



Whose economy? 10

The guardian of cyberspace 32

Animal viruses infecting people 40

Easy justice is fake news 46

*Superhero's mission:
To save science
page 25*

Let's not fan the flames

In 1929 - the year of the crash on Wall Street - aircraft accidents killed 61 people, i.e., one death for every 1.6 million kilometres flown. The growing disapproval of the public soon led to safer flying: manufacturing and testing improved, vital systems were redundantly duplicated, and maintenance was strictly scheduled. Even psychologists helped improve pilot training by introducing flexible cockpit hierarchies, which improve the chances of survival when a captain is incapacitated. Nearly 90 years later, the rate of fatal aviation accidents is today 10,000 times lower.

It's not quite the same thing in finance. Crises continue to ravage entire nations with the same intensity. The rate of unemployment in Spain in 2012 - some 25 percent - matches that of the US in the 1930s. "There's a crisis every 10 years", overly keen economists remind us. But it's perplexing to note the fatalism of this industry, given all the time and energy it dedicates to gauging the price of the latest structured investment vehicle: the complex heart of the sector that Warren Buffett calls a "financial weapon of mass destruction".

Given the potentially catastrophic consequences, is it right for finance to carry on in this way? Just like aviation, economics is a science capable of advancement. It must progress first and foremost towards societal relevance, just as it must seriously render the economic system less fragile. The walls between schools of thought must be torn down, and the repeatedly exposed dogmas placed at arm's length, in particular 'efficient markets' and *Homo oeconomicus*, neither of which actually exist.

The challenges are enormous. We must anticipate the impact of both climate change and divestment from fossil fuel economics. There are the demographic shocks and the redistribution of global production to be absorbed. Social and environmental costs will need to be integrated into balance sheets, and alternative growth models developed for a world of finite resources. And given that certain conglomerates have become more powerful than some countries, we must also tackle tax evasion.

To bear this out, education will be critical. Universities craft the elite of tomorrow. We must work towards solving problems and not exacerbating them.

Daniel Saraga, chief editor



horizons





Keystone/EPA/Andy Rain

Focus: Updating the economy



David Boller

Knowledge and politics

10

The economy needs updating

If the economy's going badly, everyone suffers. But economists are finding it difficult to develop new models.

12 **Thinking outside the box**

If we're to develop new economic models, economists and humanities scholars need to work together. But they're not all on the same page.

15 **What have economists learnt from the crisis?**

"Too little", says financial expert Marc Chesney; "Enough", thinks HSG Rector Thomas Bieger. Our double interview.

18 **New approaches needed**

Today, economies, society and politics everywhere are faced with huge challenges. Here's ten of them.

21 **Less would be more, if only it stayed the same**

People don't necessarily always want more. The principle of equality is more important. But it's still not enough.

24 **Harmony and innovation are poor bedfellows.**

Getting comfy makes for sluggish minds, warns environmental researcher Rolf Büntgen.

25 **Superhero saves science**

In our comic, our Superhero's mission is to save science. Will he succeed?

29 **"Science studies asks painful questions"**

Bruno J. Strasser explains why science studies has struggled to develop in Switzerland.

30 **Self-censorship protects researchers**

Scholars researching into Turkey tell of a state of fear.

◀ Cover: In theory, the economy is well under control and there's only one direction: up.

◀ Inside cover: The reality is more complex, less just and more erratic – except, perhaps, for those with golden parachutes.

Image: 2. stock süd/Christoph Frei

32

Valérie Chételat



Environment and technology

32 Fighting for cyber security
Cyber expert Solange Ghernaouti advises governments and UN organisations.

34 Copying neurons
Computers will soon be unable to run any quicker - unless they use new technologies like memristors.

36 Turning CO₂ into formic acid
CO₂ could be used to create a liquid commodity. The problem is the catalyst.

**37 Cheaper transparent electrodes
Entropy and mind-reading
Buildings that sense people**

In pictures

6 Stressed-out pines

Debate

8 Should universities of applied sciences be allowed to award doctorates?

38

Keystone/Science Photo Library/Visual Unlimited, Inc./Joe McDonald



Biology and medicine

38 Self-correcting genes
Paramecia use a feedback loop to eliminate their own junk DNA.

39 Fighting fat, step by step
What keeps you fitter? Standing or sitting?

40 Virus reservoirs
Like Ebola, Zika and Sars, more and more viruses are jumping from animals to people.

42 Circuitry of fear
Two groups of nerve cells decide whether a mouse runs away or not.

**43 Breastfeeding prevents respiratory infections
Neuroticism endangers the brain
Predicting the risk of hip fracture**

Fieldwork

44 Burning Man

How does it work?

49 Blessed are the cheesemakers

44

Keystone/Salvatore Di Nolfi



Culture and society

46 Judges and the public
Judges and the general public think more alike than is suggested by the current debate on 'easy justice'.

**48 Undernourished middle-class kids
Holes in the Iron Curtain
Difficult meetings**

Access all areas

50 Valuable exchange

Inside the SNSF and SA

51 A new president for SATW

There's still life

Here ten young Scots pine trees display what might normally escape the eye: the delicate intertwining of their roots. As part of a study into the effect of drought on different species, Christoph Bachofen of the Institute for Forest, Snow and Landscape Research (WSL) has been growing these trees in two-metre long boxes in Leuk, Valais. The plants on the right have been growing under normal conditions, whereas those on the left have been subjected to intense artificial droughts. In order to ensure that the natural competitive environment

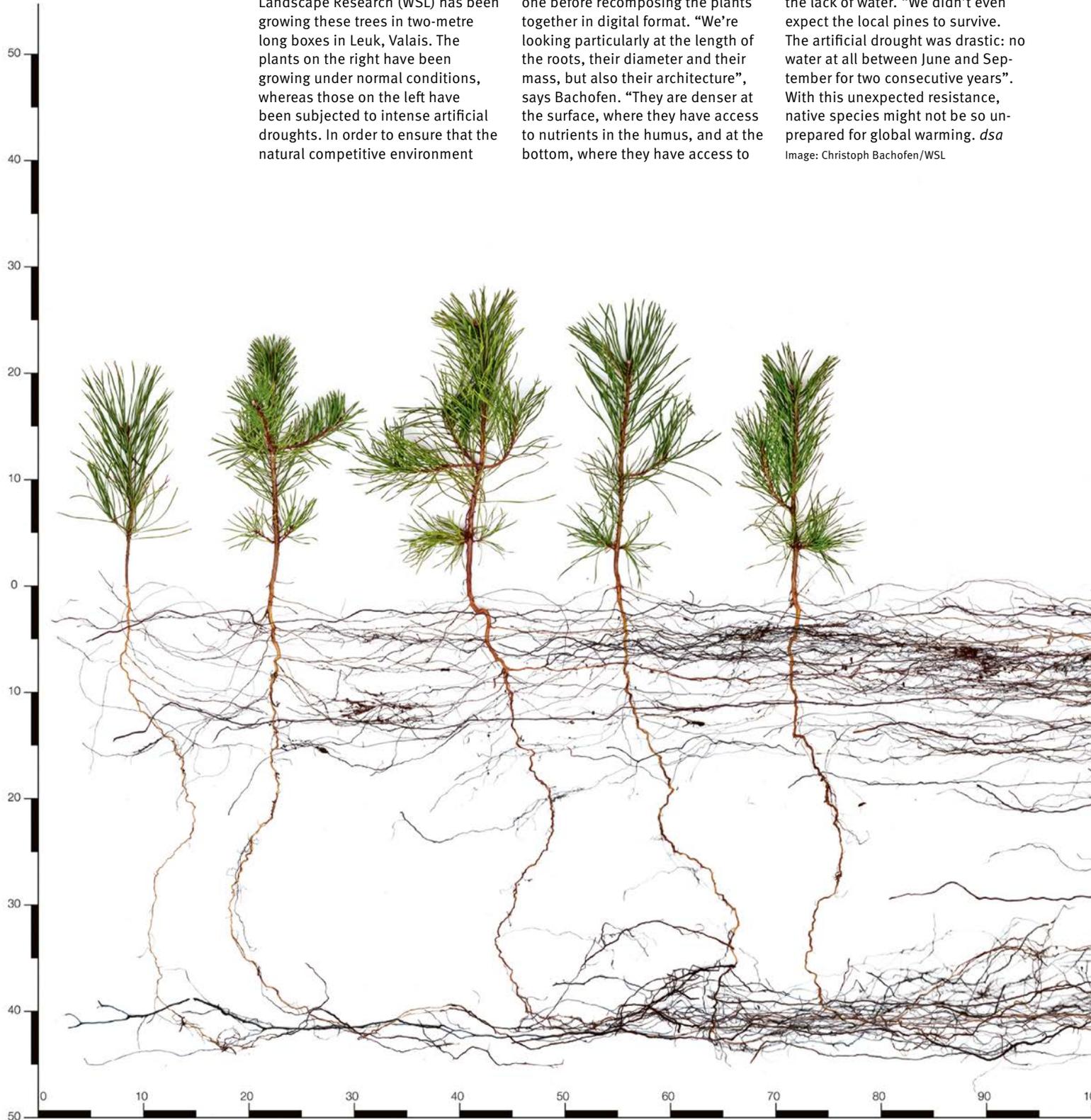
was reproduced, several trees were grown in each box.

The researchers waited three years before opening the boxes and then carefully took them out with their roots intact. On a white background, they photographed each one before recomposing the plants together in digital format. "We're looking particularly at the length of the roots, their diameter and their mass, but also their architecture", says Bachofen. "They are denser at the surface, where they have access to nutrients in the humus, and at the bottom, where they have access to

water accumulating in the sand and gravel. This is highly representative of soil profiles in Valais".

The study failed to confirm the hypothesis that the Spanish, Greek and Bulgarian pines (2nd, 3rd and 5th from the left) would fare better with the lack of water. "We didn't even expect the local pines to survive. The artificial drought was drastic: no water at all between June and September for two consecutive years". With this unexpected resistance, native species might not be so unprepared for global warming. *dsa*

Image: Christoph Bachofen/WSL







Valérie Chételat (photomontage)

“The current situation is marked by hypocrisy... It’s not the best way to assist doctoral students”.

Should universities of applied sciences be allowed to award doctorates?

Professors at universities of applied sciences (ASUs) can only supervise doctorates in partnership with colleagues at a university. But should ASUs become autonomous instead?



“We mustn’t devalue our dual vocational training”.

Applied science universities (ASU) already offer adequate infrastructure for conducting research. It's now time to open them to doctoral students to work autonomously, as this is an essential condition for long-term projects. Research carried out at an ASU is sufficiently mature to support the writing of doctoral theses.

In my field - the development of physical-chemical technology to preserve works of art - there has for some time been the opportunity for museums and archives to propose and directly manage research projects, so long as they have an agreement with an ASU. This is demonstrated by the new modalities for support from the SNSF, which has a new category for application-oriented basic research. This is a step forward for those ASU wishing - and able - to invest in research. We are now seeing the pooling of finance, something previously separated between universities and ASUs, and this is a sign that ASUs have become competitive. They have systematically increased the levels of finance being raised in recent years.

The current situation is actually marked by hypocrisy: there's no long-term viability for the involvement of 'ghost' supervisors

- university professors whose name goes on the paper because of the regulatory requirement for doctoral students to be administratively connected to a university. It is not the best way to assist doctoral students, as the follow-up of the professor is not always done regularly. This way of doing things leads to unnecessary difficulties, particularly in highly interdisciplinary projects that require skillsets rarely found in universities.

Yes

says Claire Gervais, Bern University of Applied Sciences.

In my laboratory, the support needed by my two doctoral students must be provided by experts specialised in the preservation and restoration of works, in the chemistry of materials, as well as in the physics of objects. This skillset is only to be found in institutions that have developed all of those areas, such as in the case of some ASUs. Given that there are no Swiss univer-

sities offering this form of expertise, most students interested in the field opt to write their theses in France or Germany.

If we are to retain this source of potential scientific discovery, we should now expand access to doctoral studies to ASUs. The requirement for examining panels to include at least one university professor will ensure that the quality meets the necessary standards. I have absolutely no doubt that it will.

Claire Gervais is an SNSF professor at Bern University of the Arts. She directs the 'new technology for old materials' laboratory, which currently has two doctoral students.

When Switzerland created its applied sciences universities in 1995, it filled a gap in its educational system. Later, with the provision for easy transfer between different courses, it achieved a further optimisation. These two independent measures played a role in helping us to train specialists and to prevent educational 'dead-ends'. If a national economy - to put it in technical terms - wants to optimise the educational potential of its population, then both ASUs and permeability are indispensable.

Recently, more and more requests have emerged from ASUs wanting to be able to award doctorates of their own accord. As a former director of education, I reject this.

In contrast to the traditional universities, the ASUs should have people at their disposal who have undergone a vocational training after attending school. This is application-oriented. In their programmes for prospective students, the ASUs place their emphasis on practical applications, not exclusively on a general education as is the case at traditional universities. The legislators believed - and still believe - that the task of the ASUs is to consolidate professional knowledge and skills.

The differentiation between the two types of university was intentional. Traditional universities carry out fundamental research, while ASUs carry out applied research. This also results in the different teaching aims of the different universities. The slogan that was coined at the time the ASUs were founded, 'equal but different', remains valid today.

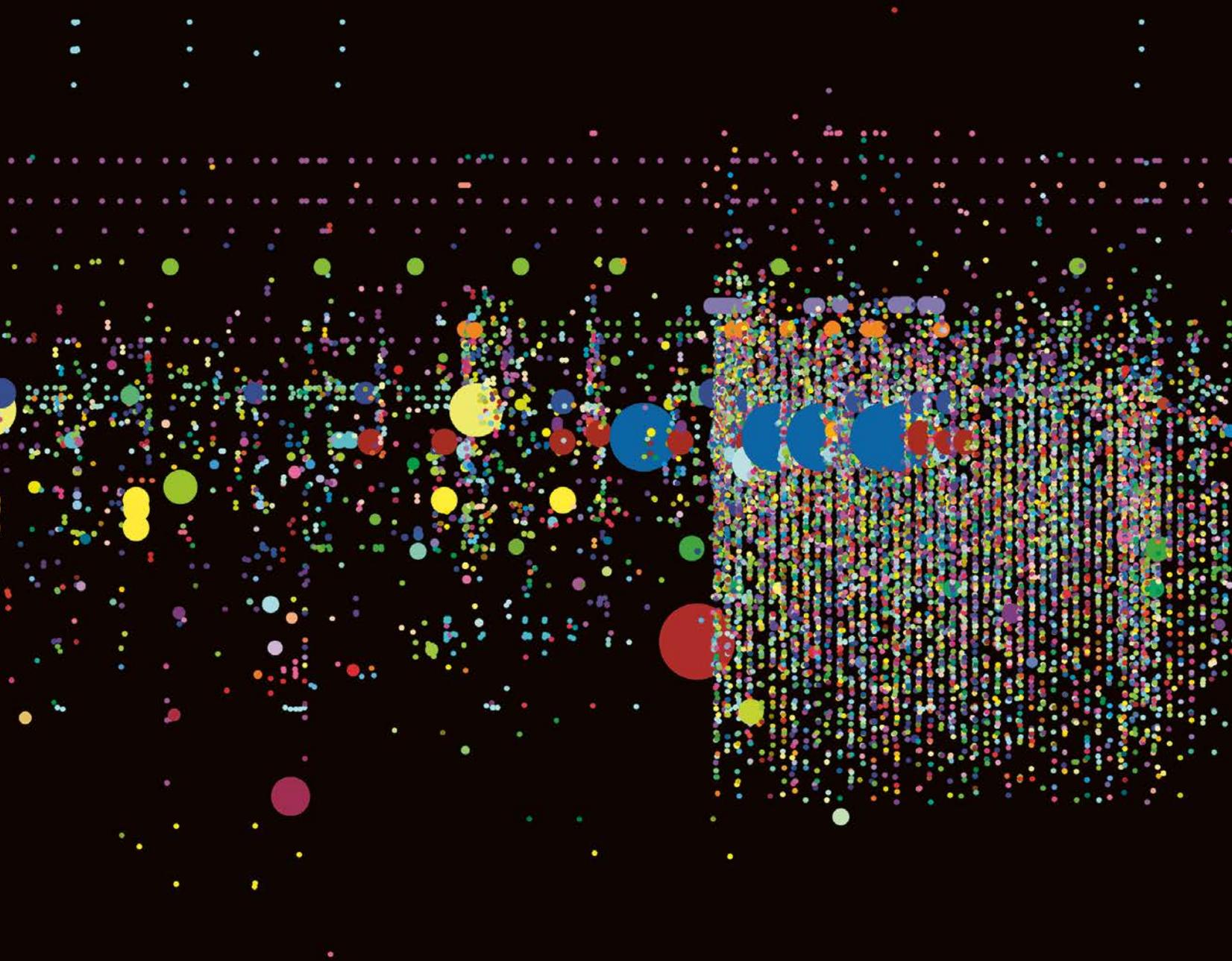
No

says Christoph Eymann, National Councillor.

