the world and ground our expectations of what our senses will reveal. When this is sufficiently subtle, it makes us aware of those stereotypes and suggests other ways of looking at things. Disruptions can also challenge the accepted functions and norms that underpin our expectations.

This is what demonstrators who practice civil disobedience do by standing in the street and defying a ban on demonstrations without resorting to violence. They frustrate motorists' expectations that they will be able to drive quickly through the city at this time of day. And they confront authorities' expectations that citizens should behave in a certain way and stay quiet. The demonstrators challenge, in a restricted sense, the normative requirement that people should always obey the law. And they do so, justifiably or not, in the name of weightier norms of a community based on the rule of law, such as a fairer distribution of communally generated wealth. As the Irish poet Oliver Goldsmith once protested: "Ill fares the land, to hastening ills a prey/Where wealth accumulates, and men decay."

Disruptions should be judged according to whether, and to what extent, the expectations they frustrate are themselves justified. This in turn depends on what one thinks of the functions and norms upon which these expectations rest. Cardiac arrhythmia is an evil, since nobody can really want their heart not to function in the way it is expected to. Certainly, an evil can be tolerated, but this does not make it any less of an evil. A disruption to traffic by demonstrators may seem a trifle by comparison. Yet disobeying the law in a democratic state subject to the rule of law is no such thing. In this case, a disruption is judged according to whether this act of civil disobedience is making a crucial contribution towards the common good for citizens. On the other hand, there seems little doubt about how to judge the disruption of an ecosystem. Who argues against environmental concerns these days? And nobody is really against biodiversity – so long as this harmony remains purely rhetorical. But this does not rule out different assessments: for example, whether the impact of ecosystem disturbance on biodiversity is judged bad because it frustrates the fulfilment of a function of that diversity, namely benefiting us humans, or whether it is judged bad because biodiversity itself has intrinsic value.

Yet the fact that there can be differences regarding how we evaluate a disruption does not mean that there is no such thing as an objective, correct judgement. The existence of a disruption – either in the form of the opposition and indignation of others, or in the resistance of nature – tells us something important; on the one hand, we have expectations about what is or should be the case and, on the other, there is objectively that which is or

## “Knowledge is a disruption-proof belief in what is true.”

Lutz Wingert

should be the case. When our expectations are shaken, this teaches us, sometimes painfully, to be mindful of this difference. Knowledge of this difference is what prompts us to experiment in the empirical sciences and have discussions in a democratic society. We subject our own expectations to the test of a reality that may then disrupt them.

Dogmatic people don't do this. They tend to neutralise disruptions to the point of denying reality. Those who rightly claim knowledge about the world of experience behave differently. Instead of merely regarding disruptions as a negligible irritant, they consider that they expose errors in our assessments of reality. For what disruption reveals is a reality, be it natural or social, that is beyond our reach. Knowledge is also an error-sensitive belief in what is true or right. Those who believe they can completely eliminate disruption also believe they can mould reality like putty in their hands. This belief is not disruptive; rather, it is destructive. ○

<sup>1</sup> I am grateful to my doctoral student Jérôme Léchoy for providing details about this.

<sup>2</sup> My thanks to my student Jonas Derissen for alerting me to this example.

# SHAKING THE



The soil bacterium *Myxococcus xanthus* (above) and potato blossom (right)

Evolution never stops – and disruptions can speed up the process. Now ETH researchers are delving deeper into the secrets of evolutionary change.

TEXT Peter Rügge



# FOUNDATIONS OF LIFE

Images: Gregory J. Velicer, Colourbox/Alfred Hoter

The evolution of life on Earth has taken a long, long time. Protocells – the precursors of today’s unicellular organisms – formed around four billion years ago, eventually evolving into bacteria and archaea. The first eukaryotes emerged two billion years ago, providing the basis for more complex, multicellular organisms. As life evolved, it faced numerous disruptions in the form of meteorites, volcanic eruptions, ice ages and periods of great heat. Our planet has experienced at least five mass extinction events over its long history – yet still life has continued, undaunted.

Change is one of the driving forces behind evolution: all organisms, from bacteria to elephants, must constantly change and adapt to deal with challenges such as increasing competition for food and space, food scarcity, environmental changes and climate change. Failure to adapt means extinction.

**SUCCESS THROUGH COOPERATION** Bacteria are ideal for investigating evolutionary processes because they are small and have very short generation times. ETH professor Greg Velicer opted for the soil bacterium *Myxococcus xanthus* as a model organism because it forms cooperative groups and hunts other microorganisms. When food becomes scarce, thousands of *Myxococcus* cells aggregate into a fruiting body and produce spores, which can survive in the soil for long periods of time under stressful conditions.

“It’s now clear that microbes, far from being isolated loners, are actually highly social

organisms. Microbes cooperate with, deceive and fight other microbes, both within their own intra-specific social groups and within extremely complex multi-species communities,” says Velicer, Professor of Evolutionary Biology at the Institute of Integrative Biology. These findings also apply to pathogens. For example, cells of the dreaded hospital bug *Pseudomonas aeruginosa* or the cholera pathogen *Vibrio cholerae* communicate with one another in order to form resistant biofilms and in producing cytotoxic agents.

“One of the key questions for evolutionary biologists is how cooperation evolves over time, and especially how it persists in the face of selfish, non-cooperative behaviour,” says Velicer.

A while back, he and his colleagues were able to show that some individual bacteria in groups of *Myxococcus* cells exhibit cheating behaviour towards other cells in the same group: these mutant cells – or cheats – do not themselves produce fruiting bodies or spores. Mix these cheats with cooperative, spore-forming cells, however, and they benefit from this work without making any contribution of their own – in other words, without providing →

the required energy in the form of chemical messengers and enzymes. This enables the cheats to increase their frequency in a population at virtually no cost to themselves, thus threatening the survival of the cooperative system. “We’ve even seen cases of cheating that have driven entire populations of cooperators and cheats to extinction,” says Velicer.

Nevertheless, cooperation continues to be a successful evolutionary strategy that has proven to be evolutionarily stable against such cheating across many biological systems. For example, cooperative *Myxococcus* bacteria can quickly give rise to social adaptations, as Velicer discovered in a further study. He observed how a strain that began by exhibiting cooperative behaviours evolved first to become a cheat and then later evolved back into a cooperating strain – in fact, a new, better-adapted form of cooperating strain that was highly resistant to its own progenitors’ attempts at cheating. A subsequent study by one of Velicer’s colleagues showed that cooperation was restored thanks to a single mutation in a previously unknown small RNA (sRNA). It emerged that this sRNA plays an essential role in the regulation of fruiting-body formation.

**DRAMATIC DOUBLING OF THE GENOME** Mutations in DNA occur spontaneously and randomly, yet they are fundamental to evolution. While most are inconsequential and have no effect on the organism, some genetic changes are more profound and affect the entire genome. One example of such a sudden and dramatic event is the duplication of the entire set of chromosomes. During meiosis – the cell division of germ cells – the chromosomes do not split into the daughter cells evenly. Chromosomes are threads of DNA wrapped around a

protein scaffold. A normal human cell has 46 chromosomes: two sex chromosomes and 22 pairs of non-sex chromosomes.

When meiosis goes wrong, one of the daughter cells gets all the chromosomes and thus all the genetic material of the parent cell. It remains diploid, while the other cell receives nothing and dies. If two diploid germ cells then fuse, this produces an organism with cells that have four sets of chromosomes. The organism is now polyploid, which poses significant challenges in regard to cell biology and the organism’s physiology.

Kirsten Bomblies, Professor of Plant Evolutionary Genetics at ETH Zurich’s Department of Biology, has been investigating this phenomenon: “Polyploidy can occur randomly or due to environmental changes such as drought, cold or salt stress.” It is common among plants, though less frequent in fish and amphibians. There is only one example of a polyploid mammal – though even this case is heavily disputed. Most polyploids are evolutionary dead ends but some acquire an advantage. “Plants with multiple sets of chromosomes are far more resistant to drought and salt than their predecessors,” she explains. Polyploid plants also have larger fruits and seeds, which makes them an interesting model for breeding new varieties of crops with higher yields and resilience. In fact, many important food crops have already been bred to be polyploid: wheat, potatoes, maize and coffee all have multiple sets of chromosomes.