The further education of professionals at ASUs is of crucial importance for the structure of the many small and medium-sized enterprises in Switzerland. Thanks to this practice-oriented type of university, we have been able to maintain and perhaps even improve the quality and competitiveness of these businesses. Giving the ASUs the right to award doctorates would do nothing to improve them further.

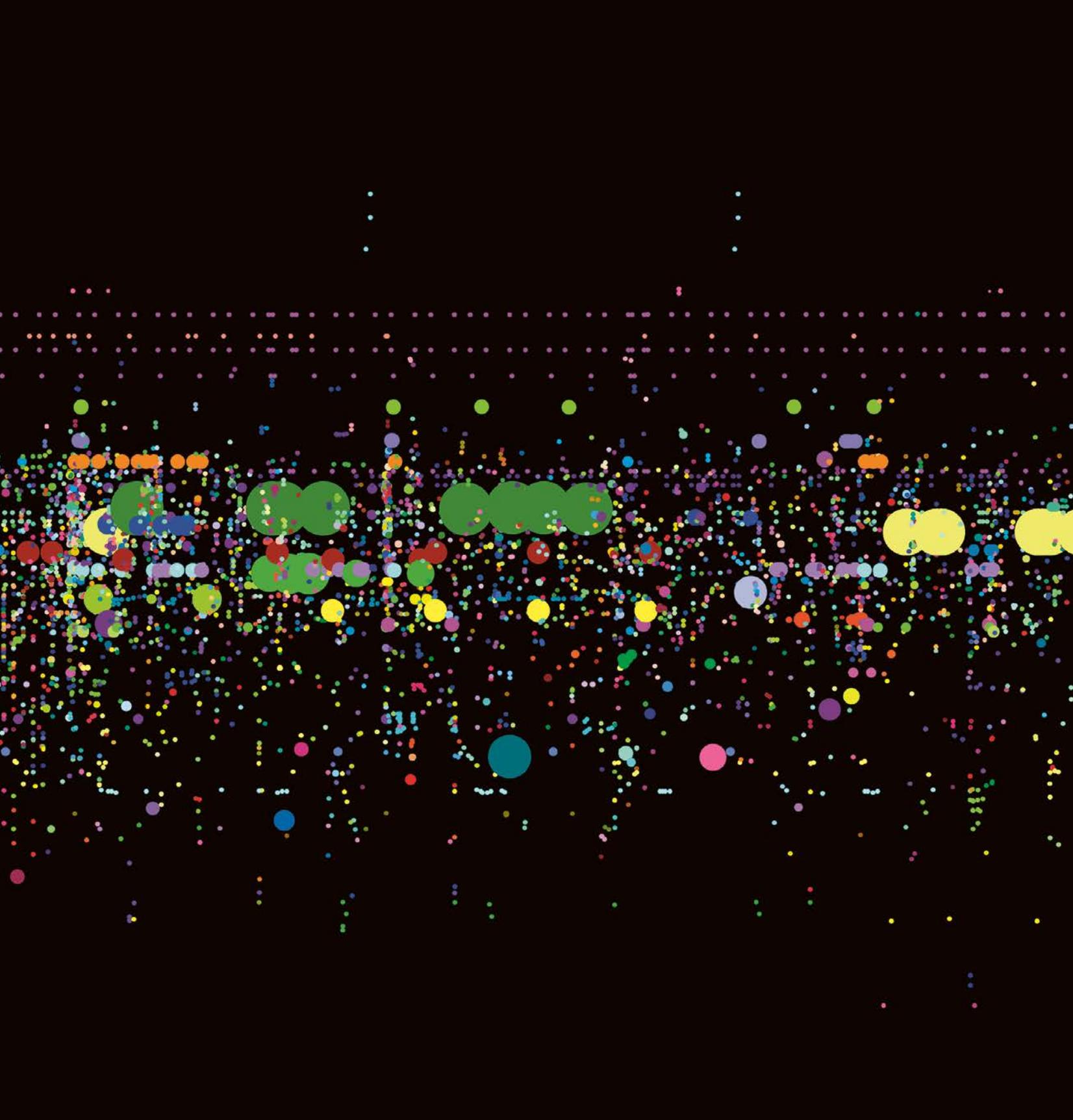
Furthermore, the general population is generally hostile towards a process of 'academisation'. So we mustn't devalue our dual vocational training. Nor would the cantons that fund the ASUs agree to awarding doctorates. There are times when it's difficult enough to justify providing funds for any research at ASUs.

Christoph Eymann (LDP) is a member of the National Council and of the Commission for Science, Education and Culture. He is a member of the Basel University Council and from 2013 to 2016 he chaired the Swiss Conference of Cantonal Ministers of Education.



One minute of trading on Nasdaq, 3:35 p.m. on 8 March 2011. The size of the circles shows the number of stocks traded, the vertical axis shows the rate. The algorithms for high-frequency trading work in microseconds, and were the reason for the 'flash crash' of May 2010.

Image: Graphic by Stamen



No more crises

After the rise comes the fall. And after growth, crisis. We try and find the reasons why we're still waiting for a new economy that can free us from this fatal dynamic.

Sustainability is a distant dream

The phrase ‘sustainable economy’ ought to be tautological. But it’s not, in part because of problems of comprehension among different scientific disciplines.

By *Marcel Hänggi*

Our economy is supposed to help us lead a good life. That’s something most scientists and politicians would agree upon. And if, by ‘us’, we mean future generations too, then ‘sustainable economy’ ought to be tautological. If the economy isn’t sustainable, then it defeats its very purpose. After all, ‘economy’ originally meant the art of good housekeeping.

But the phrase ‘sustainable economy’ isn’t tautological at all. In some quarters, the concept of ‘sustainable’ is even an object of scorn. And yet our increasing consumption of resources, the impact of climate change and species extinction are just a few indications of the unsustainability of our present economy. Why is this? And how can we change it? These simple questions open up a host of others. Why do economic operators – from the single-person household to multinational enterprises – act the way they do? Shouldn’t or couldn’t other incentives be set? What statutory regulations would be politically acceptable? How can we promote and finance green technologies? Can the economy both increase prosperity and use less resources? Is a stable, zero-growth economy conceivable? What do we really mean by ‘prosperity’ or ‘good life’? These are all questions being asked today by different sectors of the economy and by different disciplines in the social and technical sciences and the humanities.

Development is too slow

Gunter Stephan is a professor in economics at the University of Bern, and President of the Steering Committee of the National Research Programme ‘Sustainable Economy’ (NRP 73). He believes that academia finds it difficult to answer these and other interdisciplinary questions because of how it is organised into individual disciplines. In his opinion, research should concentrate on setting different incentives for every

aspect of the economy – whether in production, consumption or distribution. And it should investigate how to train the kind of experts that will be needed once we have achieved the goal of a sustainable economy.

We turn next to Stephan’s colleague, Lucas Bretschger of ETH Zurich, who sees further topics that need more research. He is currently the President of the European Association of Environmental and Resource Economists. His vision is of research into the long-term connections between the economy and ecology, taking into account the momentum of each of them and the North-South problem.

“Many economists don’t want the humanities involved at all”.

Christian Arnsperger

Naturally, each field has its own research needs. Joëlle Noailly is the head of research at the Centre for International Environmental Studies in Geneva, and she is looking into the role of innovation. New, ‘clean’ technologies will do more than just reduce the pressure on the environment, she says. They could also create new jobs, while research and development in this sector will bring an especially large surplus of knowledge from which other sectors could also profit. This is because clean technologies could find applications in many areas, including the semiconductor industry and thus in IT. “But development is too slow”, says Noailly. The ‘big players’, namely the big energy corporations, are not very innovative. After all, pollution doesn’t bring costs with it. This is a factor that the market alone cannot correct; we need political regulations instead. But the lack of innovation in certain sectors isn’t merely a result of the regulatory framework: it also

comes down to mentality. “The impact of regulations has to be studied more intensely. A lot of research is already being carried out, but we now need fine-tuning between the different instruments. According to the textbooks, incentive taxes are the most effective. But in practice, other measures often function better, such as subsidies for ‘clean’ technologies, or bans on ‘dirty’ technologies”.

Helga Weisz is a professor at the Humboldt University in Berlin and at the Potsdam Institute for Climate Impact Research. She is researching in the field of industrial ecology. There is pretty good research into industrial resource flows on several levels, she says. “However, researchers often only look at energy and greenhouse gases, while other resources and waste products receive little attention. And we know little about the social and cultural framework conditions that determine resource flows”.

Traditionally, industrial ecology considers two approaches: resource efficiency and the recycling economy. The former, says Weisz, can be integrated well in economic models. It’s a darling of politicians because it promises to let us have more and use less at the same time. But there is a danger that increases in efficiency in fact only serve to keep us on the wrong paths for a longer time. The idea of the recycling economy, on the other hand – in which all waste is a raw material for something new – is a plausible vision, but the big, open question among researchers is how it might be incorporated into economic models. “There are numerous good examples for circular production”, says Weisz, “but to what extent can we expand and resize them? We are still lacking a systems analysis for this”.

People as automata

Weisz and Noailly talk about cultural frameworks and mentalities – and these are issues typical of the humanities. But up to now, the humanities have been lit-

“The neoclassical paradigm itself – with its focus on maximising wealth – has remained untouched up to now”.

Helga Weisz

tle involved in economics research. It's time for that to change, says Christian Arnsperger, an economist and professor of sustainability and economic anthropology at the University of Lausanne. But there is resistance to be overcome. “Many economists don't want the humanities involved at all. Economists orient themselves traditionally on the natural sciences and want to see the laws of the economy as laws of nature. In order to model economic procedures, they treat their actors largely as automata. They're interested in what people do, but not in what they think and feel”. Concepts from the humanities – such as fear and estrangement – are foreign to mainstream economists, but they are important, says Arnsperger, if we want to understand what really motivates people, or what in the short-term keeps them from adopting alternative patterns of behaviour. Is this attitude perhaps even one of the reasons why we lack sustainability in our economy? Arnsperger hesitates to answer this, but then tentatively agrees: “Yes. By blocking these things out, economists are also passively helping to make the economy what it is today”.

The schools are divided

Arnsperger here addresses a factor that is making research into a sustainable economy even more difficult. It's not just that we need to involve many disciplines that all have their own, different knowledge cultures. Within these disciplines themselves, too – and especially in the field of economics – there are different schools of thought that sometimes offer very different answers to the same questions, according to their respective basic assumptions about the world. These assumptions in turn depend on their own research areas and methodologies. For example, whether people favour tax incentives or subsidies has a lot to do with their ideological preferences.

In broad terms, we could say that the mainstream – the neoclassical economic approach – seeks ways in which economic performance can be uncoupled from environmental consumption. Heterodox schools such as ecological economics, on the other hand, tend to search for alternatives to an economy founded on growth compulsion. These two perspectives are difficult to reconcile.

“If someone rejects the basic tools of economics, then it's naturally difficult for them to collaborate with economists”.

Lucas Bretschger

Stephan acknowledges these difficulties. “In many ways, the representatives of these two schools of thought simply talk past each other”. But there isn't even any unanimity about whether these two schools are actually different in the first place. Bretschger says: “The environmental economy has taken up many issues of ecological economics. We've never been of the opinion that prosperity can only be judged by the growth rate of a country's gross domestic product. You only find that kind of thing in old textbooks”. Nevertheless, he does add that many of those politicians responsible for the economy have indeed read those old textbooks. They also have other reasons for wanting growth, and we have to take their opinions seriously. Because in a democracy, you always have to find solutions with majority support.

Bretschger adds something else, too: “We're always open to critical perspectives, but if someone rejects the basic tools of economics, then it's naturally difficult for them to collaborate with economists”. And yet these ‘basic tools’ are precisely what

are being criticised by the other schools in the economic sciences. Weisz is a former member of the executive board of the European Society of Ecological Economics, and she resolutely disagrees with Bretschger's assessment. She does agree that neoclassical economics has integrated several findings of the ecological economists into its models, as these can no longer simply be ignored. But this has still always been done within the neoclassical paradigm. “This paradigm itself – with its focus on maximising wealth – has remained untouched up to now”.

Growth is therefore the 64-thousand-dollar question when it comes to sustainable economics. And there is an immense need for more research, regardless of how you approach the question. “Some want economic performance uncoupled from resource consumption”, says Weisz, “but they can't tell you how it should happen. Others criticise economic growth but can't tell you how we might avoid massive social upheaval if economic output slows down. The key issues remain open on both sides”.

Marcel Hänggi is a freelance science journalist in Zurich.



Creative Commons are a means of sharing your own works and clarifying their terms of use. They are a symbol of the rise of the sharing economy. A participative, rational, controlled use of common goods is both possible and widespread, as the work of the Nobel Laureate Elinor Ostrom demonstrates. Human beings are not just greedy – they're also reasonable.

Image: creativecommons.org

The crisis-free economy that has yet to be invented

Ten years after the housing bubble burst, the economic sciences are still battling with reforms, says Marc Chesney. Thomas Bieger, on the other hand, insists that economists are today also taught the psychological and sociological aspects of their discipline. We've interviewed them both.

Moderator: Philipp Hufschmid

Is there a scientific basis for the development of the economy and the financial system? Marc Chesney, professor of quantitative finance at the University of Zurich, believes that economists have failed to integrate ethical aspects and the issue of natural resources. Thomas Bieger, Rector of the University of St. Gallen (HSG), replies: "I'm convinced that we have learnt the necessary lessons".

"Why did nobody see it coming?" asked the Queen of England back in 2008 on a visit to the London School of Economics. Prof. Chesney, should economists have seen the financial crisis coming?

Marc Chesney: Figuratively speaking, it's as if we're driving a car faster and faster as the mists get thicker and thicker, until finally we have an accident. We don't know when it will happen. But as economists, we should have warned about the systemic risks in good time, before the financial crisis. With a few exceptions, we didn't.

How do you see it, Prof. Bieger?

Thomas Bieger: Our economic development has been characterised by the more or less regular occurrence of economic and financial crises. One famous example is the Dutch tulip crisis of the 1630s. The mechanism is always similar: people invest in something - it might be tulips, or property in the case of the USA up to 2007. The higher the prices rise, the more people speculate with borrowed money in the hope of making big, quick profits from their investment. Until the bubble bursts. Though of course everyone hopes that they'll be able to get out in time. There is a deeply human phenomenon behind all this: people want to get rich quick, with little effort. So the financial crisis of 2007 won't be the last one. But it was very big because major, undetected risks were able to accumulate through new, derivative, off-balance-sheet financial products.

MC: All the same, financial crises don't happen according to some natural law. Unlike in an earthquake zone, where you've always got to reckon on an earthquake happening, the financial world can take preventive measures. The financial crisis was also a consequence of excessive indebtedness and the development of a financial 'casino' that got out of control after Bill Clinton repealed the Glass-Steagall Act in 1999. That act, which separated commercial from investment banking, had ensured that there were fewer banking crises between 1933 and 1999. So there is room for manoeuvre for politicians and economists to try and prevent financial crises.

TB: It's true that there were fewer banking crises. Instead, there were oil crises and even property crises, because people placed their 'bets' elsewhere. On the one hand, I believe our task as economists lies in providing instruments to detect crises early and to cope with them; on the other hand, we should also be providing guidance so that politicians, managers and ordinary citizens can contextualise events. There are economists who warned about the coming financial crisis, but they were hardly noticed by the public.

Economics are part of the social sciences, whose predominant paradigm is that of constructivism. In other words, the behaviour of people is not characterised by objective reality but by perceived reality. If the dominant perception is that current economic laws can simply be suspended - for example, if many people believe property prices can rise indefinitely while indebtedness increases - then people hardly take notice of any other opinions.

What lessons do economists have to learn from the financial crisis?

MC: Economists have to recognise that the financial crisis wasn't a purely technical crisis. It was also a crisis of values. I

always show my students e-mails from traders, such as Jérôme Kerviel from Société Générale, who made dubious trades for which some of them have had to go to prison. Over the course of their career, they lost all sense of values. In these e-mails, one of them compares himself with Frankenstein, another with a prostitute, while yet another describes himself as addicted to money. As economists, it's our responsibility to talk about values when we teach, not just about prices.

Are prospective economists taught too little about values, Prof. Bieger?

TB: As a direct reaction to the economic crisis, the University of St. Gallen (HSG) and other economics universities across the world asked themselves how they could improve their teaching and research, for example in the context of the Global Alliance in Management Education. We need to take measures on three levels. First, on a technical level, by looking for the reasons for systemic failures and by finding the right regulations for financial instruments. Then we have to achieve a better understanding of the interaction between the different financial markets. At HSG, for example, we founded a School of Finance to this end in 2011. The second level is interdisciplinary. We have to understand the chain of effects running from human behaviour to the markets. For this, we need an integrative way of thinking that goes beyond economics. We are promoting this in St. Gallen in our so-called contextual studies, where a quarter of the lectures are in subjects of the social sciences or the humanities such as sociology or history.

So is the third level about values?

TB: Indeed, we are giving greater weight to personal behaviour and questions of responsibility. For this reason, we've introduced elements into almost every course where the students are confronted with



Warnings about the failure of democracy

Marc Chesney is a professor of quantitative finance and head of the Department of Banking and Finance at the University of Zurich. He has a doctorate in finance. He wrote his post-doctoral habilitation at the Sorbonne in Paris. He is the author of the book 'De la grande Guerre à la crise permanente. La montée en puissance de l'aristocratie financière et l'échec de la démocratie' (From the Great War to permanent crisis. The rise of the financial aristocracy and the failure of democracy). Chesney is 58 and is married with three children. He is a dual citizen of France and Switzerland, and lives in Zurich.



Head of a business management university

Thomas Bieger is a professor of business administration with a specialisation in tourism, and Director of the Institute for Systemic Management and Public Governance at the University of St. Gallen, where he has been Rector since 2011. From 2010 to 2014 he was chairman of the Global Alliance in Management Education (CEMS). He is chairman of Jungfrau Holding and chairman of the Société Suisse de Crédit Hôtelier. He is 56, married with two children, and lives in St. Gallen.

“Many people believe that property prices can rise indefinitely”.

Thomas Bieger

“There are no incentives to learn from the financial crisis”.

Marc Chesney

the challenges of sustainability and responsibility. What's of prime importance here is that placing the students in dilemma situations means they can get to know themselves better and reflect on their own behaviour.

How does this work?

TB: For example, we've got a trading area at HSG where we can play through market situations. And we engage in more discussion with the students in case studies - why they made a specific decision in a certain situation, and what the consequences would be if all market participants were to act in the same way. We have assimilated what we were able to learn from the last crisis.

Do you see a need for further action, Prof. Chesney?

MC: For an academic career, publications in the top scientific journals are decisive. In the financial sector, these publications are heavily influenced by the Chicago School and especially by their Efficient-Market Hypothesis. Anyone whose stance is critical of this School has a markedly smaller chance of publishing an article there. The result of this is that young economists tend to choose topics that have a better chance of getting published, so they can make progress in their careers. A topic as important as sustainability doesn't appear in the leading finance journals. So what we need is new, top-quality journals that make a broader variety of topics possible.

Is independent research in danger on account of the compulsion to publish in specific top journals?

TB: Various scientific and scholarly communities put a great emphasis today on having publications in the top journals. Some disciplines are indeed very much moulded by individual publishers or specific networks. Young researchers can't avoid publishing there if they want to get noticed internationally. So my advice is: you should do the one, but not ignore the other.

We've spoken of reforms in institutions. But shouldn't certain theories and models in the economic sciences be scrutinised too?

MC: Yes. Regrettably, there are many models today that have little relation to reality. It is difficult today to justify the assumption that there are risk-free investments that will allow you always to make a positive return. For example, are government bonds risk-free? In Switzerland, their returns are often negative. For a while, that was also the case in Germany and Japan. We should take a good look at what theories and models are still valid and relevant today, and to what extent new concepts have to be developed. That hasn't really been done. If you compare the university lecture lists today with those of 2006, you'll see that very little has changed.

TB: Let me offer another example. It was always assumed that if interest rates drop, then there will be more money to spend, and so consumption will rise. But in fact, in several countries with negative interest rates, the savings ratio is increasing. One hypothesis for this behaviour is that people realise that negative interest rates have an impact on their old-age provision and that they have to save more to make good their losses. That is precisely why an interdisciplinary perspective is important to evaluate economic models - a perspective that meets the needs of people in a comprehensive manner.

After the financial crisis, economists were accused of having failed to develop models for sustainable growth. Is this a topic of debate today?

MC: I don't know of any economics lectures that seriously ask whether growth is absolutely desirable for the total population. Growth at any cost seems to be a dogma. Growth criticism is largely taboo. There are too many economic models that are uncoupled from resource consumption. But we have to challenge this desire for growth and try to develop new models.

TB: The concept of sustainable growth, in which no non-renewable resources are consumed, is at the forefront of all aspects of university education today. And the concept is broadly anchored in our research, too. We have several institutes, such as the Institute for Economy and the Environment, where we research into sustain-

ability. But we also have a responsibility towards the poorer regions of the world, where the population is growing rapidly. In the foreseeable future, they will have a need for growth that will hopefully be sustainable.

So growth criticism is primarily something for an affluent society?

MC: Yes. If you've got to survive on less than two dollars a day - as innumerable people have to across the world - then for them, more is better. But we should at least think about the type of growth we want, and develop other paradigms.

Have the economic sciences learnt enough from the financial crisis?

MC: No, there are no incentives to learn from it.

TB: I'm convinced that we have learnt the necessary lessons from the last financial crisis. What concerns me is that up to now, the post-crisis was always a pre-crisis. And that we still never know where the next problem might arise.

Philipp Hufschmid is a journalist and an editor at the Berner Zeitung.

Limited resources for perpetual growth

Many more than the world's current population of 7.5 billion people are going to have to share our natural resources, such as land and drinking water. According to the UN's prognosis, by 2100 the world population will have grown to more than 11 billion, and will make demands on resources that are already rare in some places today.

Once those resources have been exploited, countries' sources of income will disappear too. Climate change, pollutants and mismanagement will make the soil infertile, and cultivating foodstuffs will get more difficult. What we need are new, resource-friendly technologies, a more responsible approach to our existing resources, and sustainable supply chains.

The new monopolies

The famous four – Google, Apple, Facebook and Amazon – are the giants of digitisation today. They are developing at a rapid pace and are untouchable in the current domination of their respective sectors. They gather user data from all areas of life, they manage their prices dynamically, they hold sway over digital advertising markets, and are ousting traditional businesses.

Some think that these companies have already attained such a dominant position on the market that they are distorting competition. Is it at all possible for competitors to attain the critical mass necessary for them to participate in the market too? Who will get access to these mountains of data, and at what price? And how can countries adjust their antitrust laws to their business models to make them applicable to these multinational concerns?

Regulating digital finance

Digital transformation is revolutionising the financial sector. Algorithms are replacing financial advisers and investment bankers. Mobile phone payment systems are replacing cash, while unacquainted private citizens are offering each other online credit. Virtual currencies such as Bitcoin are radically decentralised, anonymous and volatile. We still have no answers to questions of regulation and security, nor do we know just what impact, say, automatic trading has on the financial markets.

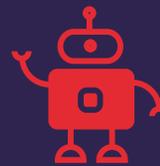


THE BIGGEST CHALLENGES



Fair sharing

Airbnb, Uber and others have shown that the principle of sharing, not buying, can enable successful business models to emerge. The ad-hoc service providers of the sharing economy also have unwanted side-effects, however. For example, Airbnb is soaking up the housing market in town centres and is competing with hotels. Furthermore, the tax authorities are losing out. Uber places the entrepreneurial risks on its drivers, who in contrast to normal employees have neither social nor accident insurance. Legislators and service providers will now have to design sharing business models that are socially acceptable.



Artificial and friendly intelligence

Algorithms permeate our everyday lives. They don't just determine our Internet search results and write simple news announcements. They analyse huge volumes of data so quickly and efficiently that the advice we are given by online shops, and the timelines in our social media, reflect our interests in a manner both accurate and frighteningly manipulative. There is hardly any profession today that is immune to automation.

Should we be controlling algorithms? Who will be responsible if a robot causes an accident? How can today's education system produce the workers needed for the jobs that will only emerge in 20 years' time?

New definitions of work

The traditional concept of work is a productive activity by human beings that enables them to earn money. But this concept is facing a stern test. Digitisation means some workplaces are being lost, while others are being created. It is difficult to discern how, in future, the vacancies offered and the candidates available will be able to adapt to each other.

Do alternative, socially compatible and financeable models exist for full-time paid employment until the age of retirement? To what extent should unpaid work in the family and volunteer work be taken into account by social systems? How can we regulate globalised micro-jobs distributed by crowd-sourcing? Is the idea of a basic income politically realistic?



The South is catching up

The West is no longer the centre of the economic world: China, Brazil, India, Russia and South Africa have risen to become important partners in industry and trade. A multipolar, global economy has emerged with a multitude of new trade agreements and rules that are not exclusively dictated by the West. The challenge remains of opening up the markets to those countries that have not yet turned the corner economically. And the West has to be prepared for a new distribution of power.



Society, politics and the economy are faced with major challenges on account of the increasing pace and global scope of change today. Horizons has been looking at the most important issues.

Text: Pascale Hofmeier Infographics: CANA atelier graphique

The next crisis

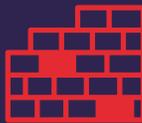
Financial crises occur on a regular basis, and there is no reason to believe that this will change. How can countries and businesses prepare themselves properly for the next big shock?



Monitoring migration and profiting from it

One in 30 people today is a migrant. In the year 2015 there was a total of roughly 244 million people in countries other than their own. They were there for the most varied of reasons, such as political instability, climate change and unemployment in their native lands. The number of people who are fleeing their homes has increased considerably: by late 2016, it was over 67 million. Globalisation means that we can hardly expect migration to decrease.

What influence do these movements of people have on the economic systems of their home countries and their destinations? How can society – both local and global – adjust so as to be able to integrate them and also profit from their development potential?



The return of protectionism

Major shifts in the global labour market have led to a growing number of people being left behind by globalisation. While the West is divesting itself of its industries, the economy is booming in lands of cheap labour where there is also often little concern shown for its social and environmental impact. The more visible the real and perceived negative side-effects of globalisation become, the more countries turn again to protectionism. Two examples of this are Brexit and the 'America first' slogan of President Donald Trump.

Should our economies prepare themselves for a wave of de-globalisation? Should politicians start to question our basic liberal principles and strive for protectionism in certain sectors while at the same time supporting globalisation through the targeted support of other sectors?



This is the facial average identified in a psychology experiment as the stereotype of an investment banker. Economists often describe people by means of numbers and averages.

Image: Julian Oldmeadow

Growth hunger

According to neuro-economists, our desire always to want more is not fully explained by simple human biological determination. Anthropologists even see it as a political and social imperative.

By Nic Ulmi

“Technological innovation and economic growth began when our ape-like ancestors produced simple stone blades, using one stone to knock flakes off another”. This quotation was taken from the financial magazine *World Finance* and is a reflection of the current view of the mechanism that has led to humanity’s accumulation of wealth. It is a trait of our species. It results from an innate and universal drive that has developed throughout our evolutionary history, and which is still present in contemporary society. Any attempt to control the growth of production to reduce the overall environmental impact is destined to fail; it will clash with a fundamental aspect of our mind-set.

However, empirical studies have produced a much more complex image of the psychological side to our economic behaviour. For example, behind our desire always to have more lies our aversion to loss, and coming hand in hand with our propensity to maximise personal interest is a spontaneous and continual desire for equality. The result is that the different impulses of our brain converge into a complex interaction of biology and culture. Both in economics and elsewhere, human nature seems to show plasticity.

Overly rational steps

Both Adam Smith and the schools of classical and neoclassical economics that followed saw ‘the progress of opulence’ in societies as based on two deeply rooted individual drives: the desire to improve one’s lot and the need to be acknowledged by others. Each drive aims to increase the wealth of the individual continually, through perfectly rational means. Smith argued that this stretched back to the dawn of time and that human beings were naturally equipped with a propensity to maximise their personal interest.

As of the 1970s, behavioural economics started attacking the foundations of this vision. On the one hand, classical economics saw rationality as perfect, but it now seems that it is not. When faced with a choice, we use neither all of the information available to us, nor all of the resources of rational logic; we most often make intuitive judgement calls, produced automatically by the fast-reacting circuits of our brains and not our analytical faculties. These “fast and frugal” heuristics, as they are called by Gerd Gigerenzer and Daniel Goldstein, often allow us to get things just right, but they also lead to what psychologists call ‘cognitive bias’. This bias opens us up to influence and leaves us vulnerable to manipulation by economic actors, who can push us to make decisions that go against our own interests, according to Klaus Malthus, a law professor at the University of Lucerne, in 2015.

“The political discourse suggests that contributing to growth must be a personal motivation”.

Christian Arnspenger

In the 1990s the MacArthur Economics Network drew together approaches from experimental economics, psychology and anthropology. This network of researchers, including the pioneering neuro-economist Ernst Fehr of the University of Zurich, observed that the vision of human nature at the heart of economic theory was blind to a number of elements. “People care both about other people, and about how social transactions occur—not just the outcomes”, they wrote in an article in 2004. Laboratory

and field experiments led by these teams, both in the West and further afield, showed no sign of the *Homo oeconomicus* that they had expected. What they found was *Homo reciprocans*. In this individual, “the logic of ‘reciprocal fairness’ takes precedence over selfish self-maximizing behaviors”. Intercultural comparisons show that the psychological impulses behind our economic behaviour vary greatly among groups of humans. There may be a universal human nature, but it is expressed in a number of different ways when it comes to the mutual construction of culture.

Familiarisation and envy

There is a contemporary vision of economic anthropology and psychology that aligns itself closely with that of Adam Smith, as put forward by Bruno S. Frey of the University of Basel, a specialist in the economics of wellbeing. “Our research on wellbeing shows that having an advantage in terms of material resources is very important to those who have very little. What we see is that, if someone has a low income and their income later increases, there is a spectacular growth in their life satisfaction. This is because they are leaving behind poverty which is a very unhappy situation”.

Those who are already better off will still try to increase their incomes, but they do it for very different reasons. “If you are a senior manager, you will compare yourself with your colleagues in similar positions. But, even if you earn more in Switzerland than you would in France, Germany or Italy, you will still tend to compare yourself with peers in the US financial sector, who are paid even more”. This is a universal law, says Frey. “There seems to be an innate tendency to compare oneself with those who are in a better situation. This envious tendency is not necessarily a likeable feature of human

“From a biological, evolutionary point of view, we just cannot identify such a drive”.

Jörg Rieskamp

nature, but the systematic comparison with people who are more successful is what pushes humanity forward”.

A third impulse makes up the system, maintaining it in perpetual movement even for a person at the top of the prosperity ladder. This is the familiarisation effect. This impulse leads us to perceive an objectively constant state as increasingly less satisfying, the longer it lasts. In other words, our minds perceive what is an unchanging quantity of resources to be a decreasing quantity. This is because our expectations fail to stop adjusting upwards. “This familiarisation factor plays a more important role, when it comes to income, than in other areas of life. It neutralises a large part of the increased effect on individual material well-being”, says Frey.

“This familiarisation factor neutralises a large part of the increased effect on individual material well-being”.

Bruno S. Frey

According to Jörg Rieskamp, a psychologist and specialist in economic heuristics and decision-making, also at the University of Basel, there is one other factor that explains our desire. “Evolution has clearly given our species hedonic preferences. We tend to seek pleasure and to avoid unpleasant situations. But that does not mean that we are driven to grow in such a way as to make us want more than we have. From a biological, evolutionary point of view we just cannot identify such a drive. What we can see is, on the one hand, an element pushing us to achieve the necessary resources for survival, and on the other, a drive to avoid loss, in other words, a strong tendency to avoid losing resources”.

So, what then is the relationship between loss aversion and growth impulse? “In principle, once we have sufficient resources, we are happy with preserving the status quo. But in reality, it is difficult to keep things safe. There are always fluctu-

ations, uncertainty and risk. Our tendency to avoid all potential negative change drives us to seek security by always aiming to have a little more resources in the immediate future. We are therefore trying to accumulate more material goods, because we see that as the safest strategy for avoiding having less, even if deep down we would be happy with the status quo”.

Anthropological plasticity

It is conceivable that these psychological faculties make up only one of a range of possible states of mind. This is the argument put forward by Christian Arnsperger, the director of the University of Lausanne’s Institute of Geography and Sustainability. He sees the psyche of *H. oeconomicus* as corresponding less to the immutable human nature inherited from the hunter-gatherers of the Pleistocene and more to a “cultural and political project”. In Adam Smith’s time, this was a humanist approach, “enabling the emergence of a society free of the shadow of hunger and early death”.

Is *H. oeconomicus* therefore an exclusive product of the European 18th century? “I’m not really in favour of purely historical explanations: I think that there is a human foundation that stretches throughout history”, says Arnsperger. “But within this human foundation, there is an ongoing internal debate. The human in favour of growth is only one of the possible variants of the human being”. We are very far from being truly determined by a rigid neurobiological programme, and we do indeed show some anthropological plasticity, in other words, an “innate capacity to overcome our innate faculties”, leading to a large range of different ways of being a human being. Interestingly, the biological sciences are also showing a similar image, where even the genome and the very architecture of the brain can lead the way to a variety of different behavioural and physical results.