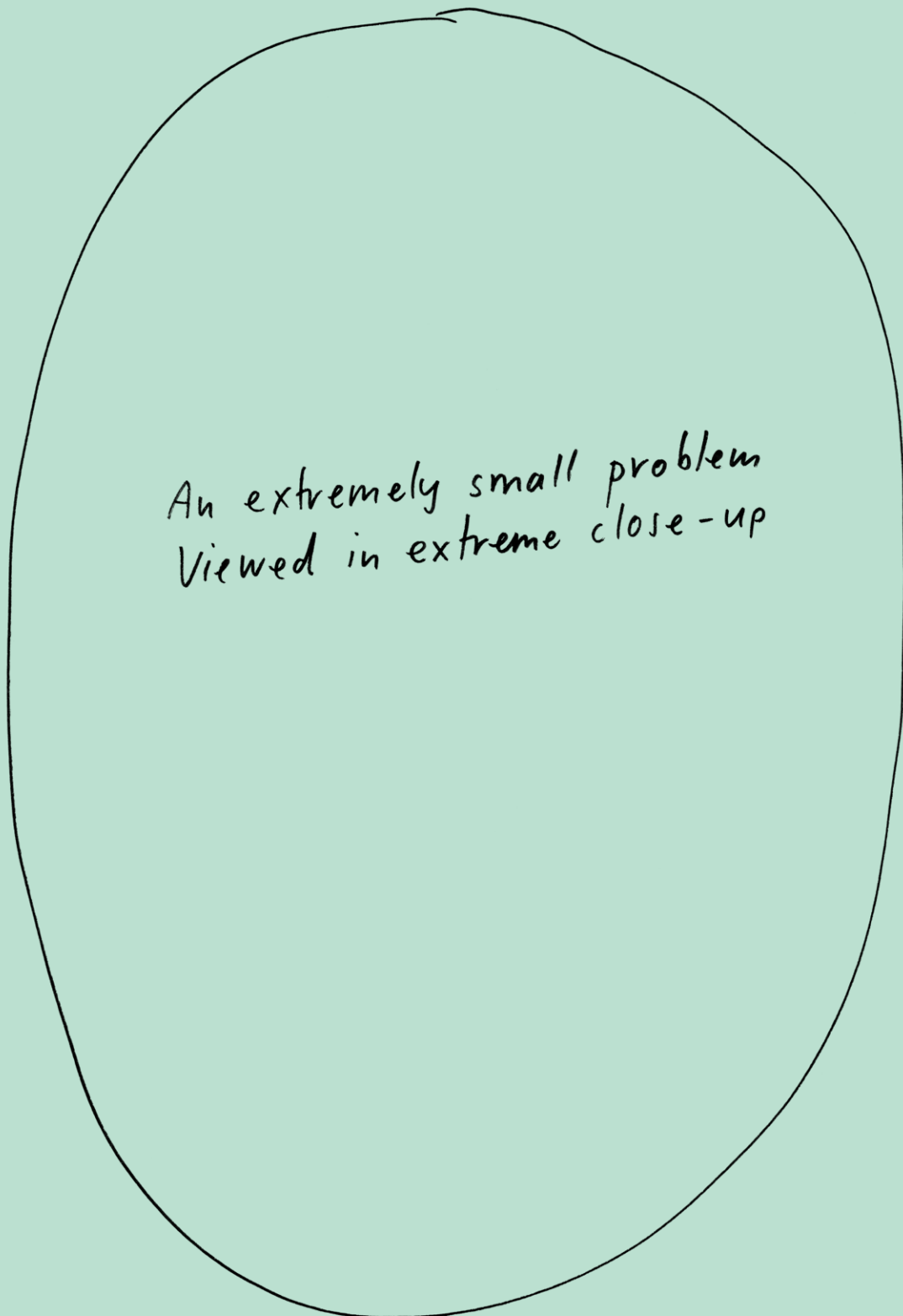
In one of her projects, Bomblies is investigating why polyploid plants are so stress-tolerant. One reason is cell size. Polyploid cells are larger than diploid cells, and this affects their interactions with the environment, such as the exchange of gases and water. “For an evolutionary biologist, polyploidy is as an absolutely fascinating example of disruption,” Bomblies says. “It’s a profound evolutionary force because it changes everything in an organism’s biology.” ○

**KIRSTEN BOMBLIES** is Professor of Plant Evolutionary Genetics. She conducts research into adaptive evolution in plants.  
—> [impb.ethz.ch/research/research-evo](http://impb.ethz.ch/research/research-evo)

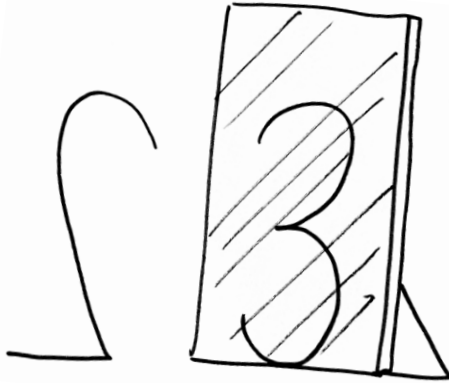


**GREGORY VELICER** is Professor of Evolutionary Biology. He studies the social behaviour of microbes.  
—> [evo.ethz.ch](http://evo.ethz.ch)





An extremely small problem  
Viewed in extreme close-up



# RESILIENCE AS A POSITIVE FORCE

Disruption has the power to upend our lives. But approached constructively, disruption and resilience can be positive.

TEXT Angelika Bühler

Disruptions can affect individuals, society or technology and are almost impossible to avoid. So what's the best way for humans and machines to respond to these glitches? And how can they bounce back stronger from challenging situations?

**TWO SIDES OF THE SAME COIN** Disruption often creates uncertainty because we are unsure how to deal with it. "We sense that our power and control over the situation is limited," says psychologist Petra Schmid, Assistant Professor in the Department of Management, Technology and Economics. Disturbances in our day-to-day life trigger a chain reaction. "When our routine is interrupted, we have to exert more self-control to compensate for the disruption," she explains. That makes it harder to concentrate and means we are more likely to lose focus, but how this affects our resilience varies from one person to the next. "Depending on how vulnerable an individual is to disruption, they may actually emerge stronger from a negative experience if they apply the right resilience strategy," says Schmid.

**THE KEY TO PROGRESS?** Disruption may be undesirable, but it can have a positive knock-on effect by paving the way for change. "Disruption creates a sense of flux or upheaval that we can use to our advantage," says the psychologist. Times of change offer an opportunity to reflect and focus on our core values. They prompt us to ask what really matters – and what we really want. "People tend to be less inclined to address these kinds of issues when things are running smoothly," she adds. History shows that disruption leads to remarkable change and progress as people strive to escape disorder and return things to a state of equilibrium. So might disruption actually be a prerequisite for progress?

Petra Schmid believes it is: "Disturbances in our day-to-day lives inspire creativity and innovation." If everything always ran smoothly, we wouldn't want to make many changes – which is why Schmid sees

positives even in the coronavirus pandemic. She argues that it has given rise to new forms of working and encouraged people to spend more time on hobbies they would have neglected in normal times, from new sporting activities to language learning and self-improvement.

**YEARNING FOR NORMALCY** Cognitive scientist Christoph Hölscher is interested in resilience in all its forms – and not only in humans: “The concept of resilience can be applied to various disciplines.” That’s because all systems can be in one of two states: their normal state or a disrupted one. A system in this context might be a human being, a piece of technical infrastructure or a combination of the two. When a system is disrupted, it yearns to be restored to its normal state.

Thus, the principle of human resilience can also be applied to technical systems, provided that these systems are capable of responding adaptively to their environment. “One way to develop resilience is through adaptive cognition,” says Hölscher. This is the ability to react appropriately to one’s environment and to learn from challenges. “Whether you’re a machine or a person, learning takes place when something happens that doesn’t fit within your standard framework.”

#### RECIPE FOR GREATER RESILIENCE

Hölscher is particularly interested in how this applies when machines learn from their users and vice versa. For example, how can medtech companies design ventilators that can be used quickly and appropriately in a stressful situation? He suggests there are two key strategies: “The first is to acknowledge that the perfect system doesn’t exist. But even more important is that the user acquires the necessary expertise in operating the device.” Specifically, this means practising how to use the system under normal, non-stressful conditions and then steadily raising the levels of stress as the training continues. This is the principle behind pilot training, which requires humans and machines to work closely together.

“But however much expertise someone has – and however well the system is designed – what ultimately counts is the individual’s ability to cope with stress,” says Hölscher. The degree to which we attribute a disruption to ourselves or to an

external event is key. In other words, do we blame ourselves or the situation? “It’s important to take a certain amount of personal responsibility, but attributing too much blame to ourselves can end up blocking our way forward,” says Hölscher.

**DRIVER OF CHANGE** The fact is that we need disruptions to set transformation processes in motion. “Disruptions create opportunities for long-term change,” says Hölscher. Like Schmid, he views the pandemic as a disruptive event that is serving to accelerate certain trends and innovations such as working from home and video conferencing. Disruptions can have positive consequences on both an individual and societal level but they always come at a price, says Hölscher. Coping mechanisms are important here, as is the ability of the systems involved to adapt to change. With plenty of reflection and the necessary expertise, we can let disruption and resilience reveal their positive side. ○

“Disruption creates a sense of flux or upheaval that we can use to our advantage.”

Petra Schmid

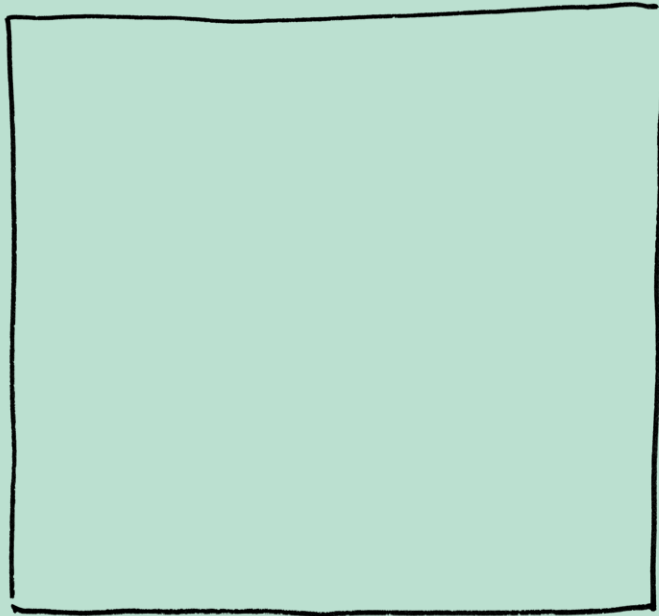
**PETRA SCHMID** is Assistant Professor in the Department of Management, Technology and Economics. Her research focuses on the role of affect, motivation and self-control in the effects of social power.  
—> [ob.ethz.ch](http://ob.ethz.ch)



**CHRISTOPH HÖLSCHER** is Professor of Cognitive Science in the Department of Humanities, Social and Political Sciences. His research focuses on human interaction with technical systems.  
—> [cog.ethz.ch](http://cog.ethz.ch)



*A poorly managed triangle*





# KEEPING AN EYE ON SYSTEMS

Even minor disruptions in infrastructure systems can have fatal consequences. Researchers and practitioners counter that risk by taking action on multiple levels.