How has this quest for increased wealth led to a behavioural second nature? On the one hand, it is a consequence of economic mechanisms themselves. “The creation of money, for example, came hand-in-hand with the creation of debt, and henceforth individuals and societies have the obligation of growth”, says Arnsperger. On the

other hand, “growth is being increasingly presented as a collective project. No individual acts spontaneously with the goal of macroeconomic growth in mind. However, what we see in the political discourse is an increasing frequency of the suggestion that contributing to growth must be a personal motivation. It is of course true that there is a minority holding capital who do have a direct interest in economies growing incessantly as a whole”.

So, as Arnsperger argues, we are faced with an unprecedented task. “Faced with the progressive destruction of all of the key elements of our biosphere, creating a culture of sustainability for human life on Earth does not just mean stopping all growth, but electing a selective and temporary growth model, made up of conscious decisions with regard to where growth is desirable and for how long”. He also calls for a real “anthropological transition”, which will be made possible thanks to the very plasticity of nature. “Of course, today we need to lead this project in a different way than through the top-down employment of constructivism used by totalitarian movements”.

Nic Ulmi is a journalist in Geneva.

$$\Pr [T_A < 1, T_B < 1] =$$

$$\Phi_2(\Phi^{-1}(F_A(1)), \Phi^{-1}(F_B(1)), \gamma)$$

This is 'The formula that killed Wall Street' – thus ran a headline in 'Wired' magazine, back in 2009. But the problem isn't the math, it's the blind trust that the financial world placed in it. This formula describes the probability that any two values will both default at the same time, whose mutual dependency is expressed by the single parameter γ .

Image: 2. stock süd

POINT OF VIEW

To those who have

As a science location, Switzerland is a trendsetter – and that is precisely why it could miss important opportunities. The innovative spirit of its researchers and their readiness to take risks will be crucial in Switzerland’s future successes or failures. By Ulf Büntgen

WSL



ETH Zurich is the only university on continental Europe to have been on the same level as the top American and British universities for any number of years. Outstanding research conditions and lavish salaries are complemented by a multitude of attractive location factors. But this can result in a high saturation level that leads to inertia, a decrease in risk-readiness, and a creeping loss of innovation and creativity. Furthermore, Switzerland’s direct democracy can delay decision-making processes, just as its striving for harmony can make it more difficult to develop and defend any individual stance. And if a scientist’s career runs only in straight lines, it can even have a negative impact on their performance.

“It’s important to leave your personal comfort zone”.

To be sure, this is complaining at a high comfort level. And we can really only wish for every scientist and scholar to have a secure job. Nevertheless, it is important to recognise areas of irritation, especially in

large, less flexible organisations. The Swiss research elite should thus react to even the smallest signals in their customarily sovereign manner. A sustainable educational policy means we have to place a very high value on international collaboration, experience abroad, both interdisciplinary and unconventional projects, a high degree of risk tolerance, innovative capacity, a critical discursive culture and a readiness to leave one’s personal comfort zones. What we especially need is the kind of top performers whose careers are founded precisely on these criteria. In order to compete internationally, researchers would do better to orient themselves according to dynamic development processes instead of taking delight in the status quo. And funding bodies should in future also create the necessary incentives to support inconvenient mavericks and those with a special thirst for knowledge and achievement.

Ulf Büntgen has been a professor of environmental systems analysis at the Department of Geography, University of Cambridge, since January 2017. He is also a Senior Scientist at the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), where he was a researcher for 14 years.

QUOTE

“We shouldn’t touch basic research”.

European Commissioner Carlos Moedas, on the EU’s Ninth Research Framework Programme, in Research Fortnight.

IDEA

Semantic publishing

Publishing articles online and including elements identified by semantic tags. The tags structure information, making the articles accessible to algorithms. Example: bit.ly/Ho_sempub

TOOL

Paprr

Nicknamed the ‘Tinder for preprinting’, this smartphone app enables the one-click classification process for the most recently posted articles on the platform Biorxiv. The four possibilities oppose ‘exciting’ and ‘boring’, and ‘plausible’ and ‘questionable’. bit.ly/Ho_paprr

INVESTIGATING RESEARCH

■ Preprints for project reviews

Project reviews by the UK’s Medical Research Council (MRC) and Biotechnology and Biological Sciences Research Council (BBSRC) can now include preprints, in keeping with the practice at the US NIH. bit.ly/Ho_bbsrc

■ Elsevier copyright violations upheld

A US federal court has awarded the publisher Elsevier USD 15 million in compensation for copyright violations committed by pirate websites including Sci-hub and Libgen, which have been freely distributing research articles. bit.ly/Ho_Elsev1

■ Open science: more than just trust

Many researchers have spoken in favour of open science, but then put up their collars when it comes to their own research contributions. They are afraid that their ideas and results will be stolen. The Finnish sociologist Heidi Laine conducted interviews with participants in two open science projects, showing that the trust of colleagues was “an important but not crucial factor”. She writes: “For now, nothing is calming fears related to the further opening and further stealing of ideas and results”. These concerns are deepened by

the central role attributed to publication, which contrasts with the curiosity-driven motivation of open science researchers. bit.ly/Ho_scoop

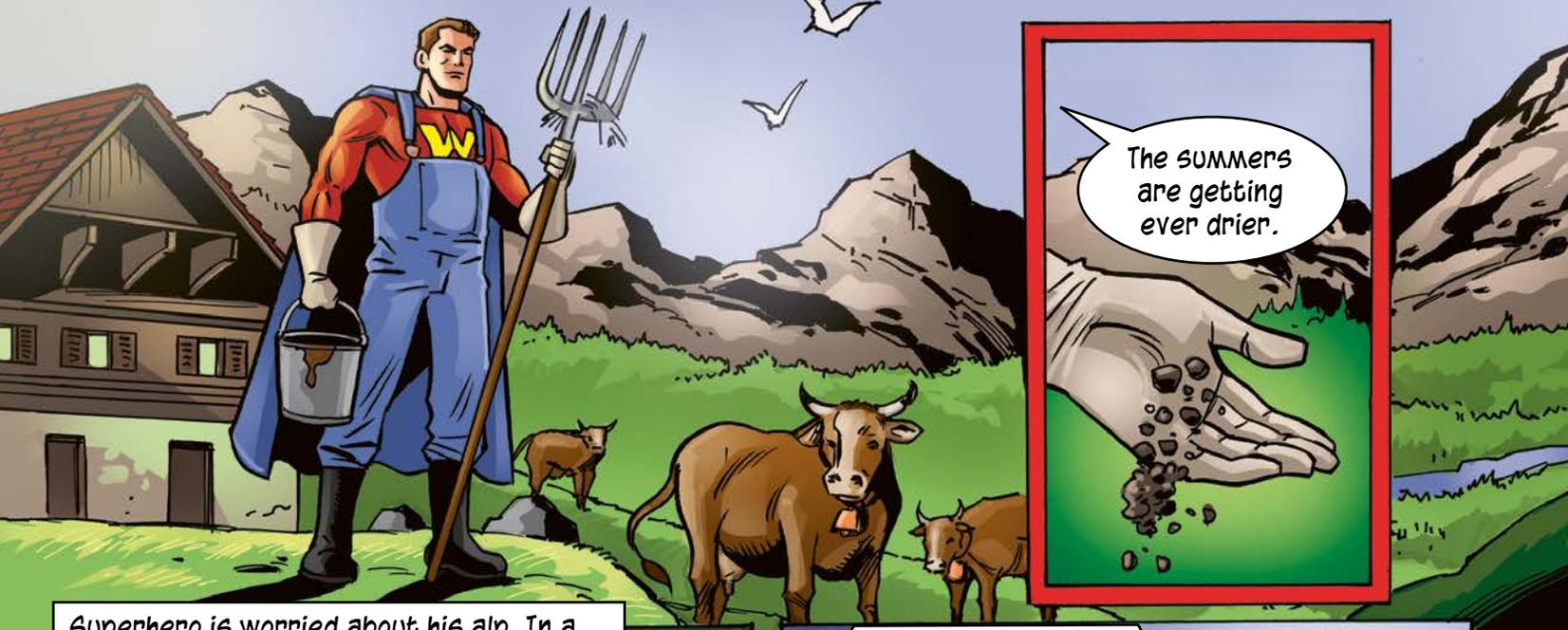
■ Seductive but not skilled

People are less likely to judge a scientist as being ‘probably good’ if they also judge his/her face to be attractive or sociable, according to a British study of 600 photos. No strong correlation was found for ethnicity, age or gender. The study involved a two-step process in order to verify that the primary conclusions were reproducible. doi.org/b9dr

■ Putin’s new role in research

It will soon be the role of the Russian President to approve the appointment of the head of the Russian Academy of Sciences if a new bill is passed. doi.org/b9gh

SUPERHERO SAVES SCIENCE



The summers are getting ever drier.

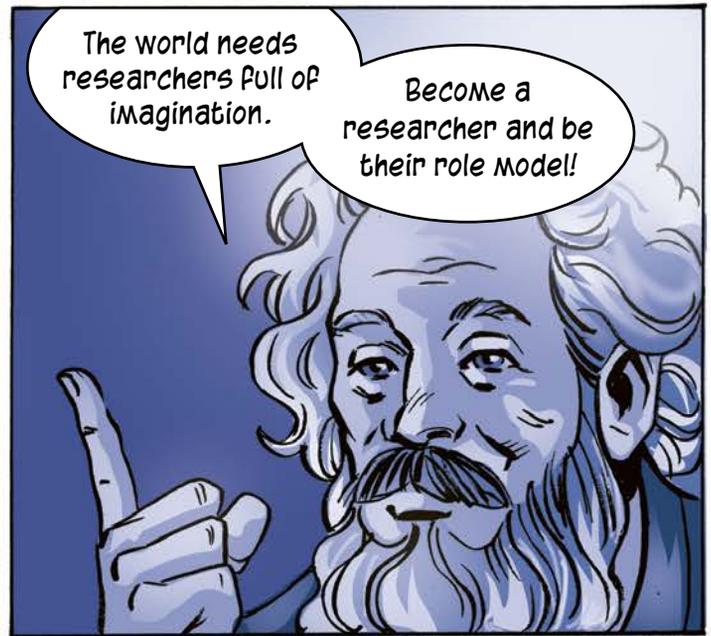
Superhero is worried about his alp. In a dream, he has a vision of Prof. Darstein ...



Save your alp, save the world – by curing science!



Researchers pay homage to the *h*-index.*



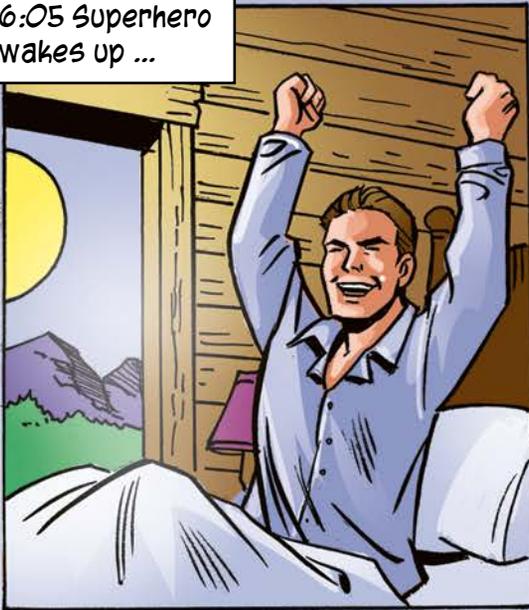
The world needs researchers full of imagination.

Become a researcher and be their role model!

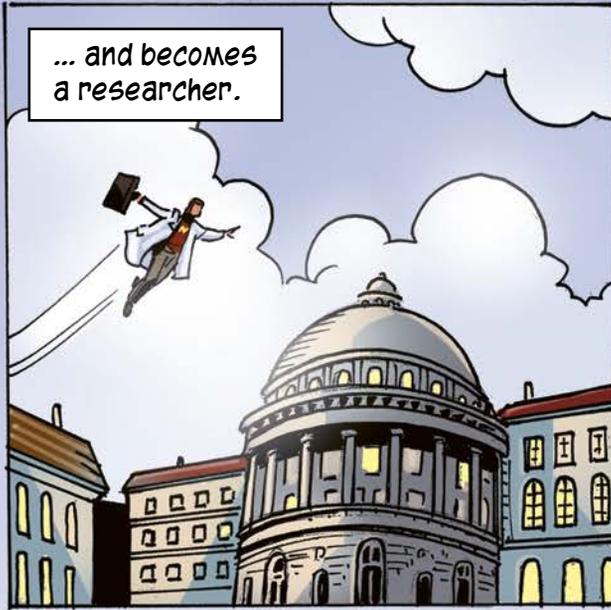
*The *h*-index reflects a researcher's number of publications and citations and is a means of measuring scholarly achievement. 25

Drawings: David Boller / edited by: Marcel Falk

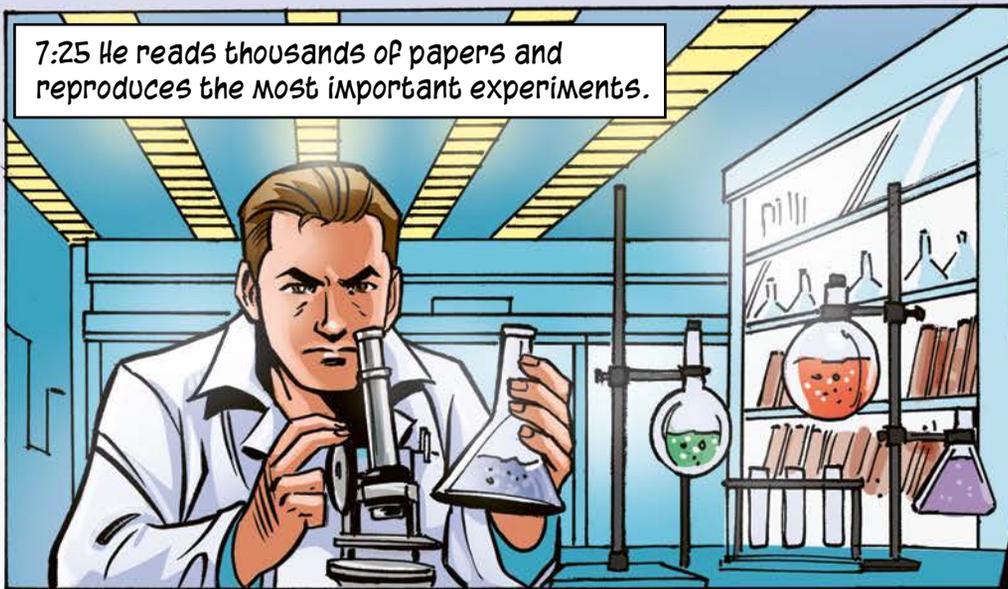
6:05 Superhero
wakes up ...



... and becomes
a researcher.



7:25 He reads thousands of papers and
reproduces the most important experiments.



9:43...

That could
work ...



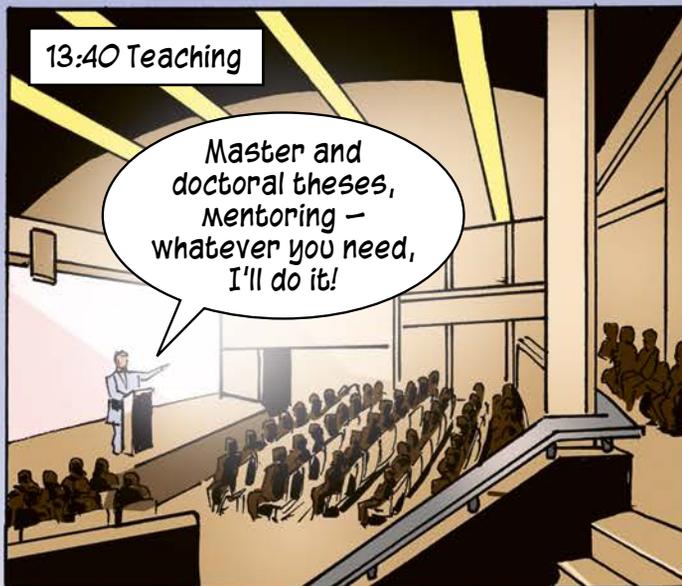
11:52...

Hypothesis
confirmed!

I need solid
results. Let's
repeat it 42 more
times.