TEXT Martina Märki and Michael Walther

$$\sqrt{4} = 3$$

## MAKING URBAN SYSTEMS MORE RESILIENT

By trade, Božidar Stojadinović is an expert in earthquake-proof construction. Now a Professor of Structural Dynamics and Earthquake Engineering, he specialises in urban systems and how to make them more resilient to earthquakes. “Systems engineering has become increasingly important in resilience research,” he says. His combination of skills made him an obvious choice to head up a research cluster in the Future Resilient Systems programme in Singapore – even though earthquakes are one of the few topics not on the agenda. Instead, the goal is to understand the resilience of high-density urban systems – of which Singapore is a good example – and to strengthen them in preparation for future challenges. The key challenges confronting Singapore are climate change and land scarcity. Responding to this will require long-term planning and timely changes to urban infrastructure.

Together with researchers from Nanyang Technological University Singapore (NTU) and the National University of Singapore (NUS), Stojadinović is developing a comprehensive computer model of the city that can be used to simulate urban systems as well as any challenges and their effects. In addition to incorporating all the buildings and associated infrastructure systems, such as power and water, this digital representation can be used to model user interactions with the systems. The model itself is based on a computer software framework originally developed for military war games and now widely used in gaming. The software lets users run multiple simulations of a variety of systems and exchange information →

between them. “That’s a crucial feature,” says Stojadinović. This is because of the sheer complexity of urban systems and the way that individual subsystems influence each other. “We’re already pretty good at modelling and optimising individual systems, but often we don’t fully understand how systems influence each other,” he adds. The model that Stojadinović and his fellow researchers are developing aims to solve that problem and encourages experts to look beyond individual infrastructure systems and to perceive urban systems as a whole.

→ [frs.ethz.ch](https://frs.ethz.ch)

**RISKS IN CRITICAL NETWORKS** “Nobody could have predicted it” is an oft-heard response to system failure. Giovanni Sansavini, ETH Professor of Reliability and Risk Engineering, works tirelessly to disprove that notion. An engineer by training, he studies risks in complex networks such as interdependent energy networks and large supply chains.

Risks in complex systems are hard to grasp in scientific terms. That’s because systems tend to grow or shrink over time and change their structure. Many of them span the entire globe, and they often have no fixed mode of operation. Power grids, for example, are subject to diverse influences, and under load they respond differently than in normal operation. To address these challenges, Sansavini and his group experiment with computer models. They identify risks using the scientific method of uncertainty quantification, which allows researchers to capture a broad spectrum of conceivable impacts, errors and failures, and to observe how the modelled network behaves. Such Monte Carlo simulations make it possible to analyse the interrelationships between numerous failures. This opens the door to the discovery of hidden or “systemic” risks – the kind that can trigger the cascading failures that are often the cause of serious problems in complex systems. One example of this was a major blackout in Italy in 2003, which was caused by automatic systems shutting down one after the other as they came under increasing load.

Sansavini’s models serve not only to identify risks, but also to quantify them. Thus, the researchers can determine which combinations of failures have the worst consequences for a system and how likely they are to occur. Understanding these scenarios is the basis for providing systems with adequate protection. In the case of energy grids, that



“We often don’t fully understand how systems influence each other.”

Božidar Stojadinović

might mean making them more flexible and less reliant on individual energy sources. Or setting up early-warning systems, introducing technical improvements to address vulnerabilities, and helping the grid quickly return to normal after disruptions. “Of course, however robust we make the systems, people will still make mistakes, and unexpected things will happen,” Sansavini cautions. The good news is that even these mistakes can be replicated in the virtual model. This means we can predict the system evolution and make it more resilient to disruptions in the future.

→ [rre.ethz.ch](https://rre.ethz.ch)

**ALGORITHMS IN ACTION** Olga Fink and her team conduct research on faults in complex systems, from aircraft and gas turbines to infrastructure systems such as railways. As Professor of Intelligent Maintenance Systems, Fink develops intelligent algorithms that learn from data collected by condition-monitoring devices. These algorithms

address various challenges, from detecting system faults and diagnosing different failure types to predicting when the next failure might occur – or even implementing a prescriptive maintenance strategy. “Our goal is to predict the remaining useful life and then control the operation of a system to prolong its service life,” says Fink. The intelligent algorithms learn from both historical and real-time operation and condition-monitoring data.

One hurdle is that machine-learning algorithms need a lot of data. “Failures are rare in safety-critical systems, so we don’t really have enough data to learn from,” says Fink. Fortunately, the researchers have some tricks up their sleeve: “One approach is to use data that represent the system’s healthy state and train the algorithm to detect deviations.” It can also be helpful to use condition-monitoring data from similar systems and adapt them to a specific system. Yet, in many cases, even

these methods may not be sufficient. The researchers must then go a step further, by combining their algorithms with physical models that simulate the system they are monitoring or enriching the AI models with physical domain knowledge. This means the algorithms can work with less data and are easier to interpret by the experts who have to make decisions based on the algorithm’s outputs. In one project with NASA, for example, the researchers were able to predict the remaining useful life of aircraft engines. Olga Fink is particularly proud of this achievement: while early fault detection is now a mature process, predicting the remaining useful life of a system is a lot harder. It has been, she says jokingly, the “holy grail” of her area of research.

→ [ims.ibi.ethz.ch](https://ims.ibi.ethz.ch)

**DISRUPTIONS ARE PART OF THE JOB** Managing disruption is part of everyday life for Walter Iten, Head of Facility Management at ETH Zurich. His department is in charge of technical and infrastructure management for all ETH buildings and facilities. Iten says power failures are the biggest problem: “Nothing works without power!” That’s why ETH relies on redundancy. Facility Management can draw power from two different substations for part of the Zentrum campus. And, in the event of a major power cut, the most important areas also have access to back-up diesel generators. For particularly sensitive research equipment, batteries are used to ensure an uninterrupted power supply.

But the jewel in the crown is the predictive maintenance strategy for all the facilities and buildings, which aims to prevent disruptions of all types from occurring in the first place. An IT maintenance tool keeps track of each system’s operating hours and maintenance schedule, and triggers maintenance jobs as they become due. An increasingly important role is also played by sensors, which monitor systems to detect sudden failures. The Facility Management team can access these data remotely on a computer and intervene to a certain extent in the operation of the system. Currently, the facility-monitoring system and the maintenance tool are not connected – but, with the latest advances in sensor technology and AI, it is only a matter of time. ○



Images: Colourbox

1  
Planning decisions have a long-term impact on the resilience of urban systems – and not just in Singapore.

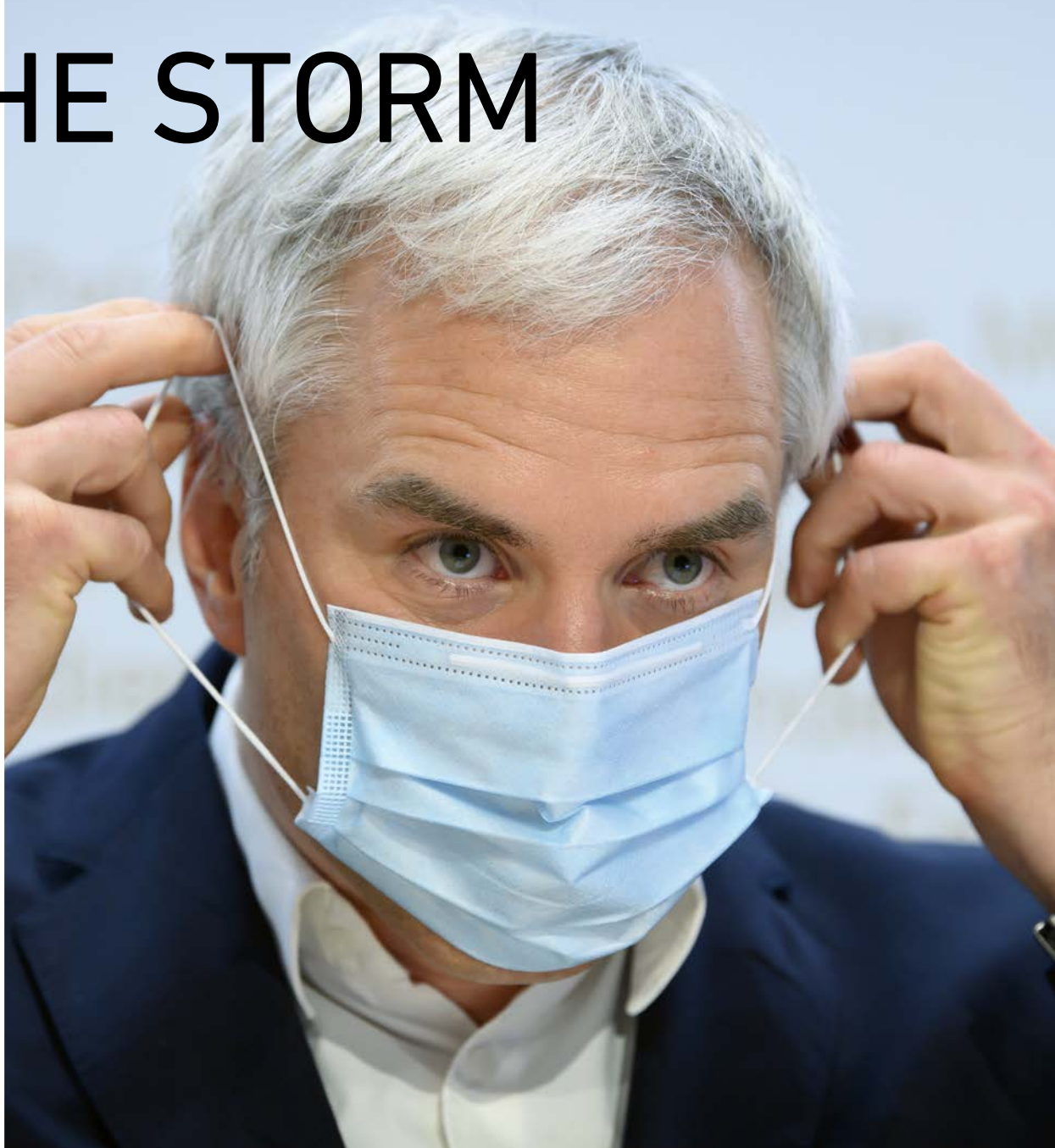
2  
ETH researchers can predict the remaining life of aircraft engines using machine-learning algorithms.

As Chair of the National COVID-19 Science Task Force, Martin Ackermann has to perform a constant balancing act between science, politics, the media and society. How does he do it?

INTERVIEW Corinne Johannssen and Felix Würsten

FOCUS

# IN THE EYE OF THE STORM



**Mr. Ackermann, you're the Chair of the Swiss National COVID-19 Science Task Force, a role that includes advising the Federal Council on the coronavirus pandemic. Do you ever wish you were a Federal Councillor yourself?**

It's never really occurred to me! In the situation we're in right now, I suppose it would sometimes feel more satisfying to be involved in making decisions rather than just giving advice. So it's an interesting idea. But I've also seen how much responsibility politicians have and how much pressure they're under – so maybe I'm better off as a professor after all (*laughs*).

**So all you can really do is give recommendations?**

We provide the scientific rationale, but it's the politicians who make the decisions. As Chair of the Task Force, I also take part in the government press briefings. A lot of the behind-the-scenes work is about relationship-building and dialogue. It took us quite a long time to win the trust of the political establishment. After all, we can only do our job properly if the decision-makers trust us! We play multiple roles: we're the voice of science, we advise the government and provide the public with information. It's quite a balancing act to do those three things simultaneously. As an independent body, we are supposed to question and probe the government's response, but our role as advisers only works if politicians trust us.

**What have you learned about politics over the past few months?**

I have tremendous respect for politicians because they work within a framework that influences virtually everything they do. That way of working is not something I'm familiar with as a scientist. When we conduct research, we're the ones who set the standard we want to achieve, and then we work until we achieve it. But politicians are faced with these huge practical constraints that affect just about everything. Having said that, I've met politicians who not only understand the politics of this pandemic but also have an excellent grasp of the science.

**How about the media?**

It's amazing how well some journalists keep on top of things: I learn as much from talking to them as they do from talking to me. But I've also learned that the media have this tremendous urge to highlight differences. Because media voices have a major impact on public health, that emphasis on differences can be damaging – and I'm not convinced that everyone in the media is fully aware of that responsibility. At the same time, of course, the media has an important role in probing and questioning the official line and government decisions.

**Switzerland seems to be having a hard time dealing with this crisis. Would you agree?**

Yes, I think that's a fair assessment. Last autumn, in particular, a lot of people got infected, and a lot of people died.

**Does that surprise you?**

Yes, it does. Obviously, this crisis surpasses anything I could have imagined, but I still thought we would cope with it better. I expected us to take an evidence-based approach, deploy all sorts of tools and make the most of our technological assets. I had high expectations, but I've been disappointed.

**Might it stem from our belief that we're somehow better than everyone else?**

I think the biggest problem was how quickly people seized on the idea that we had to choose between health and the economy. That coloured the whole debate and made it very difficult to take bold action at an early stage. The Task Force has reached a very clear consensus that the best solution for both public health and the economy is to impose tough restrictions that bring case numbers down rapidly rather than taking a light-touch approach and accepting long periods with high case numbers.

**But how do you persuade the public of the need for tougher restrictions when, even at the height of the second wave, a quarter of ICU beds were still empty?**

The problem is that we're not very good at understanding exponential processes. When the number of cases surged in October, some voices argued that we should add an extra 200 certified ICU beds and ask staff to work an additional four hours a week. Despite knowing that this suggestion →

**MARTIN ACKERMANN** joined ETH Zurich as a researcher in 2004 and has been a full professor since 2015. He heads the Microbial Systems Ecology research group at ETH and Eawag. He was appointed as Chair of the Swiss National COVID-19 Science Task Force in August 2020.  
→ [mme.ethz.ch](http://mme.ethz.ch)

wasn't feasible, the Task Force still calculated what impact those measures would have had. Our calculations showed they would have gained us just 36 hours! You can't fight exponential growth with linear measures, but it's hard to accept that when you're right at the beginning of that kind of development.

#### **Is that why so many people are sceptical?**

Even when hospitals are full, the effect coronavirus has on most people's day-to-day lives is minimal or non-existent. You can't see it or feel it, even though everyone is telling you that it's terrible and that you have to accept all kinds of restrictions to combat it. That's a tough thing to grasp, so it doesn't surprise me that so many people are sceptical. That's why it's so important for hospital staff and patients to tell the public what they're going through.

#### **It's starting to feel like some people have stopped listening to scientific evidence. Have we done something wrong?**

I think a lot of it comes down to empathy. You can't get people on board without first knowing where they stand. Listening to people and understanding why they believe what they believe is extremely important. But that's obviously difficult in group situations such as press briefings. It's something you need to tackle on a one-to-one basis.

#### **What skills are most important to you right now?**

Talking to people, swapping ideas. The most important thing at the moment is relationship-building. We need to focus on listening and understanding so that we can find solutions together – and on not losing our cool when things don't work out. There are aspects of this pandemic that are closely related to my specialist field, and scientific expertise is a key part of our work on the Task Force – but, taken by itself, it's not enough.

#### **You actually work as a professor at ETH, but do you have any time left for that side of things?**

ETH and Eawag were both incredibly supportive and let me hand over nearly all my responsibilities, but it's been much harder for my research group. I've been setting aside time for one-on-one sessions, but I can't contribute as much at the moment as I would like to. That's tough because there's a lot at stake for the careers of these young, talented individuals.

**“In Switzerland, people quickly seized on the idea that we had to choose between health and the economy.”**

Martin Ackermann

#### **And how are you coping on a personal level?**

##### **Do you get any time to switch off?**

I often wake up in the middle of the night with my thoughts turning straight to the pandemic. But I'm being careful not to burn myself out. What really saps my energy is conflict. It really affects me and I can get quite down about it. Fortunately, it's a rare occurrence! Most of the interactions I have are positive – in the end, people understand that we all have the same goal.

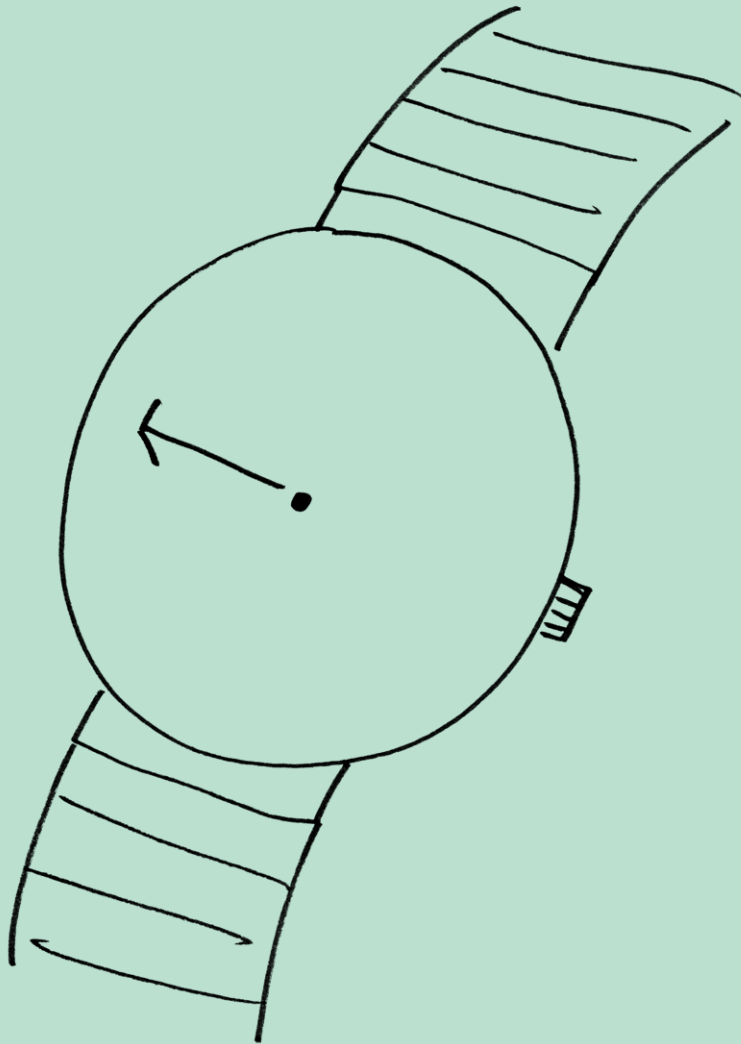
##### **Do you see any positives to all this disruption?**

The picture we had of ourselves and of Switzerland is being severely challenged – and that's a painful process. On a positive note, it's a chance to learn and ask questions: How quickly can we put new technologies into practice? How far have we come with digitalisation? As a scientist, it's exciting to come out of my bubble and help tackle these pressing problems.

##### **How about for you personally?**

These are tough times, and sometimes I'm just exhausted. But I'm also fortunate to have this opportunity. It's difficult to be sitting around and feeling powerless in a crisis of this magnitude. I'm lucky enough to be able to lend a hand – and that's a huge privilege. ○

Countdown to problem



# COMMUNITY



ETH employees have moved into the Octavo building in Oerlikon.

Image: Tom Kawara

## New forms of collaboration

ETH Zurich has experienced a major growth spurt, with student numbers up, the faculty expanding in size, and continued expansion into new academic fields. To create more space for teaching, research and knowledge transfer on campus, the Executive Board domains of Infrastructure and of Personnel Development and Leadership moved to the Octavo building in Zurich Oerlikon in late 2020.

What began as a relocation project soon evolved into an exploration of new working environments and forms of collaboration. This partly comes down to the remit of the two Executive Board domains, which is to provide infrastructure and services for teaching, research and knowledge transfer. Increasingly, this requires the deployment of interdisciplinary, flexible teams – a new way of working that calls for new office and furnishing concepts. The building boasts an open, multi-space office layout with differently designed areas that can cater to a range of requirements. These kinds

of flexible and efficient workspace models – particularly multi-space and desk-sharing solutions – will become more common at ETH in the future. The experience gained at Octavo will therefore be extremely helpful. “We’re already applying our insights from the Octavo project to upcoming projects, including in the area of teaching and research,” says Ulrich Weidmann, Vice President for Infrastructure.