13:40 Teaching



15:26 Politics



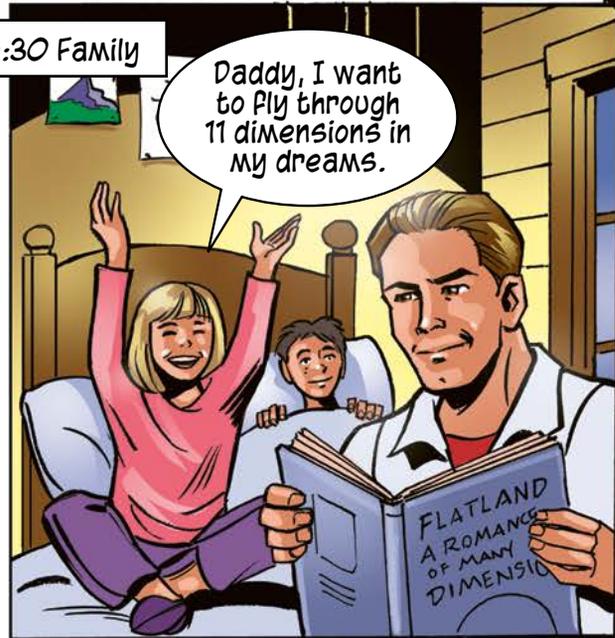
16:15 Spin-off



17:15 Dialogue

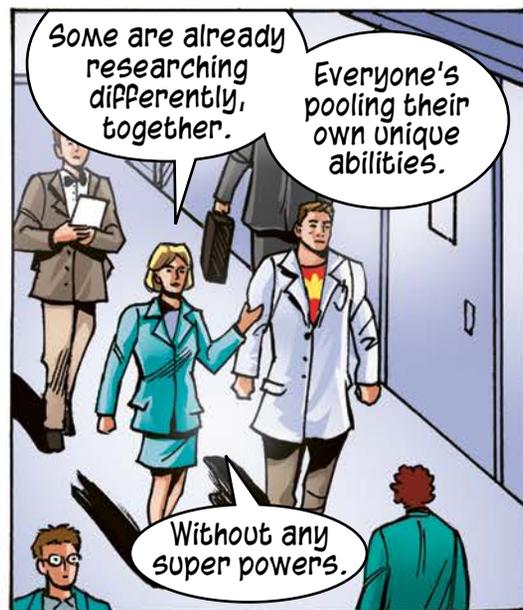


19:30 Family



21:15...





“Science studies asks painful questions”

Academia must cast a scientific eye on itself, says the science historian Bruno Strasser. He explains why science studies has struggled to develop in Switzerland.

Interview by Daniel Saraga

Academia is reforming, from science citizens to open science. Is it happening in a scientific way?

It's the question that's painful... science demands that politicians take an evidence-based approach to their work, but it can't necessarily take that road itself. One issue is that science studies often relies on the jargon of social sciences, which is poorly understood by biologists and physicists. They really don't have access to new knowledge. That's a shame.

Is it a culture issue?

Yes, but not solely. Up to the 1960s, the meta-discourse on science was principally the domain of researchers working in the natural sciences. It was only later that sociologists and historians started looking from the outside in. That's when science studies became professional and started raising more painful questions about the way research works. The result was increased tensions between the natural and social sciences.

Those tensions have died away since then and the discourse of science studies has achieved better understanding and acceptance. But that is much less the case in Europe than in the US, where universities foster the liberal arts and students follow both hard and social science courses, which facilitates exchange between the domains.

What about Switzerland?

There's still few initiatives in science studies. The exceptions are ETH Zurich's Collegium Helveticum, the University of Lausanne's Sciences and Technologies Studies Laboratory and EPFL's College of Humanities. In 2014 Basel closed its chair, resulting in top-notch researchers emigrating. The majority of students and researchers in the natural sciences don't have a human and social sciences culture. There is a high level of institutional specialisation, meaning there's no natural home or base camp for science studies.

In your opinion, what's the most pressing matter in the field?

The critical approach to expertise. Shouldn't the public be in a position to trust academic experts when it comes to political votes and decisions?



“Citizen science also serves to legitimise research”, says Bruno Strasser.

Image: Carmen Püntener

That sounds like a populist anti-elite slogan. Is there a risk of science studies being hijacked?

Absolutely. The science sociologist Bruno Latour was reproached in 2004 for having laid down arguments in his critical writing that were later picked up by politicians to refute the science of climate change. We've even seen creationists quote science studies in court. But that doesn't mean we can self-censor on the basis that our research will be misappropriated.

That said, populists are developing the idea of extreme relativism, attempting to argue that common sense prevails over expert opinions. Science studies has nothing to do with this position, which is in fact scarier than the all-powerful technocrat. The approach is based on the critical interpretation of scientific facts, and particularly the undermining of their degree of reliability. Researchers are well aware of this argument, but it is often hidden behind the narrative of intermittent progress, historical discoveries and Eureka moments.

How can confidence be restored between scientists and the general public?

At the end of the 20th century, nation states feared that critical approaches to science would undermine taxpayers' approval of research. Their response was to introduce participative programmes, such as the evaluation of technology policies. The results appear to be mixed, as studies have shown that consultations were held too late in the process, i.e., after a technological project had already been chosen, and that the public felt somewhat cheated.

We're still looking for ways to get people involved, not just in decision-making, but also in producing scientific knowledge. Studies that we have carried out within my research group on science citizens show that there is broad diversity. In some cases, the citizen is happy to classify images of galaxies or neurones. He or she can learn a lot from the experience. But it leads people to believe that they are experts, when actually they're just executing simple scientific tasks with no real autonomy. This portrays a simplistic image of science. It can even be interpreted as demagogic: the public is brought on board with the intention of making it accept the form of research.

At the other end of the spectrum is the DIY Science movement, e.g., Hackarium near Lausanne, where citizens can concoct their own research projects. This is of course mainly young people with a scientific education, but these forms of participative experiments do open up a new platform for other forms of research.

The research citizen

Bruno J. Strasser is a professor of science history at the University of Geneva and an associate professor at Yale. He has also worked on the history of biology and medicine in Paris, Berlin, Princeton, Barcelona and Manchester. He is currently investigating the history of science citizens.

Science under duress

The tense situation in Turkey is making it increasingly difficult to conduct research there. Foreign scientists working in Turkey are also aware of this, and they describe diminishing freedoms and a vague sense of fear.

By Simon Jäggi

Our call is answered by an anthropologist on the Aegean coast of Turkey. She travelled there just a few days ago to find out more about the political situation: “I would like to know what kind of research is at all possible here at the moment”. She would rather not offer any information whatsoever right now – and the same goes for other researchers. In order not to endanger either her, her partners in Turkey or their current research, some of the sources for the following text remain anonymous.

This anthropologist has been researching in Turkey for many years now. What kind of research will remain possible in the future is something that she cannot guess yet: “Either way it will become more difficult to do research here”.

She is one of several researchers from all over Europe who have been deeply engaged with Turkey. Many of them also see the situation the same way – it’s unpredictable and there’s a sense of latent threat. Many of them find themselves confronted with far-reaching complications in their work: either they aren’t given research permits any more, or get them only after a laborious process. It’s become more difficult for them to access archives, and their partners on the spot have become warier. These scientists often find it difficult to assess the extent of state surveillance right now. Our anthropologist is concerned least of all about herself; the worst that could happen to her is to be expelled from the country and be forbidden from returning. But it could be worse for her research partners in Turkey itself, or for the PhD students with Turkish passports who are working with her.

Self-censorship ...

The Western media often discuss how scholarship is under pressure in Turkey. But the figures also speak for themselves.

Since the putsch attempt in the summer of 2016, the Turkish state has fired more than 4,800 scholars and begun criminal proceedings against over a hundred of them. The University of Lund published these figures in the spring of 2017. In early June, the American organisation ‘Scholars at risk’ published another report on the situation in Turkey. It describes the persecution of scholars having reached an “unprecedented scale”. Universities are being closed, while staff are being fired, forbidden from travelling, and even arrested. According to the report, thousands of scholars are affected by this state repression. And the persecution is continuing.

The increasing pressure on scholarship and science is having a negative impact on foreign researchers working in Turkey. But the repercussions of the current political climate extend much further. They affect the jobs of people in the universities where scholars evaluate and publish their findings. “We consider very carefully what we can publish”, says another social scientist. This professor has been engaged in a study of Turkey for over 30 years. He and his colleagues completed their fieldwork there before the attempted coup last summer. He was lucky, he says. “We were doing research that we couldn’t carry out any more today”.

“We are currently working with the hand brake on”.

Nataša Miškovic

His colleagues returned from Turkey more than a year ago now, including one researcher with Turkish nationality. They are evaluating their data and preparing their initial publications on it. They are writing about thorny issues regarding the

Aliye Berger was a well-known artist who came from the uppermost echelons of the former Ottoman court. She was accused of having shot and wounded a rival for the affections of her later husband. This and many other such press photos are part of the research project of Nataša Miškovic.

Image: SIBA database



relationship between the state and society. “We have to be very careful, and can’t write everything that perhaps we would like to”. Their primary goal in their publications is to protect their Turkish colleagues and their Turkish sources, who are opposition politicians or employees of NGOs.

... can protect partners on the spot.

On the one hand, there is the desire to publish all possible relevant findings; on the other hand, there is a vague fear of repression, which has been intensified by events such as the arrest and dismissal of employees of universities and other organisations in Turkey.

It’s a dilemma, as Nataša Miškovic can also confirm. She is an SNSF professor at the University of Basel and is active in a project of many years’ standing, researching into the emergence of the Turkish Republic and everyday life in Istanbul and Ankara



in the 1920s and '30s. Her group's focus is on press photographs from the major daily newspapers Cumhuriye and Akşam. Their research is complete, and they are currently preparing for an exhibition that is also supposed to be shown in Turkey. This demands a great deal of caution. "We have intense discussions on what topics we can show, and where". In order to not lose cooperation partners, they have also made

certain compromises. They become careful whenever state authority becomes a topic. "Just like many other researchers, we are currently working with the hand brake on", says Miškovic.

Our conversations with these scientists are repeatedly suffused with a vague feeling of threat. Despite the unpredictable situation, they want to continue with their work. "We can't leave every country that

doesn't want us to research there", says our anthropologist on the telephone. But at that point she finished the conversation because half an hour later she was to meet with employees of a local organisation. A feeling of uncertainty will stay with her.

Simon Jäggi is a freelance journalist in Basel.

Timeline

3 October 2005: Turkey begins accession talks with the EU.

15 July 2016: A putsch attempt in the night of 15/16 July. The government accuses the preacher Fethullah Gülen of being the mastermind behind it.

21 July 2016: A state of emergency is declared.

Basic rights are suspended, and freedom of assembly is limited.

4 November 2016: Figures show 110,000 civil servants, judges, public prosecutors, policemen and soldiers sacked or suspended, including numerous scientists. Tens of thousands arrested; some 170 newspapers, magazines, TV stations and news agencies closed.

8 February 2017: New mass firings: 4,500 civil

servants, including 330 university teaching staff.

16 April 2017: The people accept the disputed referendum on the constitution, with a slim majority.

18 April 2017: The government extends the state of emergency by another three months.

30 April 2017: Turkey blocks access to Wikipedia.

1 August 2017: 500 alleged putschists are put to trial.

A pioneer of cyberspace



Solange Ghernaouti is a world leader in digital security. Horizons meets the straight-talking fighter.

By *Martine Brocard*

When we asked 58-year-old Solange Ghernaouti if she was a woman in a man's world, her reply was, "I am a scientist who wants to understand and to share: that's asexual". She went on to add, "but I am not a man. Let's be clear about that. I believe humans complement each other". In her office of 30 years, Ghernaouti walks about barefoot with her hair tied youthfully, and is followed everywhere she goes by her dog Swak, even to her lectures. Ghernaouti is a professor in computer security at the University of Lausanne and she wears this badge proudly.

"The moment we expose ourselves, we run the risk of not being appreciated. But I don't care, what's important is being respected". Before specialising in the security of telecommunications networks, Ghernaouti started out designing them. She went on to become an authority figure in cyber security. Her books have since been translated into Chinese, she gives conferences around the world and she advises governmental and United Nations bodies.

She is known to her entourage as a fighter, and she is currently fighting for a 'Geneva Declaration of Cyberspace' to govern the digital environment, to set forth the specific rights of Internet users and to define the limits to acceptable practices. "Just as with the climate and the environment, we must reflect upon what kind of cyberspace we would like to hand down to our children".

360-degree vision

Ghernaouti claims to take an interdisciplinary approach to cyber security. Her projects look at not only technology and risk management but also philosophical, social, economic and political dimensions. In this regard, her concerns extend from the impact of computer conglomerates on our private life to the rise in Internet criminality. This approach does not win her very many friends. In 2015 the website of her research team, the Swiss Cyber Security Advisory and Research Group, was hacked, apparently by the Islamic State. "I marked that one down to experience. It was a lesson in cyber security from the victim's perspective".

But it would take a lot more to upset Ghernaouti. When she was very young she had to fight to take her own path. She was born to French parents in Algeria during its war of independence. Her father was a geologist in the Sahara and she has a brother who is one year older than her. Before long, her family returned to Paris. "We were not rich. My mother was always very proud to be able to put food on the table every day".

Ghernaouti was a dreamer, fascinated by dictionaries, and dyslexic at a time when the disorder was still relatively unknown. "There are so many letters in my surname that I used to mix them all up!", she says, smiling. She was placed with the dunces at the bottom of the class, and it was only thanks to her ability in mathematics that she lifted herself from that position and successfully left school at 16 years old. "It was because I had to fight continually that I became as strong as I am".

"We must reflect upon what kind of cyberspace we would like to hand down to our children".

Solange Ghernaouti

As she progressed through adolescence, she became inspired by Leonardo da Vinci. "I was fascinated by his ability to invent and to think into the future, but above all by his mirror writing". She demonstrates by taking a pen in each hand and writing the same sentence simultaneously both left to right and right to left. That's not bad for a dyslexic girl who used to have difficulty holding a pen. The same can be said of the 30 books she has published, including the first entitled "What do I know? [Que sais-je?]" about the Internet, co-authored by Arnaud Dufour.

Independence first

In the mid-1970s, she left home and her strict upbringing to go into computer studies. "It was the innovative and abstract sides to this discipline that attracted me. Just as a child does with a new toy, I wanted to know exactly how it works and what one can do with it". To finance her studies, she worked as a carer, maths teacher and neuropsychiatrist, before creating her own company to provide software development services. "It was fun, but really I was just trying to get by. I wanted to be independent and not to have any favours to repay". Having obtained her PhD, she applied to the University of Lausanne and, at 28 years old, became the first female professor in an applied business school, where she still works today.

"Ghernaouti is an exceptional person, she is an extraordinary researcher who

identifies new topics to look into and she knows how to get her staff to work", says Igli Tashi, a former doctoral student and now head of computer security at the Vaud Cantonal Bank. "But what I admire most, beyond any form of prejudice, is her open-mindedness".

Years later she gave birth to a young girl. She sees it as a "wonderful adventure" but also an "extreme marathon", because she was both a single mother and a career woman. "That's the real achievement and no one cares!", she says, adding, "I was on the verge of quitting almost every day". Her colleague, the biologist Liliane Michalik, describes her as "a very brave and generous woman, devoted to her child and to her work" in a macho academic environment. Despite this, Ghernaouti still finds the time to go one step further: for more than 10 years she has chaired the university's social committee and its equal opportunities committee. "It's normal, almost a duty in terms of solidarity and setting a female role model".

Today she spends her spare time with her daughter, her books and her friends. She likes the forest, stargazing, and dreams of keeping chickens. She takes long daily walks with her dog: "this is the time I use to revitalise my mind, think outside the box and organise myself. In fact, it's my dog who walks me!", she says, laughing. But her driving interest is understanding, thinking and sharing. "I want to be always open to new ideas. That's a way of living. People who only see restrictions cannot appreciate that, but personally I find it elating".

Martine Brocard is a journalist for ATS, Les Alpes et LargeNetwork.

A Legion of Honour in Lausanne

Born in Algeria in 1958, Solange Ghernaouti obtained her PhD in computing and telecommunications in 1986 from the University of Paris VI. In 1987 she was appointed professor of the business school of the University of Lausanne. She is a member of the Geneva Centre for Security Policy and the Swiss Academy of Engineering Sciences and a participant at the French national defence institute IHEDN in Paris. In 2014 she was appointed a member of the Legion of Honour. She is a French-Swiss citizen and has one grown-up daughter.

Chips and brains

Memristors can remember past activities, just like nerve cells. Researchers are using them to build quicker chips for more efficient data analysis.

By *Sven Titz*

We've all got used to our computers getting ever quicker. But this development is now coming up against physical limitations. This is because of the current way in which computers are constructed, explains Yusuf Leblebici of EPFL in Lausanne. Processors and memory are separate units in the classical von Neumann computer architecture, and the connection between them is increasingly becoming a bottleneck: "If the processors work at high speed, it becomes more difficult to transfer the data quickly enough between memory and processor".