The building is also a meeting place for visitors, with the ground-floor restaurant open to both ETH staff and the general public. It also features a publicly accessible wall display that showcases fascinating exhibits from ETH’s extensive collections and archives. ○



## Transforming cooperatives

Cooperatives play a major role in the Swiss economy. An interdisciplinary research project at ETH Zurich is aiming to promote a broader understanding of cooperatives in a changing world. The project is run by Michael Ambühl at the Chair of Negotiation and Conflict Management and Stefano Brusoni at the Chair of Technology and Innovation Management.

Funding for the research group comes from a partnership with Swiss insurance cooperative Mobiliar, which will be supporting the group's activities for a period of five years. ○

## Olga Sorkine named ACM Fellow



Image: Giulia Marthaler

Olga Sorkine-Hornung, Professor at the Institute of Visual Computing, has been named an ACM Fellow for her contributions to digital geometry processing, computer animation, computer graphics and visual computing. The Association for Computing Machinery (ACM) awarded this honour to a total of 95 members. ○



Image: ETH Foundation / Valeriano Di Domenico

Left to right: Pius Baschera, President of the ETH Zurich Foundation's Board of Trustees; donor, ETH alumnus and Honorary Councillor Martin Haefner; and ETH President Joël Mesot

## Donation for a highly specialised physics laboratory building

ETH Zurich is keen to further expand its leading position in quantum research. However, work in this field relies on highly complex infrastructure. This is because fragile effects at the atomic level can only be detected by means of extremely elaborate experiments. These experiments must be performed in environments that reduce interference as much as possible – hence ETH Zurich's plan to erect a research facility perfectly suited to that purpose. The ETH Foundation recently received a donation of CHF 40 million from Martin Haefner, who is Executive Chairman of the Board of Directors and owner of the company AMAG as well as an alumnus and Honorary Councillor of ETH Zurich. This has given the project a major boost. If everything goes according to plan, construction will begin in 2022 and the building will be ready in 2028. ○

# Climate change in slow motion

As global warming continues, climate-change communication and education are becoming more important than ever. To address these issues, the Plant Science Center will be rebooting its Climate Garden 2085 initiative in a project supported by the Federal Office for the Environment. Starting in April 2021, the Center will launch its hands-on art and science experiment at ten secondary schools and vocational colleges in German-speaking parts of Switzerland. Two separate greenhouses will be used to simulate different climate scenarios, giving students the chance to experience the impact of climate change on crops. The project team also plans to run debates led by doctoral students at each school as well as workshops looking at sustainable nutrition and the impact of climate change on Swiss agriculture. Helping people enjoy the beauty of plants and nature is another key project goal. ○

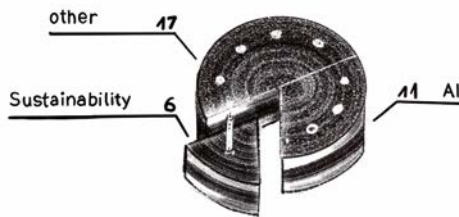
→ [klimagarten.ch](http://klimagarten.ch)



Image: Nina Mann

The Climate Garden aims to make climate change tangible.

## ETH spin-offs in 2020: AI and sustainability



ETH Zurich can look back at a very successful year for spin-offs. Thirty-four founding teams took the leap into entrepreneurship in 2020. The number of spin-offs per year has risen steadily over recent years, but the figure for 2020 sets a new record. Once again, many of these new companies have their roots in information and communication technology, including 11 based on artificial intelligence (AI). Six of the new ETH spin-offs are developing sustainabi-

lity-related products or services. More and more ETH students are founding spin-offs immediately after completing their Master's degree – a clear sign of their business acumen and feel for the market.

ETH spin-offs generally perform well in the market: last year, ETH companies raised more than 400 million Swiss francs in capital. Examples here include GetYourGuide, Climeworks and Scandit, which closed financing rounds of approximately CHF 129, 100 and 77 million, respectively. Meanwhile, fledgling AI spin-off DeepCode has been acquired by Snyk, a leading code security analysis company. In a bold move, ETH spin-off HeiQ – which was founded in 2005 and manufactures antiviral textile products – began trading on the London Stock Exchange. It is the first time an ETH spin-off has been listed on a stock exchange outside Switzerland. ○

## Green nanotechnology for cleaner water

Cosmetics, medicines, fertilisers and detergents contain all sorts of chemical compounds, many of which cannot be completely removed from wastewater by today's treatment plants. As a result, they end up contaminating our water resources and the wider environment as micropollutants.

ETH spin-off Oxyle offers an environmentally friendly method of removing problematic organic microcontaminants from wastewater. The method works by inducing the decomposition of chemical residues in contaminated water in an automated reactor. It does this using a novel material system, which consists of a combination of nanomaterials with an extremely high surface area. This robust nanocatalyst is not directly involved in the chemical reaction; rather, it simply accelerates the conversion of the substances into harmless compounds.

The treated water can be safely discharged into the standard sewerage system.

This method can be used to treat wastewater in sectors including the pharmaceutical and chemical industries, hospitals, the electronics industry and wastewater treatment plants. ○

Oxyle: ETH spin-off company established in May 2020  
Product: sustainable wastewater treatment  
→ [oxyle.ch](https://oxyle.ch)



The reactor offers a fast cleaning rate with a small footprint and can be powered by green energy.

# New rules for the doctorate

New regulations will apply to anyone starting doctoral studies from autumn 2021. The new Ordinance on Doctoral Studies will introduce the mandatory assignment of a second supervisor as well as clearer rules on collaboration.

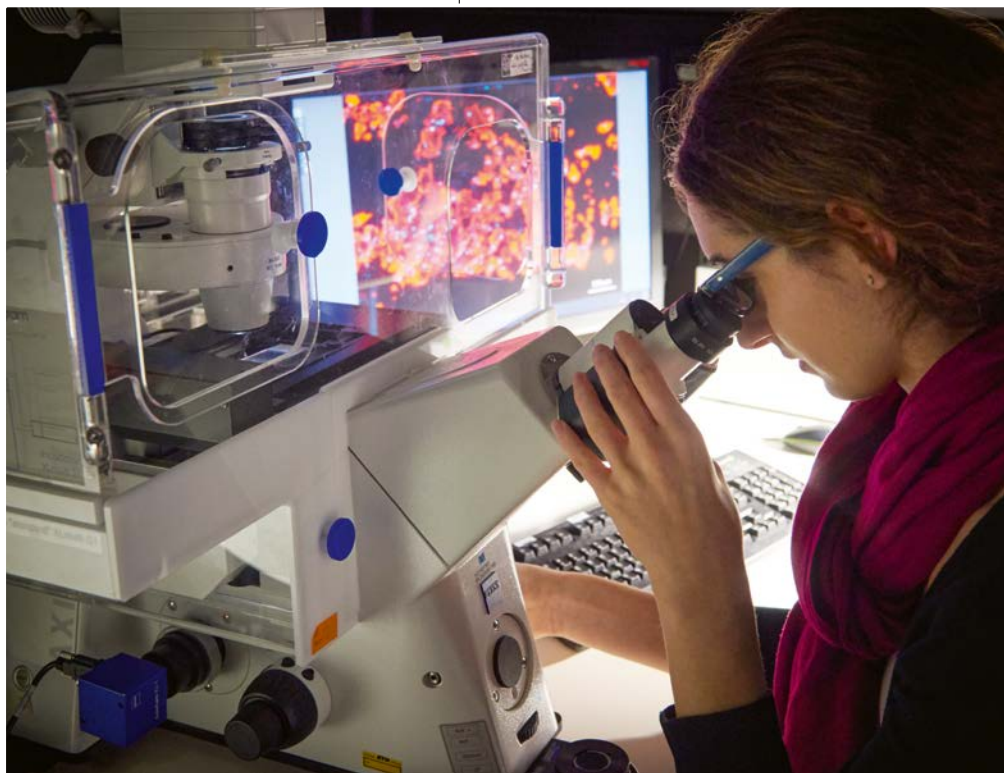
TEXT Michael Walther

ETH Zurich confers over 800 doctorates a year. During their studies, doctoral students are required to complete a large part of their research independently. In recent years, the doctorate has been the subject of much discussion at ETH, and a number of cases of poor supervision have also underlined the need for action. A symposium on the supervision of doctoral students in early 2019 laid the foundations for work to begin on a new set of regulations, the result of which is the new Ordinance on Doctoral Studies. Following approval by the Executive Board on 26 January 2021, it has now been submitted to the Swiss federal government for review.

The biggest changes concern the supervision of doctoral students. In order to reduce doctoral students' dependence on a single supervisor, the supervisory role will now be shared between several persons. At the same time, the doctoral system will place more weight on the principle of peer review. Antonio Togni, serving Vice Rector for Doctoral Studies until February of this year, headed the group in charge of amending the ordinance. "The work on the new ordinance inspired lively discussion at ETH," he explains. "That was both healthy and necessary. We wanted not merely to address the negative cases that have attracted media attention, but also to redefine the meaning of collaboration in doctoral studies."

**SECOND AND THIRD SUPERVISORS** In the future, every doctoral student will be assigned a second and, if they wish, a third supervisor right

Research is a central part of the doctorate.



from the start of their studies. The ordinance defines a second supervisor as “a person with expertise in the relevant field who provides the doctoral candidate with additional academic support and assistance”. If required, a third supervisor will act as a mentor and assist with, or mediate on, any questions relating to collaboration within the group. At the same time, a co-examiner must be appointed, who is responsible for preparing a written report on a candidate’s registration for the doctoral examination. The aim is to ensure that doctoral candidates remain independent of their second supervisor.

#### GUIDELINES FOR GOOD COLLABORATION

Under the new ordinance, candidates must draw up a doctoral research plan in consultation with their supervisors. This describes the research proposal as well as their teaching duties and participation in the research group. Candidates must then attend an aptitude interview, where they present and defend their research plan. A three-member aptitude committee makes the final decision on admission. Once admitted, doctoral candidates must report annually on the progress of their research. For their part, thesis supervisors are required to conduct an annual interim review, which must take into account not only research but also collaboration within the group. In addition, the stages of conflict resolution in the event of disputes and the procedure for changing the thesis supervisor have now been regulated in more detail.

As Togni explains, the purpose of the new rules is also to ensure that all research collaboration at ETH is on equal terms. Similarly, it is vital that supervision does not fall short, since doctoral candidates are still students who are going through a process of learning. “We’re confident that the majority of research groups have a healthy culture and are already practising many of the new rules,” says Togni. However, what doctoral students and professors expect from doctoral studies has shifted markedly over the past 10 to 20 years, and ETH is a lot bigger than it once was. “The old Ordinance on Doctoral Studies was no longer fit for purpose,” he adds.

**IN FORCE BY SUMMER** Over the course of two extensive consultation rounds, the Rectorate gathered feedback from all the academic departments and university groups. “Our priority was to encourage a detailed and transparent discussion on this subject,” says Christoph Niedermann from the Rector’s staff.

The ordinance must now go through an official consultation process at the federal level in Bern. Once this is complete, and the wording finalised, it is due to enter into force on 1 August 2021. ○

## PHILANTHROPY



BY  
Donald Tillman

### Every little counts

Since graduating from ETH Zurich in 2004 with a Master’s degree in industrial manufacturing and engineering, Daniel Uhlmann has built a successful career in the automotive industry. He lives in St. Gallen and has two children. When he turned 35, he began making donations to ETH’s Excellence Scholarship programme, starting at 50 Swiss francs a year and gradually increasing the sum as time went by.

Uhlmann is just one of many young people who are embracing philanthropy. Small donations add up – and together they can make a big difference. The community of ETH benefactors is growing steadily year by year, boosting the amount of targeted support available for outstanding students and projects. Over 5,000 individuals have already signed up, most of them alumnae and alumni, professors and staff members. All of them deserve our gratitude. “You don’t have to be a Rockefeller to support research and teaching at a top university,” says Uhlmann. “I’m proud to be doing my part to tackle major future challenges, help young people attend university, and foster equality of educational opportunities.”

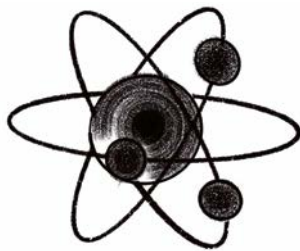
—> [ethz-foundation.ch/en/together](https://ethz-foundation.ch/en/together)

Image: Gian Marco Castelberg

Image: Eline Keller-Soerensen

# Raising the profile of quantum research

Quantum research is one of the most promising areas of research being pursued today. Scientists hope it will lead to pioneering breakthroughs in a variety of fields, seeding new applications in areas such as computing, sensor technology, communication and data security. Quantum research is also of great importance to ETH Zurich, which now has a significant number of professorships in this field. The role of the



quantum sciences is becoming increasingly important, not just in the Department of Physics but also in other disciplines.

Keen to forge closer ties between the key players in this field, ETH Zurich has now set up a new ETH Quantum Center, which will bring together expertise from ETH's various disciplines under one roof. A total of 28 professorships from 6 academic departments and PSI have already joined the new ETH Quantum Center, which also aims to raise the public profile of ETH's quantum research. This includes making ETH Zurich even more successful at securing European funding for quantum technology, boosting its status in future collaborative projects with businesses, and enhancing its ability to access third-party funding. In all these cases, ETH will benefit from the ability to present the full breadth of its expertise under the umbrella of the new Quantum Center. ○

Support quantum research:

→ [ethz-foundation.ch/en/quantum](https://ethz-foundation.ch/en/quantum)

# Renovation plans off the table

In light of growing staff and student numbers, ETH Zurich had planned various new buildings and major renovation projects. Due to the coronavirus pandemic, however, ETH Zurich now expects to have less financial flexibility in the future. The decision has therefore been made to suspend plans for a major extension and renovation of the canteen and multi-purpose building, including the Polyterrasse. An initial phase of essential technical refurbishments will still go ahead. Suspending these plans will enable ETH Zurich to cut its construction budget by a total of CHF 135 million over the next six years. This will give the university greater financial flexibility to move forward with research buildings – such as the new HPQ centre for physics on the Hönggerberg campus – and infrastructure for existing professorial appointments, thus fulfilling its basic mandate to provide teaching, research and knowledge transfer. ○



Image: Alessandro Dellabella

The popular Polyterrasse before the pandemic.

## IN PERSON



**BERND BODENMILLER**  
studies the mechanisms  
of cancer development.  
The quantitative biologist  
uses 3D analysis and virtual  
reality to detect groups  
of cells that break away  
from tumours.

TEXT Karin Köchle

**BERND BODENMILLER** is a Professor at the ETH  
Department of Biology and at the University of Zurich.  
—> [mhs.biol.ethz.ch](https://mhs.biol.ethz.ch)  
—> [bodenmillerlab.com](https://bodenmillerlab.com)

**Some ten years have passed since you completed your doctorate under ETH Professor Ruedi Aebersold. What pops into your head when you think back to that time?**

The main thing I remember is how much fun I had! It was a fantastic time with a great group of people, and I was free to try out a lot of new ideas. It was also when I met my wife: she spent six months working there as a visiting student.

**You've been back at ETH Zurich since last autumn. What opportunities has that opened up for you?**

My research group studies tumours at the level of individual cells. We analyse thousands of tumour samples and often discover a relation between tissue structure and clinical outcome. The Molecular Health Sciences (MHS) Platform gives us the infrastructure and expertise we need to explore disease mechanisms on the basis of model systems. The topics pursued by MHS research groups are the perfect complement to those being explored by the Department of Quantitative Biomedicine at the University of Zurich, which is my second home!

**You developed an imaging mass cytometry technique that actually makes it possible to "walk through" tumour models. What benefits does that offer?**

Using 3D visualisation helps us detect structures that we can't see on tissue sections, such as groups of cells that have broken away from a tumour. Virtual reality gives us completely new perspectives on a tumour. The human brain is very good at identifying visual patterns, so these new perspectives can lead to new ideas and insights.

**Is VR something you would also use at home? Perhaps to pay a virtual visit to another country?**

Absolutely. The Google Earth VR experience is already very impressive. I'm actually surprised that VR hasn't taken off more during the pandemic.

**What's the best decision you've made in your career so far?**

I can think of several good ones. Perhaps the key decisions were doing my doctorate under Ruedi Aebersold, going to Stanford for my post-doc, and taking up my position as assistant professor at the University of Zurich. ○

# IN THE GIANT'S WORKSHOP

TEXT Samuel Schlaefli  
IMAGES Daniel Winkler







2

1

A view of the laboratory reveals the impressive scale of the research facilities.

2

Andrea Frangi, Professor of Timber Structures, is a scientific adviser on the timber high-rise project.

**REPORT** | Plans are underway to build an 80-metre-tall timber building in Zug. Basic research for this pioneering project is being carried out in the laboratory for experimental research (Bauhalle) on the Höggerberg campus.

At first glance, this huge neon-lit space could be mistaken for a shipyard somewhere in the port of Hamburg. A mobile overhead crane arches above, poised to hoist massive steel components, concrete columns and wooden beams across the hall. Around us are bolts as long and thick as an adult's forearm and nuts as big as plates. Are we in some kind of giant's workshop?

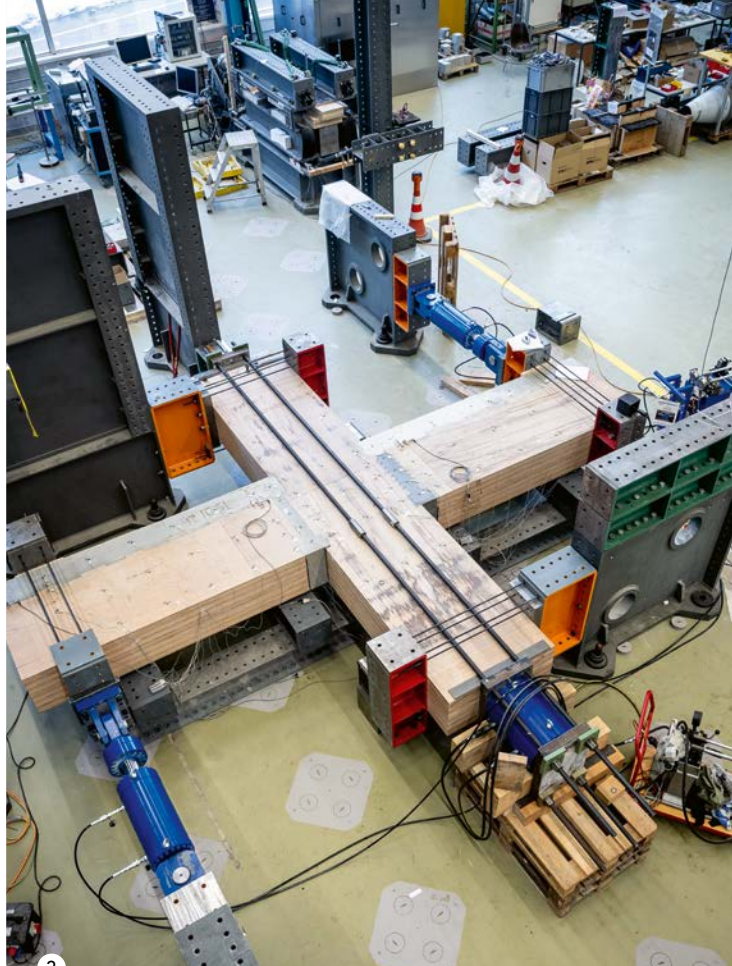
"Generally speaking, our approach to testing is to keep increasing the load on something until we destroy it," says Dominik Werne with a smile. He has spent the past 12 years heading up a team at the Bauhalle, the laboratory for experimental research run by the Institute of Structural Engineering (IBK) on the Höggerberg campus. Together with four permanent staff members, he assists with experiments conducted on behalf of the institute's seven professorial chairs. Werne points to the pastel green floor beneath us, explaining that this is perhaps the most important part of the whole facility. Made of 1-metre-thick concrete heavily reinforced with steel, it can support a total weight of several thousand tonnes. Much like Meccano, the test setups are assembled as required from various components, some of which weigh several tonnes. "Planning and building a test setup can take months," says Werne. In fact, this often takes much longer than the experiments themselves.