The solution could lie in new structures for computer chips. New electronic components could play a role here. Researchers like Leblebici are taking biological nerve cells as their models. They want to develop neuromorphic chips whose electronic construction is like a network of nerve cells. The advantage of this is that computational and storage activities are much more closely interlinked.

Essentially, neuromorphic chips can be built with conventional electronic components - the Truenorth chip of IBM is based on this principle, for example. It digitally imitates the characteristics of nerve cells.

Leblebici is pursuing a different possibility, employing new components called memristors. Put simply, these are electrical resistors that remember the electric currents that have previously flowed through them. This is similar to the learning ability of nerve cells in the brain.

In the coming years, Leblebici will be developing several prototypes of neuromorphic chips in a collaborative project with IBM and the Institute of Neuroinformatics at the University of Zurich. He and his colleagues are proceeding on three levels. In one part of the project, they are constructing new memristors; in a second they are making circuits based on these components, such as coupling them with sensors; and a third group is busy integrating them into a total system. In this manner, Leble-

ici hopes that they will be able to carry out video recognition with one of the prototypes in just a few years.

Pardonable errors

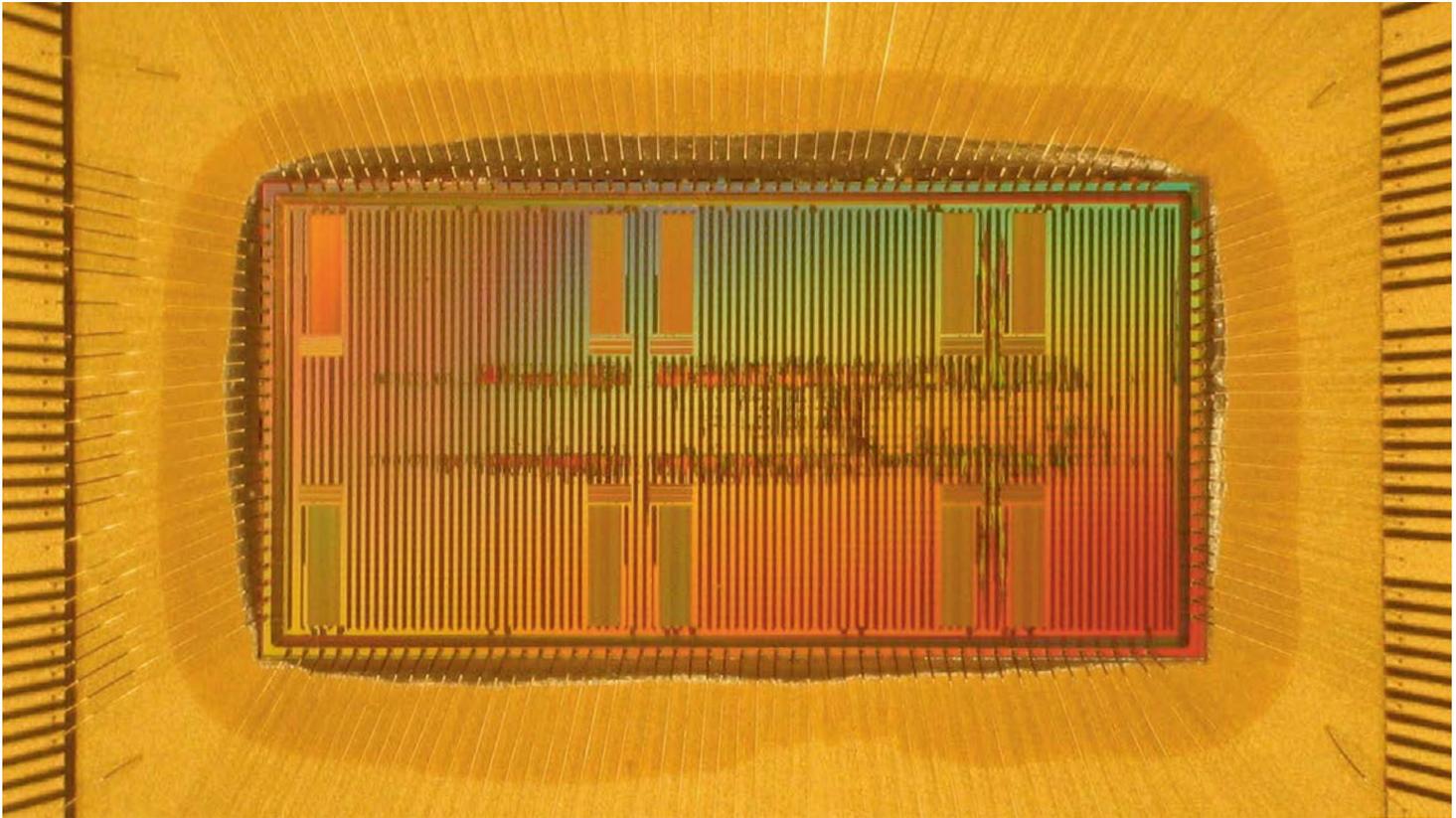
The main advantage of chips built from memristors is their high surface density, explains Leblebici. Individual computational functions can be carried out on a hundredth of the surface of conventional chips. The price of this is a reduction in computational accuracy. Memristor chips cannot deliver results precisely to a large number of decimal places. But many other tasks require an extremely high velocity to process huge amounts of data, and one or another small error is of little consequence in such cases. Typical examples are the recognition and analysis of audio data, photos and videos. The eye won't complain if an individual pixel has the wrong colour.

The biggest challenge for memristors is their lack of durability.

All microelectronics companies are very interested in ideas for neuromorphic chips, says Markus Kubicek from the Technical University of Vienna. Three years ago, he made the headlines with an article on the mechanisms that could one day replace flash memory. He wrote it at ETH Zurich together with Jennifer Rupp.

There is a fundamental difference between memristors and classical silicon transistors, explains Kubicek. Unlike transistors, memristors often don't recognise the states of 0 and 1, but also something between them. This is a characteristic that doesn't just enable them to learn, but can also be used to realise 'fuzzy logic' - a variant of logic that allows for unclear statements.

According to Kubicek, it's still anybody's guess whether chips using memristors will



The BioNet chip imitates a network of nerve cells. It's going to be linked to a real nerve-cell culture in order to study its activity.

Image: Stefan Schiefer

prevail, or neuromorphic constructions using more conventional components. There are in fact many different types of memristors. Kubicek usually uses oxides for them, such as titanium or strontium oxide. Their operating principle is founded in oxygen defects. Other groups use metal filaments, for example.

Memristors could also be made with an even higher density than up to now. To achieve this, researchers would have to realise a three-dimensional architecture – and thereby pile up the memristors one on another, so to speak. Such constructions could accommodate ‘deep learning’, says Leblebici, which is important in the development of artificial intelligence.

Surviving a billion cycles

It is often suggested that chips using memristors could use much less electricity than conventional chips. But Leblebici wants to curb such optimism a little. “You mustn’t forget that memristors need electronic circuitry on their periphery, too”, he says. And this circuitry needs extra electricity.

The biggest challenge in developing memristors is very different, says Kubicek. It’s their lack of durability. From a technical standpoint, they need to remain stable over more than a billion cycles. Sometimes even more than a thousand billion. “Most

memristors today can’t yet manage that”, he says. But that could change.

The production process of memristors is still too diverse for industrial applications, says Christian Mayr of the Technical University of Dresden. He is also researching into neuromorphic structures. “Several production steps are necessary to manufacture memristors”, he explains. “That’s a problem. Manufacturers of semiconductors dislike every extra step in production because it leads to increased costs”.

Mayr believes that there are promising applications for memristors in the field of neuroprosthetics and other, similar interfaces between computers and biology. Mayr was experimenting with such systems during a research visit to Zurich from 2013 to 2015. Other interesting applications are opening up in information compression. The human eye is capable of reducing information density by a factor of 100 before the visual signal is sent to the brain, says Mayr. Perhaps neuromorphic chips will be able to do something similar in future. Whether this will involve memristors or not still remains an open question.

Sven Titz is a freelance science journalist in Berlin.

Resistor with a memory

A memristor (a combination of ‘memory’ and ‘resistor’) is one of four basic passive components of electrical circuits, alongside capacitors, resistors and inductors. Its resistance changes according to the volume and direction of the current that flows through it, and it can be changed constantly. They were invented back in 1971, and researchers hope today that they will be able to build new types of computer with them. *ff*

Turning CO₂ into something sensible

A research team from ETH Zurich is developing new types of catalyst that can turn carbon dioxide gas into a storable, liquid resource. We've taken a peek at their laboratory. *By Dölf Barben*

We're in a laboratory of the Department of Mechanical and Process Engineering at ETH Zurich face to face with cables, containers and gas flasks, all rather small and not at all impressive. Before our visit, Professor Philipp Rudolf von Rohr had promised us that we'd be seeing a "real research facility". But standing in front of us, atop a chest of drawers, is just a block of metal with a small window in it. We're told it's actually a viewing cell in a catalytic reactor. When used together with a Raman spectrometer, the reactor enables the researchers to observe material properties down to the molecular level. The interactions between the light of the laser beam and the material inside the reactor produce the signals that interest experts.

Now, at least, it's obvious that the size of the test setup is inversely proportional to the importance of the project, which is the joint effort of Philipp Rudolf von Rohr and over a dozen researchers from eight countries. "Our goal is to turn CO₂ into something sensible", says Rudolf von Rohr.

This isn't about getting carbon dioxide from the air around us - though it does have to do with our climate. They want to make it possible to turn CO₂ into a liquid resource. Using hydrogen, they want to turn this harmful greenhouse gas into a commodity from which they can in turn produce useful things such as fuels. The problem with storing CO₂ as a gas is that it requires a gigantic effort. But if it can be turned into a liquid, it can be stored and transported with ease.

Tricky catalysts

On paper, the problem looks simple enough for schoolkids to solve. And the research team has already mastered two of the three necessary steps involved. First, two catalysts are used to transform the gases carbon dioxide (CO₂) and hydrogen (H₂) into formic acid and methanol, which then unite to form methyl formate. Then another catalyst is used to break down this intermedi-



Liquid methanol can be made from CO₂. As these blue tanks demonstrate, methanol from other sources is already traded in huge quantities today. Image: Peter Beentjes

ary product into formic acid and methanol again, this time as liquids. The tricky one is the first catalyst used to produce formic acid, or, to be more precise, its interaction with the second catalyst that produces the methanol. Rudolf von Rohr and his team are experimenting with pressure, temperature, retention time, volume, yield, and much, much more. Last but not least, the researchers are faced with the problem of being able to identify reliably everything that emerges, whether by design or not.

“Problems like this can only be solved when different disciplines work together”.

Philipp Rudolf von Rohr

What's more, their desired product, formic acid, is also proving to be wayward. There is no simple method for determining what volumes emerge after a reaction. "Measuring it is not at all simple", says Rudolf von Rohr, who clearly knows innumerable ways of avoiding the concept of 'highly complicated'.

Rudolf von Rohr's team comprises chemical and process engineers, but they don't work on their own. "Problems like this can only be solved when different disciplines work together", he says. There are

four groups of researchers busy with it: specialists in catalysts, then analysts who can determine "what actually comes out at the other end", as Rudolf von Rohr says. Then there are the chemists who are trying to understand what exactly happens with the catalyst. And, finally, there is Rudolf von Rohr's own group, which is building, running and optimising the apparatus. It wouldn't work without an interdisciplinary approach, he says.

Towards a CO₂-neutral energy cycle

"This research project is worthy of support, not least because it points us in the direction of a CO₂-neutral energy cycle", explains the physicist Reto Holzner. He's the head of development at Silent-Power, a company that markets electricity generators that run on ethanol. In the light of climate change, developments towards this goal of a CO₂-neutral energy cycle are among the most important of all, he says. He sees possible difficulties in the multiple catalysts, while the high pressure involved could become a problem in later, bigger plants. But their findings are ultimately of great importance for Switzerland as a business location, says Holzner. "Otherwise, others will overtake us".

Dölf Barben is a journalist at the daily newspaper Der Bund.

Monica Morales Masis



The transparent electrodes on the glass in the foreground don't need any expensive indium.

Cheap transparent electrodes

One of the subtle characteristics of smartphone screens is their ability to conduct electricity without blocking light. The transparent electrodes behind this are about to be upgraded, thanks to a new version developed by an EPFL team at Microcity in Neuchâtel.

"There are currently very few raw materials that can be employed on an industrial scale", says Monica Morales Masis of EPFL. The most commonly used is an oxide of indium containing a low percentage of tin. Indium is not, however, a resource of infinite proportions, so its price is set to rise. This means possible price hikes not only in touch-screens, but also in solar cells, another area where these electrodes are used and one where cost is a more preponderant factor.

One possible avenue is to increase the proportion of tin and to substitute indium with zinc, which is more abundant and less costly. But blending zinc and tin oxides into a single, thin and transparent layer is easier said than done. The main author of the study, Esteban Rucavado, says: "We have been working with theorists, who've used simulations to identify the issues we're facing (Ed. too many or too few atoms). We can fix this by treating the material. And with microscopes we'll then be able to examine the transparent layer at the nanometric level to verify the improvements and to understand the fundamental properties of the materials".

The team at EPFL has also been able to show that the mix of zinc and tin oxides is very stable at elevated temperatures, which is a huge advantage for any solar application. As for industrialisation: "That always requires a little more time, but the process itself stands to transfer easily", says Morales Masis. *Olivier Dessibourg*

E. Rucavado et al.: Enhancing the optoelectronic properties of amorphous zinc-tin oxide by subgap defect passivation: a theoretical and experimental demonstration. *Physical Review B* (2017)

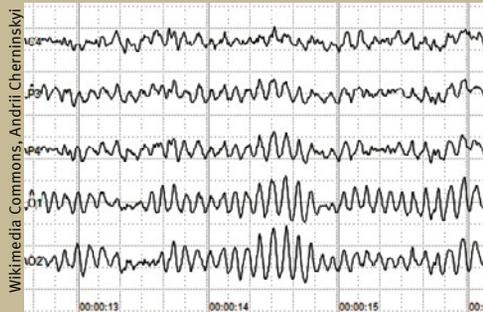
From mind-reading to speed-reading

According to research by Thomas Maillart, it is possible to use the human mind to control the speed of text-scrolling on a computer using just a single electrode. Maillart is an expert in complex systems and cyber-risks at the University of Geneva, and he has recorded electroencephalogram (EEG) data from 33 patients using just a single electrode placed on their heads. "The neuroscientists in my professional circle are somewhat sceptical, because they are used to EEG skullcaps containing dozens of electrodes, or even MRI scanners", he says.

Departing from the traditional approach of studying the brain's frequency bands (alpha, beta, gamma), Maillart has been calculating the entropy (a measure of disorder) within the EEG frequency spectrum. "Entropy is one of the simplest ways of compressing complex signals into a single value, and it captures the variation in the intensity of neural activity. Unlike the frequency band approach, there is also no need to calibrate for every subject".

The experiment was set up so that the variation in EEG entropy determined the speed of a scrolling text - in real time. Three quarters of the subjects were able to stabilise the speed of the text by controlling their neural activity. "In principle, our method could be used in a speed reading device, where the reader controls the scrolling speed using only his or her brain", says Maillart. "This is a very creative study with an approach that strays from the usual practices of neuroscience, but it is still very early days", says Dimitri Van De Ville, a bio-engineering professor at EPFL. "Entropy may be stabilised, but it remains to be seen whether this really reflects a specific cognitive function, such as concentration". *Daniel Saraga*

T. Maillart et al.: Brain Speed Reader: A neuro-feedback apparatus to read fast and remediate multi-tasking (submitted, 2017)



The disorder in the signal of a single EEG electrode is astonishingly informative.



Cornel/Shutterstock

Every step creates a vibration. One day, sensors could use this to measure visitor numbers.

Vibration sensors to detect people

All human activity generates small tremors. So, is it possible to identify signature vibrations using accelerometers, i.e., vibration sensors? A system built on vibrations would be neither as intrusive as cameras, nor limited by blind spots. Ian Smith and his team have been trying out the idea in an EPFL building and have had encouraging preliminary results.

The main difficulty is distinguishing between vibrations from people and from the environment: traffic, tubes and pipes, washing machines, etc. The practice being widely adopted is to set up a very large number of sensors within a concrete screed. "This approach is not cost effective, but by combining the vibration data and digital models of a building, it will become possible to step up the precision and subsequently reduce the number of sensors", says Smith.

The team have rendered a model of a hallway at the EPFL campus, including the depth of the screed and the configuration of walls. With four standard sensors, it was possible to detect people within a 200m² space. The system was able to distinguish people from the nearby underground trains and from the machines running in EPFL laboratories.