The test setups are located on both sides of a central aisle demarcated with yellow tape. They include LUSET, a huge steel frame measuring 10 metres by 10 metres, whose inner workings consist of 100 individually controllable hydraulic cylinders. LUSET enables large-scale testing of reinforced concrete shell elements in a smoothly →

controlled manner that mimics real-life conditions. It was commissioned by the chair of Professor Walter Kaufmann. His team carries out tests for clients like the Federal Roads Office (FEDRO) to assess whether bridges require renovation. Diagonally opposite is the equally imposing MAST, which features two reinforced concrete walls approximately 3 meters long and 2 meters high, situated beneath one modular steel crosshead, which can be moved by powerful cylinders. Professor Božidar Stojadinović designed MAST to simulate earthquakes in slow motion and analyse their effects on full-scale structural elements. “Theoretically, we could even build a small house in the test setup and test its capacity to withstand earthquakes,” says Werne.

**THE ENGINEERS AND THE CROSS** “Hold on! I can see a crack,” shouts a voice at the north end of the laboratory. He is one of a group of six men: two from Zurich-based engineering firm WaltGalmarini, three doctoral students from IBK and one lab engineer. They are huddled around a desk looking at multiple computer screens. Next to them is a bright blue box with two manometers and two levers sticking out of it – a manually operated hydraulic pump. In front of this temporary command post is a wooden cross made of a 4.4-metre-long timber column and two beams. Half of each beam is made of the same beechwood laminated veneer lumber (LVL) as the column – but the lower half of each beam includes a layer of concrete. The two beams are joined to the column by threaded rods glued into the wood. To fasten the beams in place, the research engineers have poured high-strength mortar into a joint around 10 centimetres wide. It is this joint between the column and beams that is undergoing testing today. To perform their tests, the lab team have installed the cross between two hefty hydraulic cylinders held in place by two steel reaction walls, each weighing several tonnes.

The engineers began ratcheting up the pressure at seven this morning, steadily increasing the load to see how much the cross can withstand. The aim of the experiment is to learn more about the structure’s stiffness, load-bearing capacity and ductility. High above the cross are three infrared



3



4

3

Load testing of a cruciform timber-concrete structure several metres in length.

4

Engineers examine cracks caused by the application of extreme loads.

cameras attached to a steel girder. They are monitoring 78 measuring points marked on the concrete sections of the cross so as to measure any displacement greater than 0.1 millimetres. This data can then be used to plot curves and draw diagrams showing where and what kind of deformations occur under different levels of load.

Shortly after half past nine, and with the tensile load edging above 200 kilonewtons – equivalent to the weight of 20 tonnes – the first fine cracks start to appear in the concrete. A doctoral student operating the manual hydraulic pump releases the lever to stop any more pressure being applied. A WaltGalmarini employee steps up to the concrete and carefully traces the outline of the cracks with a blue marker pen, adding a “2” to show they’ve reached “load level 2”. Later on, this will help the engineers establish which cracks occurred under which load levels. They also make notes and take photos of the current pattern of cracks. Then it’s time to release the pressure on the cross in preparation for the next step.

**PIONEERING USE OF WOOD** Today’s experiments on the test setup are designed to mimic the behaviour of an 80-metre-tall timber building in strong winds. A force of 200 kilonewtons is roughly equivalent to what the building’s timber-frame construction would face during the largest storm that could be realistically expected to hit Switzerland. The cross in the test setup is a crucial element in the development of an 80-metre-high timber building known as “Project Pi”, construction of which is due to start in Zug in 2022. Designed by WaltGalmarini, the high-rise will be built by general contractor Implenia with expert scientific support from Andrea Frangi, Professor of Timber Structures at the IBK. Ranking among the tallest timber buildings ever constructed, this pioneering project will also break new ground by dispensing with the reinforced concrete core that is commonly used in such structures, replacing it with a timber frame made of 40-centimetre-wide beechwood LVL.

Previously banned in Switzerland due to fire safety concerns, this type of structure was finally given the green light in 2015. Now, engineers are hoping to combine it with the latest innovations in timber construction. “Hardwoods are more difficult to machine, but they have better mechanical properties than softwoods,” says Frangi. “That makes them a good choice for the high loads to which high-rise buildings are subject.” LVL is made by peeling beech logs and then gluing together the 2 to 3-millimetre-thick wood veneers to produce components that offer optimal load-bearing capacity with smaller cross sections. Structures made from wood are generally lighter than conventional concrete high-rise buildings. They also have a better environmental performance, with each cubic metre of wood in a construction project tying up around one tonne of CO<sub>2</sub>. Reducing the use of concrete is an additional benefit, since cement production makes up around eight percent of global carbon emissions.

The timber-concrete composite slab – which will be used on the 27 floors of Project Pi – is another innovation from Frangi’s group. Load tests conducted in the laboratory show that it offers the same load-bearing capacity as conventional reinforced concrete slabs while also being 30 percent lighter. It also offers acoustic and vibration performance that meets all the relevant standards.

**BRITTLE VERSUS DUCTILE** “Bang!” A dull metallic thud reverberates around the hall. It’s nearly four in the afternoon and the tensile load on the two beams has just hit 510 kilonewtons (51 tonnes), which is equivalent to approximately twice the force that the building is legally required to withstand. Long cracks – each some 2 centimetres wide – are visible in the concrete section of one of the beams. This is where the horizontal timber-concrete composite slabs would be joined to the vertical timber column. Andreas Galmarini and his fellow engineer hurry to the spot where the cracks have appeared and begin to take photos and trace their outline with the blue marker. “Well, it’s all over for the tensile reinforcement at the column-beam joint!” says →



One of the cracks induced by extreme loads is several centimetres wide.

the co-owner of WaltGalmarini, who remembers the laboratory well from his own time as an ETH doctoral student.

This sudden fracture was not predicted in the engineers' modelling. They had expected to see a progressive increase in deformation prior to cracking – in other words, the kind of ductile behaviour that would signal imminent failure.

This demonstrates the importance of experimental research in civil engineering, says Frangi: "We can do a lot of the calculations at our desks – even using sophisticated software to simulate the load-bearing behaviour of components. But, ultimately, you need to validate these kinds of models through testing, especially when it comes to new developments."

A doctoral student from Frangi's group reaches for the lever of the hydraulic pump and starts pumping again. It's time for the second beam to undergo "testing to failure", as the engineers call it. Soon the student takes off his sweater, gradually getting redder in the face as the lever gets harder and harder to move. At 500 kilonewtons, a brief

cracking sound punctuates the air. The lever starts to move more easily, and the curve on the laptop flattens out. "Perfect!" says Galmarini's colleague. "We should see a smooth transition from this point onwards." The ductile failure that structural engineers aim for has finally been attained, with the materials undergoing a gradual, plastic deformation instead of sudden structural failure.

The doctoral student keeps pumping, and the manometer soon rises to 300 bar. Meanwhile, a crack in the concrete is widening. At 550 kilonewtons, there's another sharp cracking sound – this time twice in succession, and even louder than with the first beam. The doctoral student lets go of the lever. The crack in the concrete joint, which is now several centimetres wide, provides a glimpse of steel bars and rubble. The tremendous force has blown open two of the interlocking metal rings that the engineers were testing as an alternative joint between the column and beams.

**IMMENSELY VALUABLE INSIGHTS** The engineers use SLR and smartphone cameras to document the destruction of the cross, which is drooping in the fading light of the laboratory. They inspect the two beams from all sides one more time, drawing out as much information as they can from the splintered concrete and speculating on what exactly has occurred deep within the column-beam joint. In one week's time, they will be testing a second cross with two further design modifications. After that, the engineers from WaltGalmarini will consult with Andrea Frangi to decide which of Implen's joint systems should be used to construct the 27 floors of the 80-meter-tall timber tower.

"The only way you can normally get this kind of data on how concrete, steel and timber perform under extreme conditions is by visiting a region that has recently been hit by an earthquake or typhoon," says Galmarini. He spent time in earthquake zones himself while working for the Swiss Humanitarian Aid Unit (SHA). But even there, it was impossible to track the dynamics of materials and structures with the kind of slow-motion methods that are available in the laboratory. "This data is worth its weight in gold!" he says delightedly, before returning to inspect the gaping wound in the concrete. ○

# WORKING FOR PEACE

TEXT Claudia Hoffmann  
PHOTOGRAPHY Daniel Winkler

# ETH alumna Therese Adam spent 28 years in the diplomatic service working for peace and development. Now she shares her knowledge as a lecturer.

Therese Adam sees no real distinction between work and leisure: "In my life, those boundaries have always been fluid." The retired diplomat spent almost three decades heading up Swiss missions abroad in over 40 countries, including posts as Assistant Director General of the Swiss Agency for Development and Cooperation (SDC) – part of the Federal Department of Foreign Affairs (FDFA) – as well as Swiss Ambassador to Mozambique. Her work included countless negotiations with international organisations and rival factions.

She found respite from these challenging assignments by embracing the opportunities that work threw in her way. On business trips to Africa, Central Asia or Russia, for example, she discovered new musical styles at concerts and visited art exhibitions. Meeting people from many different cultures allowed her to explore the most diverse topics of conversation, which helped her build extraordinary reserves of positive energy. "That's how I enjoy spending my free time!" says Adam.