Eventually, this technology could become sensitive enough to detect an elderly person falling or to estimate the number of people within a given space. "We're still at the experimental stages, but there's huge potential, for example, in care homes, where it's unthinkable to put cameras into bedrooms, and in high security environments, such as banks and jewellers".

Lionel Pousaz

Y. Reuland et al.: Vibration-Based Occupant Detection Using a Multiple-Model Approach. *Dynamics of Civil Structures* (Springer, 2017)

The genetic clear-out

Paramecia have genetic elements that can eliminate themselves – junk DNA with a self-destruct mechanism. *By Ori Schipper*

The greatest part of the genetic material of higher organisms comprises junk DNA. This genetic ‘clutter’ contains no blueprints for proteins. Researchers have been discussing for decades why this is so, and what biological significance these non-coding genetic building blocks might have.

A group led by Mariusz Nowacki at the Institute of Cell Biology at the University of Bern has been investigating how paramecia deal with these DNA sequences, which are often regarded as being parasitic. Their findings seem paradoxical at first: these water-dwelling, single-cell organisms use these genetic elements in order to dispense with the same sequences themselves. In other words, the ‘junk’ is used to clear itself out.

Cell nuclei times 800

Paramecia are particularly suited for experiments into the role of junk DNA, because they have two types of cell nucleus: a micronucleus and a macronucleus. The micronucleus teems with non-coding DNA sequences. It contains the germ line genome. This is not used for the production of proteins, but is used exclusively for purposes of asexual reproduction.

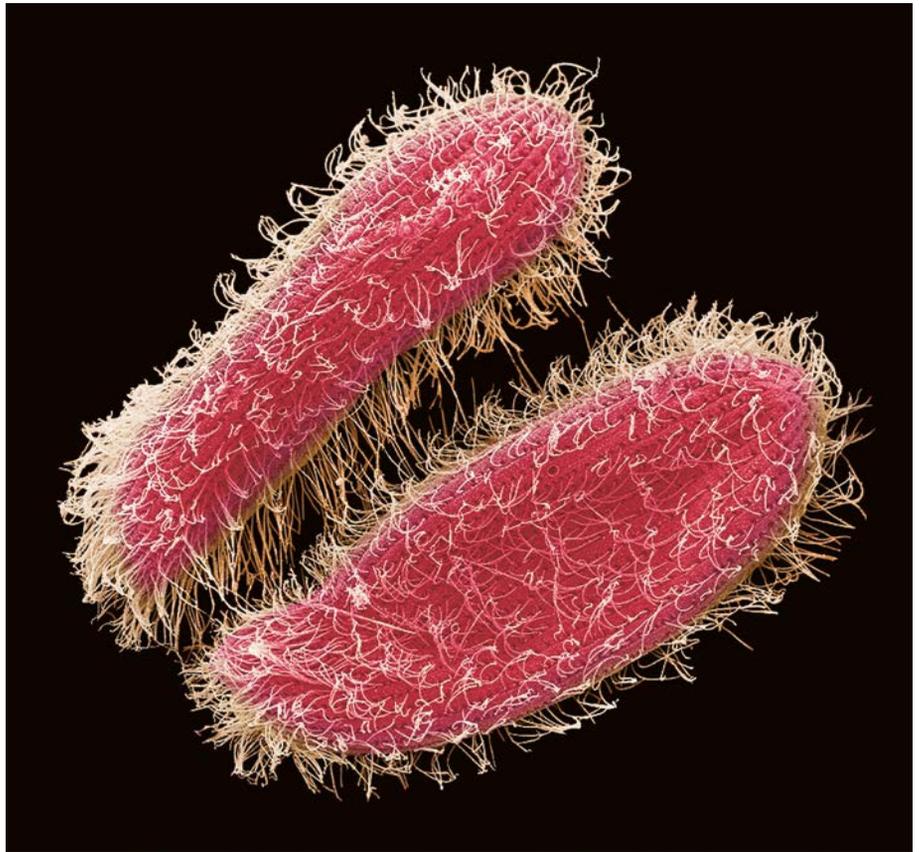
The macronucleus, on the other hand, contains more than 800 working copies of the genome. These are optimised for the immediate needs of the paramecia. In order to create the macronucleus, the genetic material of these organisms is, at one and the same time, copied and de-cluttered. The copies contain a compact, clean copy of all the paramecia genes, from which the junk sequences have been eliminated. But in the long term, these optimised copies are unstable. “That is why the paramecia now and again reproduce sexually – and subsequently create a new macronucleus”, says Nowacki. The junk then has to be eliminated all over again.

Up to now, scientists had supposed that the non-coding DNA fragments – cut out of the germ line genome by the single-cell

organisms to create a new macronucleus – were broken down and destroyed. But this is not the case, as Nowacki and his team have proven. “The paramecia glue the eliminated fragments together and make rings and loops with them”, says Nowacki. Upon reading these junk-DNA collages, they then create search templates that enable them to locate and remove further parasitic elements in their self-copying genetic material.

They can ‘switch off’ or shut down parts of their genetic material.

The more cut-out sequences they find, the quicker they can find other parasitic elements, too – a kind of positive feedback process. This method of arresting undesired genetic elements in order to use them to search for further sequences in the genetic material can also be found in the cells of animals and plants. In this manner, they can ‘switch off’ or shut down parts of their



Paramecia remove parasitic DNA from their genome – here an image magnified 500 times by an electron microscope. Image: Keystone/Science Photo Library/Steve Gschmeissner

genetic material. This could be a mechanism that in general plays an important role in defending genetic material against deposits of parasitic elements.

This is also the opinion of Rebecca Zufall, an evolutionary biologist who is researching into the architecture of the genetic material of an organism related to the paramecia. She is admiring of the work being done in Switzerland: “They’re presenting a clean model of positive feedback and signal amplification that makes sense in the context of the double genome of these single-cell organisms”.

Ori Schipper works for the Swiss Cancer League and as a freelance journalist.

S. E. Allen, et al.: Circular Concatemers of Ultra-Short DNA Segments Produce Regulatory RNAs. *Cell* (2017)

Small steps in fighting fat

Many people spend the greater part of their day sitting down. Researchers at the University of Fribourg are investigating how many calories we could burn if we were to stand instead.

By Florian Fisch

In Switzerland, almost two-thirds of adults are overweight, despite broad-based campaigns to counter it. And the trend is upwards. This also means an increased risk of cardiovascular diseases, type 2 diabetes mellitus, and even several types of cancer. Many people try to burn off excess calories by doing sports.

But the majority of our less athletic fellow citizens can also get their weight under control by moving more. In order to help them, a group led by Abdul Dulloo, a professor of nutritional physiology at the University of Fribourg, is studying the energy expended during normal activities. “Up to now, most studies have concentrated on intensive activities that require roughly five to 12 times as much energy as lying down or sitting. But in everyday life, we rarely go above four times that level of intensity”.

Measuring energy consumption

Abdul Dulloo of the University of Fribourg is measuring the energy consumption of low-level activities. Instead of having his test subjects run on a conveyor belt, he has them stand and shift their weight from one leg to the other, and uses two sets of scales to find out how vigorously they shift their weight. Or he has them cycle on an ergometer with low pedal resistance. In another test, they have to sit down and press their feet against a plank every 30 seconds.

Their oxygen use can be measured using a mask or hood, and this enables Dulloo to calculate their metabolic rate. The relationship between the amount of oxygen they inhale and the amount of carbon dioxide they exhale can even allow him to draw conclusions about the substrates used up – whether more fat or carbohydrates. His test subjects also swallow a thermometer in the form of a pill the size of a thumbnail, and this transmits the temperature in the digestive tract to an external receiver once every minute.



Measuring oxygen consumption can let us calculate how many calories it takes to press a foot pedal every 30 seconds. Image: Clemens Weber

His team’s experiments (see the box ‘Measuring energy consumption’) show that by just standing, we use on average ten percent more energy than when we sit. But they also found that standing only boosts energy consumption to any considerable extent in one out of four people. “In all the activities we’ve measured, people consume very different amounts of energy”, explains Dulloo. And this can’t be explained away just by their age or weight. Even obese people display very different degrees of energy consumption.

The goal of individualised prevention

The researchers tried to find the answers in the different ways people stand. Do people use up more energy when they repeatedly shift their weight from one leg to the other? The answer is disappointingly no. So this also couldn’t explain the differences between individuals. “In order to burn more calories properly, people have to take whole steps”, says Dulloo. Once he and his team have understood these small differences, he hopes that they will be able to individualise strategies to counter excess weight.

It is still difficult to reach the right people with national health campaigns, says Sigrid Beer from the Institute of Social and Preventive Medicine at the University of Bern. “Preventive measures have to reach both those members of the population who are not yet affected, and also those who are as yet unaware of the problem”.

Only once someone is under treatment today do they start to consider changes to their individual behaviour.

If the wrong people go on diets, this could even trigger an increase in weight later on. If people of normal weight reduce their lean body mass, the body counteracts by saving energy and by increasing its energy intake, says Dulloo. It also reduces the level of the hormone leptin, which regulates fat metabolism and indirectly holds back our appetite.

At the same time, more and more people are spending eight hours a day sitting in front of their computer screens. “We are experiencing an erosion of our daily physical activity. So we try to compensate by doing sports. But it’s not enough to jog a little and then sit around the whole day”, says Dulloo.

Florian Fisch is a science editor at the SNSF.

J. L. Miles-Chan et al.: Standing economy: does the heterogeneity in the energy cost of posture maintenance reside in differential patterns of spontaneous weight-shifting? *European Journal of Applied Physiology* (2017)

A. G. Dulloo: Collateral fattening: When a deficit in lean body mass drives overeating. *Obesity* (2017)



Their sociability and a robust immune system means these greater horseshoe bats are ideal for spreading viruses. Image: Keystone/imageBroker/Ivan Kuzmin

A perilous leap across the species barrier

Camels and bats are a reservoir for viruses. Frequent mutations mean they are repeatedly responsible for pathogens that are deadly to humans.

By Stefan Stöcklin

Camels are indispensable pack animals in the desert. But these well-loved creatures have become an unpredictable threat to humans on account of the dangerous viruses they carry. Their airways harbour coronaviruses that can provoke fatal pneumonia in people. Since the first cases of Middle East Respiratory Syndrome (MERS) were registered in the summer of 2012, a total of 1,641 people had been infected in Saudi Arabia with the coronavirus up to June 2017. Forty-one percent of them have died. When a disease can be passed from animals to humans, it's a phenomenon known as zoonosis.

"This coronavirus is a typical zoonosis, such as we have repeatedly observed in recent years", says Volker Thiel, professor for virology at the University of Bern and Head of Virology at the Swiss Federal Institute of Virology and Immunology (IVI). Many pathogens often circulate inconspicuously in animals that they do not affect. Occasionally, a chance leap across the species barrier can occur - such as into humans. The reactions can be violent, and in the worst cases, deadly to the new host. Ebola, SARS, MERS and Zika are the last cases in a long series of zoonoses. Rabies, the plague, AIDS and bird flu testify to earlier occurrences.

Diversity and cross-species infection

Volker Thiel was very much in demand in the winter of 2002 when serious cases of the new lung infection called 'Severe acquired respiratory syndrome' (SARS) occurred in southern China. He was one of the first to receive and sequence viral isolates from patients. Within a short space of time, epidemiologists were able to identify a coronavirus as the pathogen. By comparing it with the genome of harmless viruses, researchers were able to find the mutations that had been necessary for it to cross the species barrier into humans. "It needs surface molecules that can bind themselves firmly to the docking sites on human lung cells", says Thiel. They also found out how the virus was able to mitigate signals from the immune system.

"In a blood sample, whether from animals or humans, there are thousands of individual viruses that are all slightly different from each other", says Thiel. This high mutation rate creates many variants, which increases the chance that one of them will be able cross the species barrier to attack a new host. On the other hand, this variability explains a phenomenon that can often be observed: after the initial intense infections, the virus stops adapting, because it cannot proliferate if it

kills its host. "We were able to observe this weakening in outbreaks of SARS and also of Ebola", says Thiel.

In the case of SARS, the coronaviruses most likely jumped from mongooses to humans - presumably when these animals were slaughtered; they are regarded as a delicacy. Coronaviruses circulate in many animals, though primarily in bats and rodents, as an international team of researchers under Simon Anthony recently proved at Columbia University in New York. Teams in 20 countries in Latin America, Africa and Asia investigated bats, rodents and apes in a study lasting several years. They analysed tissue samples for viral genetic material, and found coronaviruses in ten percent of the bats they examined; in rodents and apes it was less than one percent. The diversity of the coronaviruses was also by far the greatest in the bats. "Bats are the most important reservoir for coronaviruses", Anthony concludes.

"Bats are the most important reservoir for coronaviruses".

Simon Anthony

One reason for this lies in the robust immune system of bats, which can keep their viral tenants in check. Another reason can be found in the large-scale social communities in which up to several million animals can live in close contact with each other. This facilitates the exchange of viruses. Furthermore, the bat species is extraordinarily large and varied. When humans enter regions they have never inhabited, such as the rainforests of Africa and South-East Asia, viruses are given a new opportunity to spread.

Colds from camels

Extensive specimen collections from the jungles of Central Africa have shown that fruit bats are the origin of the highly dangerous Ebola virus. We know that SARS and MERS also come from bats, because almost identical viruses have been found in these animals. "We assume that the MERS virus jumped from bats to camels at some point in the past, and that it has meanwhile established itself in its new host", says Thiel. From there, it now regularly jumps across to the humans who live near the animals. Thiel and his team have been able to show that the MERS coronavirus also displays surface molecules that can bind themselves easily to lung cells. Such changes of host, from camels to humans, obviously al-

ready took place in the distant past, hundreds of years ago. In collaboration with the renowned virologist and co-discoverer of the SARS virus, Christian Drosten in Berlin, Volker Thiel recently found coronaviruses in camels that are closely related to one of the cold viruses found today in humans.

It is logical to assume that this virus also caused deadly infections at the time it first took humans as its host, and that it weakened over the course of time. Comparisons between the coronavirus in camels and the cold virus in humans have provided initial information about the steps involved in the process of genetic adaptation. "We can see differences in the genome, but don't yet understand their meaning", says Thiel.

Bats are by no means the only bearers of highly dangerous pathogens. Extremely hazardous strains regularly occur in an exchange between pigs, birds and humans. This is why new influenza pathogens from pigs (H1N1) and waterfowl (H5N1) are being closely monitored by virologists. Christian Griot, Director of the Swiss Federal Institute of Virology and Immunology, sees these influenza viruses as presenting the biggest risk at present. Such a virus could spread across the world in a very short space of time.

This is not yet the case with the coronavirus that causes MERS. But that may change. Every new human infection offers the virus another opportunity to adapt itself better and to infect the upper respiratory tract, which it at present finds difficult. "If it were to spread more easily from one human to another, then we would have reason to fear a worldwide pandemic with very many victims", says Volker Thiel. And it is getting more and more difficult to prevent outbreaks. Meanwhile, the MERS virus has established itself firmly in the camel population on the Arabian Peninsula. These proud ships of the desert are now a ticking time bomb.

Stefan Stöcklin is an editor in the Communication Department of the University of Zurich.

E. Kindler et al.: Early endonuclease-mediated evasion of RNA sensing ensures efficient coronavirus replication. *EPLoS Pathog* (2017)

V. M. Corman et al.: Link of a ubiquitous human coronavirus to dromedary camels. *PNAS* (2016)

Split-second decisions

Neuroscientists are investigating how circuits in the brain control our behaviour in dangerous situations. There's often only a fraction of a second for us to make up our minds.

By Yvonne Vahlensieck

When a mouse encounters a snake, it has to decide in a flash what action offers the best chance of survival. Should it enter into paralytic shock, thereby becoming invisible to the predator, or should it flee as quickly as possible? This decision is not made consciously, but is determined by a multitude of factors - such as the distance between the mouse and the snake, the availability of a get-away route, previous experiences, and the state of health of the mouse.

There is a circuit in the brain that is very important for these life-or-death decisions, and it's located in an almond-shaped area called the 'amygdala'. "All the information that can influence a behavioural reaction is channelled from the most varied regions of the brain into the amygdala, and processed there", explains the neuroscientist Andreas Lüthi. He and his working group at the Friedrich Miescher Institute for Biomedical Research in Basel have been investigating what processes then occur in the mouse's amygdala.

Circuitry controls fear behaviour

Lüthi and his researchers are especially interested in how a decision is made between two completely different forms of behaviour - passive paralytic shock or active flight. In order to find this out, they trained their test animals to fall into paralytic shock when they hear a pure tone, and to display flight behaviour when they hear a mixture of tones. They also used a genetic procedure to alter the behaviour of the different types of nerve cells in the amygdala so that these can be hindered when the mouse is exposed to yellow light. By doing this, the researchers have made it possible to switch off specific groups of nerves and observe what impact it has on the behaviour of the mice.