Now 69 and retired, her path to a diplomatic career was anything but straight. After passing her Matura, she decided to study agricultural sciences at ETH. "I wanted a profession that would pave the way for me to go abroad," she says. With its broad-based subject matter, the programme seemed to provide the perfect preparation for travel. It also combined her two key interests of natural science and social issues.

These are two subjects that have captivated her ever since she was a child. Growing up in her parents' house in Solothurn, she set up a small

chemistry lab in the garage. She and her father shared a passion for fossils, which they would collect on hikes through the Jura Mountains. Even greater perhaps was her fascination with foreign countries and cultures: by the age of 12, she was devouring every book she could find on the subject. "Reading also taught me early on how much poverty and injustice there is in the world," says Adam. She felt an affinity for historical figures who stood up for justice, such as John F. Kennedy and Martin Luther King battling against racial discrimination in the USA, or the representatives of liberation theology in South America fighting for the rights of the poor.

**VENTURING ABROAD** This inspired her to join the Commission for Development Issues (KfE), which was run by VSETH, the Association of Students at ETH Zurich. After graduating in Agricultural Engineering, she took an advanced studies programme at NADEL, the Center for Development and Cooperation at ETH. Adam soon succeeded in putting her plan of working abroad into action: in 1980, she and her partner – an electrical engineer and fellow ETH alumnus – headed to Mozambique, where they stayed for four years. They then moved to Madagascar for a further three years. In both countries, she worked with local experts as an agricultural advisor to the Ministry of Agriculture.

Although she found the work rewarding, she began to wonder if she could make more of a difference elsewhere. In Mozambique, she saw first-hand how much destruction the civil war had caused, including to the country's agriculture. "That's when I realised you can't have development without peace," she says. Determined to do more to foster peace and democracy, she applied to work at the SDC. She spent her first four years there acting as scientific expert to the West Africa Division. In 1991, she was appointed as the FDFA's Country Director of Cooperation to the Republic of Niger. "It was a wonderful opportunity for me," says Adam, who was the first woman to hold the post.

**THERESE ADAM** After completing her degree in agricultural sciences at ETH, Therese Adam worked in Mozambique and Madagascar. From 1987 until her retirement in 2014, she worked for the SDC/FDFA, including terms as Assistant Director General and Head of the Department of Cooperation with Eastern Europe, and as Swiss Ambassador to Mozambique. She now works as a lecturer.

**REBEL THREAT** Stationed with a small team in the capital, Niamey, in the south of the country, she was responsible for coordinating development cooperation, providing consular services and ensuring the security of Swiss nationals in Niger. This latter task was particularly challenging because Tuareg rebels were destabilising the north of the country, so people constantly had to be brought to safety. Adam received threatening letters: a dangerous sign that was not to be taken lightly, especially since her counterpart in Mali had been murdered by Tuareg rebels the year before. Did she ever feel afraid? Adam hesitates briefly, then says, “More for others than for myself.”

Her dispassionate answer is very much in keeping with her role as a conflict mediator – a role she played on many occasions during her subsequent career. Adam says the most important qualities of a good mediator are “being a good listener and not imposing your views”. Her first post after returning from Niger was as head of the SDC’s Natural Resources and Global Environment Division in Bern, where her responsibilities included representing Switzerland in multilateral negotiations on UN environmental conventions. She subsequently became Assistant Director General of the SDC and headed up the Department of Cooperation with Eastern Europe from 2001 to 2010. Her first years in the post confronted her with the legacy of the recently fought Balkan wars, including burnt-out

houses, landmines and displaced persons. “Conflicts like this don’t just suddenly come to an end. Achieving real peace requires so much more work,” says Adam.

**GRATEFUL TO BE INVOLVED** Her responsibilities included supporting the reintegration of refugees, establishing democratic structures and mediating between rival factions. She marvelled at the example of Kosovo, which evolved from a war-torn country into an independent state within just a few years. “That’s something I’m truly grateful to have witnessed,” says Adam. She was equally impressed by the democratic and economic developments she observed and helped promote in the post-Soviet states, as well as in the countries that joined the EU in 2004. She still regards the period she spent as the Head of the Department of Cooperation with Eastern Europe as the most important of her career.

Her desire to support the processes of peace and democracy was also close to her heart as Swiss Ambassador to Mozambique from 2010 to 2014. The civil war, long since over, had given way to a precarious peace. But the run-up to elections in 2013 saw a resurgence of old conflicts between the government and the opposition. As a representative of neutral Switzerland, Adam advised local mediators working with the warring factions – a task that requires extraordinary sensitivity. “The responsibility is huge, but you can make a real difference,” she says. The negotiations eventually led to a ceasefire that enabled elections to be held.

**SECOND CAREER AS A LECTURER** Adam has always been a strong advocate of female empowerment. In Mozambique, she worked with ambassadors from other countries to form the “Lady Ambassadors” network, which also reached out to local female politicians to discuss gender issues. As Assistant Director General of the SDC, she also ensured that job sharing was a realistic option even in management positions. Since her retirement, she has focused her energies on fostering young talent. She teaches global governance and diplomacy at several universities, including ETH, and it gives her great pleasure to share her wealth of experience. She also supports, via the ETH Foundation, ETH’s Excellence Scholarships, which enable outstanding Master’s students from Switzerland and around the world to study at ETH. She welcomes the programme’s emphasis on gender balance. “I think it’s vital that men and women receive the same opportunities,” she says. ○



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

# AGENDA

## DISCOVER

○ 4 May 2021, 10 a.m. – 12 p.m.

### 150 years of agricultural sciences

Agricultural sciences have been studied at ETH Zurich for the past 150 years – and work has now begun on an online anniversary hub to celebrate this major milestone. The website will feature fascinating facts and stories from the earliest days of ETH agricultural sciences right through to the present day. In this major online event, we will join ETH President Joël Mesot and guests on a walk through an agricultural holding. We will also step inside the Institute of Agricultural Sciences in the LFW building on the Zentrum campus and visit our research stations in Eschikon in the Canton of Zurich. The event will include online aperitif sessions with our various research groups. Come along for a chat – we look forward to seeing you!

→ [agri150.ethz.ch](http://agri150.ethz.ch)



Image: Max Bächtold



Image: ETH Library, Illustration: Claude Lüthi

○ 16 and 17 April 2021

## GLAMhack 2021

Once a year, the OpenGLAM Working Group hosts the Swiss Open Cultural Data Hackathon. Data suppliers, software developers, digital humanists, artists, Wikimedians, Wikipedians and other interested persons come together to investigate remarkable cultural data. The event explores a range of questions. How can cultural resources, collections, archives, museums and libraries be used in current research? What innovative web and mobile applications can be developed with these data? Can such content be used for Wikipedia or in artistic creation?

For more information and to register:

→ [library.ethz.ch/glamhack](http://library.ethz.ch/glamhack)



## BOOKS

### Architecture with plant fibres

The use of building materials made of fast-growing plants offers a great opportunity to lock in a large amount of carbon and thereby counteract climate change. This book presents a total of 50 biogenic building projects (residential buildings, schools, commercial properties, infra-structural installations etc.) from around the world. The materials used include bamboo, straw, cane, palm leaves, bark, grasses from the North Sea coast and the Andes, and even fungi and living plants.

Author: Dominique Gauzin-Müller  
vdf Hochschulverlag  
ISBN: 978-3-7281-4028-9  
in German

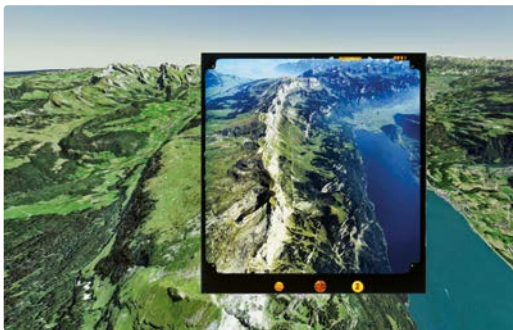


Image: ETH Library Zurich, Image Archive/Franz Bock/Cesium

### Explora: georeferencing

Like to browse old maps with your smartphone? Discover the history of where you live from a new perspective? Learn fascinating things about the geographical points along the way? Do all this and more with georeferencing, the enhancement of digital media by means of spatial information.

To find out more:  
—> [explora.ethz.ch](http://explora.ethz.ch)

## MUSIC

○ 5 May 2021, 7.30 p.m.

### Piano recital with Konstantin Scherbakov



Image: Jih-Pen

Russian virtuoso Konstantin Scherbakov is one of the great pianists of our time. Best known for his many award-winning recordings of rare piano works, he is a very popular figure on the international classical music scene.

Auditorium of the University of Zurich  
Information and tickets:

—> [musicaldiscovery.ch](http://musicaldiscovery.ch)

ETH podcast series: Uncertainty

### Climate change in light of uncertainty

ETH professors Reto Knutti and Tony Patt and student and climate activist Annabelle Ehmann reveal how they cope with the uncertainty provoked by climate change.

### Cybersecurity

ETH lecturer Myriam Dunn Cavelty discusses cybersecurity and how to handle the related uncertainty. And Karin Holzhauser explains why – after a career in business – she has returned to university to study computer science.

For this and other podcasts:

—> [ethz.ch/podcast](http://ethz.ch/podcast)

# OUT OF FOCUS



Illustration: Michael Meister

Disruption – as visualised by Michael Meister

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# Because you can't repair a motor on Mars

## **Dominik Omlin, Production Engineer**

Every move has to be just right when it comes to drives for Mars missions, and every assembly step has to be documented. If one of our drives doesn't work, the entire mission could fail. That's why Dominik and his team in Special Production work together to exchange information, discuss next steps and double check each others work on every drive system. Our diligence and curiosity drive us to excel. Explore our universe now: [mars.maxonworld.com](https://mars.maxonworld.com)



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