Their experiment demonstrated that two groups of nerve cells control fear behaviour: one group is responsible for triggering

paralytic shock, the other for triggering flight. "It seems that there is a switch in the amygdala that can be turned one way or the other", says Lüthi. Furthermore, the two nerve groups are closely linked with each other. Activating the paralytic shock hinders the flight response and vice versa. This prevents the amygdala from giving the order for two contradictory forms of behaviour to the muscles.

Understanding glitches better

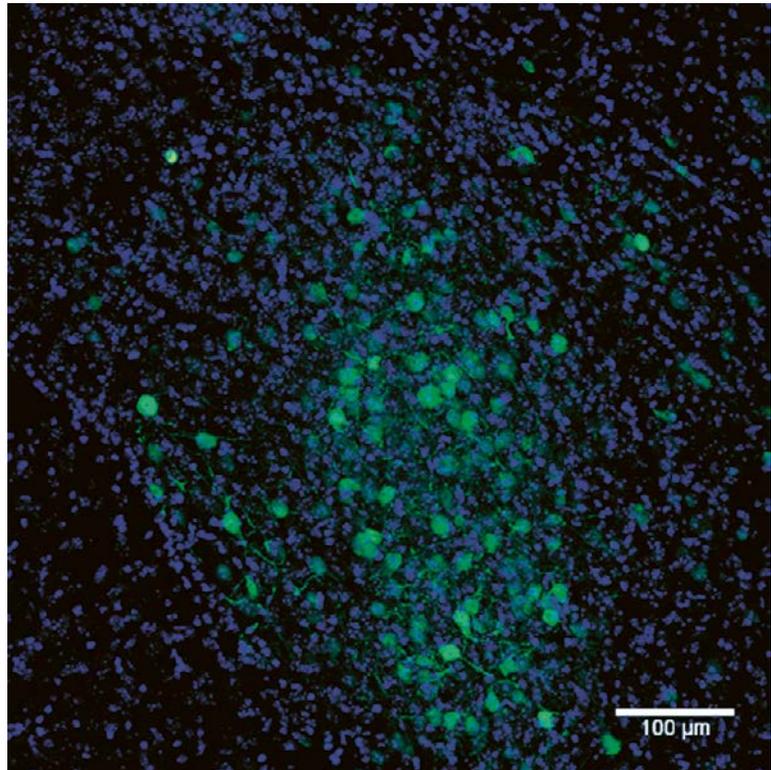
"In this case, two types of nerve cells work contrary to each other to trigger a clear all-or-nothing reaction", explains Fritjof Helmchen, one of the directors of the Institute for Brain Research at the University of Zurich. "This experiment is a perfect example of how you can use new methods to study live, non-sedated animals to find out what components in a circuit of nerve cells determine specific patterns of behaviour". Helmchen was not involved in the study himself, but he believes that findings from this type of experiment could find applications in human medicine in the coming decades, because many mental illnesses arise from altered circuitry and misdirected information flows in the brain.

Lüthi also believes that his results are essentially transferable to humans: "The

structure of the amygdala has been largely retained throughout the process of evolution, so it is constructed in the same way in humans as in mice. Anxiety disorders in people often occur because this old system dominates and is very difficult to control consciously". He also observes that human patterns of behaviour are far more complex and varied: "People often consciously take bigger risks in order to discover new things and perhaps to draw an advantage from it - whereas that would be a poor strategy for a little mouse".

Yvonne Vahlensieck is a freelance science journalist who lives near Basel.

J. Fadok, S. Krabbe, M. Markovic, J. Courtin, C. Xu, L. Massi, P. Botta, K. Bylund, C. Müller, A. Kovacevic, P. Tovote & A. Lüthi: A competitive inhibitory circuit for selection of active and passive fear responses. *Nature* (2017)



The green, fluorescent nerve cells (CRF+) decide whether the mouse will flee or not.

Image: Fadok et al.



Breastfeeding can't eradicate the common cold, but it can make the symptoms milder.

Breastfeeding prevents bronchiolitis in new-borns

It's well established that maternal milk protects new-born babies from respiratory infections. But the results are mixed on whether the benefits extend beyond the weaning stage. "Methods haven't been optimal", says Claudia Kühni, who heads a research team at the Institute of Social and Preventive Medicine (ISPM) at the University of Bern. She is seeking to improve this using data from the Leicester Respiratory Cohort (UK).

Her research has involved analysing 4,040 profiles of children between one and two years of age, recording the incidence of five respiratory infections. The risk of developing bronchiolitis was lower in around 25 percent of children who were breastfed for longer than six months than in children who were not breastfed. By way of comparison, the incidence of otitis was 15 percent lower, and there was no difference with regard to pneumonia, the common cold and croup. "The difference is explained by the fact that these latter pathologies are rare among babies, often not appearing until after the age of six months. Any protective effect due to breastfeeding in the cases of these illnesses would have been difficult to demonstrate with the data available", says Kühni.

These results suggest that breastfeeding does not eradicate cases of viral respiratory infection completely, but rather prevents their serious evolution, such as bronchiolitis. According to Kühni, "breastfeeding isn't a panacea, but it is still a good practice and must be encouraged. I think this is old advice that continues to be valid". *Elisabeth Gordon*

J. Wang et al.: Breastfeeding and respiratory tract infections during the first 2 years of life. ERJ Open research (2017)

Negative emotions lead to mental decline

Neuroticism - the trait of experiencing prolonged negative emotional states such as anxiety, depression, stress and anger - may lead to an increased risk of cognitive impairment. A number of clinical studies have already suggested this, and a more recent project has shown the link between the personality trait and cerebral episodes implicated in cognitive impairment.

This study was conducted by researchers at the Lausanne University Hospital (CHUV) and included 97 patients with an average age of 67 years. A third of the subjects showed minor cognitive impairment, and others no impairment whatever. The results demonstrate that the tendency to experience negative emotions is associated with minor cognitive impairment. Furthermore, magnetic resonance imaging showed that neuroticism is above all associated with atrophy of the medial temporal lobe, and in particular the hippocampus, a region central to memory.

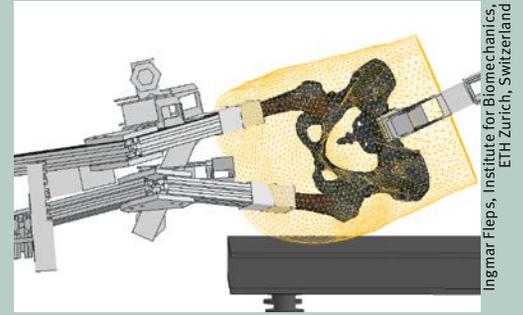
The project was led by Armin von Gunten, who, alongside his colleague Ferah Kherif, puts forward the following hypothesis regarding the neurobiological mechanisms at play: "Neuroticism is a highly extended state of stress and anxiety promoting the release of neurohormones, such as glucocorticosteroids, which are neurotoxic over the long term. These molecules have a negative impact on neurogenesis and synaptogenesis". Is neuroticism therefore a factor accelerating cognitive impairment in patients with Alzheimer's disease? "This is one of the points that we will continue to explore as we follow up prospective cohorts of patients".

Florence Rosier

V. Zufferey et al.: Neuroticism, depression, and anxiety traits exacerbate the state of cognitive impairment and hippocampal vulnerability to Alzheimer's disease. *Alzheimer's & Dementia* (2017)



The hippocampus is important for our memory. But it's smaller in people with negative emotions.



Will the bones hold, or not? The computer calculates every impact individually.

Fall simulator for hip fractures

The danger of fracturing a hip is usually assessed by making a bone density measurement. However, 'densitometry', as it's called, only allows us to make a provisional assessment of how easily bones will break under everyday conditions, and whether there is any need for action. "Some 70 percent of all hip fractures happen in people who have no osteoporosis", says Benedikt Helgason of the Laboratory for Orthopaedic Technology at ETH Zurich. "This is because the risk of fracture does not depend on the bone density alone, but also on other factors. These include the frequency of falls, the size and weight of the person in question and, above all, how much fat and muscle surround the hips that can cushion them in a fall".

Based on these parameters, Helgason and other ETH researchers have developed a procedure that enables them to determine the risk of hip fractures far more precisely than the usual method. To this end, they carried out a close analysis of the biomechanical processes involved when someone falls on their side - how the force of the impact is spread across the hip bones, where the fracture lines run and, above all, how individual anatomical factors influence these processes. The ETH researchers are now testing their procedure on some 1,200 elderly people. For them, a hip fracture can often be fatal, or result in care dependency. "We are excited to see whether our method will prove itself with this group", says Helgason, adding: "We expect an answer this year already". *Nicola von Lutterotti*

I. Fleps et al.: Understanding the Mechanics of Hip Fractures: The Load Transfer through the Hip during Simulated Sideways Falls. (in press)

I. Fleps et al.: A Novel Fall Impactor Inflicts Realistic Hip Fractures on Human Cadavers. (in press)

Into the heat

Anthropologist Graham St John studies event cultures and transformational movements. He is currently investigating how the Burning Man movement translates in Europe, having attended the original event in Nevada's Black Rock Desert five times since 2003.

"Also known as Black Rock City, Burning Man is often misrepresented in the media as a 'neo-pagan hippy drugfest'. In fact, this annual arts and fire event has developed into a socially and organisationally sophisticated transnational community.

"There are now 65 regional events in 30 countries around the world, officially recognised to be adhering to the principles of the Burning Man Project. Europe, the focus of my research, is the largest region of growth outside North America. 'Nowhere' in Zaragoza, Spain, is the longest-running event in Europe, and Israel's 'Midburn' is the fastest growing with more than 10,000 participants in 2017. Smaller events like those operated by the French, the Swiss and the Swedes are also fascinating interpretations of the prototype. My research involves tracking these events, conducting ethnography and interviewing community leaders. As an ethnographer, I try to experience as much as possible and volunteer where I can, for instance at the media liaison department Media Mecca.

"Experience is paramount; I don't wear a white coat".

"My first encounter with Burning Man was shaped by my ethnographic experience with alternative festivals and outdoor raves in Australia. I felt I knew the territory, but this could not compare with Burning Man, a 360-degree assault on my senses. I was invited to participate in a camp called Low Expectations in 2003, to which I've returned each time, and, more recently, to another camp called Blue Elephants. These people are now my family, my tribe. These camps are in the Blue Light District, part of a temporary municipality whose population swelled to 70,000 people in 2016. There are hundreds of similar self-organising camps in Burning Man.

"While there is substantial planning to the event, the experience is immediate and interactive. You can walk a few metres in any direction and encounter something

different. Random acts of kindness, gifting and beauty. One moment, someone might approach you with a tray of crispy bacon; next thing you are roller-skating in the desert, or marvelling at a 65-foot-tall cluster of lighthouses.

Experience the event

"Even as a researcher, it is impossible to become completely separated from this phenomenon. I value membership in the community. I also love science. My project has quantitative elements - largely associated with two completed surveys - but is above all qualitative. I approach writing as an art form - maybe a lost art in the social sciences. There is no such thing as pure objectivity. Experience is paramount; I don't wear a white coat. A degree of distance is necessary in anthropology, and this is assisted by having a critical angle, being self-reflective, and accepting the criticism of colleagues. It's also obtained by gaining the perspectives of as many varied stakeholders as possible, reading widely, and by developing an adequate coding mechanism for survey and interview data.

"Ours is the first study of this global movement. The project investigates the dynamics of Burning Man's diasporic expansion and how its Ten Principles are translated and modified in Europe. I gather information in advance about each event I'm researching, plan logistics and line up interview subjects.

"At an event, there is a varied schedule, including large installation burns, volunteer shifts, helping with art projects and meeting lead artists for interviews, for which I carry a recording device. I also take long bike rides or treks onsite, and fall into deep conversations with random strangers. I take most of my notes post-event.

"But there will be many random and unplanned experiences and encounters. Take No-One's Ark, for instance, a replica of Noah's Ark, 10 metres tall and 50 metres long. I had no idea about this installation beforehand, it was truly a revelation, encountered randomly as I trekked across Midburn City on my first night there in 2016. I went inside and lay down to an experimental soundbath, complete with crashing waves as if I were aboard a sea-going vessel. I was there again to witness its destruction by fire at the event's conclusion in which the entire festival population participates.

"This phenomenon literally spreads like wildfire, taking hold in far-flung places. In a real sense, the destruction of co-created art by fire is distributing the cultural seeds of this movement".

As recorded by Clare O'Dea.



Graham St John is a senior researcher in anthropology at the University of Fribourg, working with religion researcher Francois Gauthier. He holds a PhD from Latrobe University in Melbourne and has published eight books on alternative cultures.



The original Burning Man festival takes place every summer in the Black Rock Desert in Nevada, which becomes a temporary city of art and events for some 70,000 participants. The nature of the festival's culture and its sculptures like 'The Temple' (see above) and 'El Pulpo Mecanico' (right) – both from 2016 – make it impossible for anthropologists to keep their distance.

Images: Graham St John. Portrait: Michael Urashka





Someone who breaks the speed limit is given the same punishment by both judges and the public. Image: Keystone/imageBroker//Jochen Tack

Easy justice? When people and judges are at one

The public and media discourse in Switzerland suggests that the population finds the sentences passed by judges to be too mild. But a recent study now proves that the opposite is the case.

By *Julia Richter*

They were murders that horrified the public: Lucie, Adeline and Marie were all killed by repeat offenders, and their cases became synonymous with criticism of the Swiss justice system. And even before this, there were accusations that the criminal justice system was too understanding towards criminals. This resentment was given expression on a political level by the approval of several popular initiatives to tighten up penal laws - such as those on preventive detention and on the removal of the statute of limitations on paedophile criminals.

This seems to give the impression that the Swiss electorate is dissatisfied with the criminal jurisdiction in their country. And when asked for their general opinion, voters do agree that the courts pass sentences that are too lenient. But when this question is posed on a concrete level, their answers are much less clear. This is the conclusion of André Kuhn, a professor of criminology and criminal law at the University of Neuchâtel.

Since 2000 Kuhn has carried out three random tests among both the population and judges to ask how they would punish a reckless driver, a burglar, a criminal banker and a rapist (see 'The joy of punishment'). He found the results surprising: in the first three cases, a majority of the population would give a more lenient sentence than the judges. Only in the case

of the rapist did they want a harsher sentence. To be sure, in all three surveys there were people among the public who preferred highly repressive judgements, and this pulled the survey's average sentence upwards. But a majority of them offered judgements that were milder than expected. These findings suggest that the criminal justice system in Switzerland largely matches the public's expectations.

The law-and-order brigade

"These results might seem astonishing, given the 'easy justice' discourse of politicians and the media", says Martin Seelmann of the University of Zurich, who is writing his doctoral thesis on sentencing. "And yet other studies have also shown that the public often prefers milder sentences than those proposed by politicians and the media". Some politicians defer to the public's supposedly restrictive opinions on sentencing because it can bolster their stance as defenders of 'law and order'. "The fact that popular initiatives to tighten up criminal law have been accepted is also because the media and politicians have been stoking up fears among the population", says Seelmann.

"There are good reasons why we don't have people's courts".

Martino Mona

The results of this study have been confirmed by similar surveys in other countries. For example, when asked for their general opinion, people in Great Britain have also described their justice system as being too feeble. But when it came to imposing a sentence in a concrete case of burglary, it emerged that the public's judgement was at one with that of the judges.

Martin Kiliyas is a professor in criminal law in St. Gallen, and he can also confirm that the results of André Kuhn's study are consistent with other empirical findings on sentencing. "The notions of justice among the public are often the same as those upheld by the judicial system". But Kiliyas emphasises that these results only

cover a limited field. The discrepancy between these results and the political discussions on tightening up criminal law are also explicable on account of the brevity and the one-dimensionality of the case histories put before the public and the judges within the framework of the study.

This point is also criticised by Martino Mona, a professor of criminal law and legal philosophy at the University of Bern: "Such surveys of the public and of judges, which present significantly shortened, fictitious cases, cannot allow for any relevant assertions about actual practice". Asking the general population for their spontaneous response to brief case descriptions comes nowhere close to judicial practice, he says.

Kuhn doesn't see this as a problem. "It's about getting the public to slip into the skin of the judges. It's a means of assessing the public's attitude towards the justice system". He insists that his method of comparing judgements in brief, fictitious cases is a good way of achieving this.

Justice in harmony with the people?

Mona's critical stance isn't based just on methodological objections. He finds it fundamentally problematical when public opinion is used as a guideline for assessing just sentencing in concrete, individual cases. "It's counterproductive to keep evaluating the justice system on the basis of whether the judicial verdicts correspond to the will of the populace". Comparing the general opinion with the judge's decisions suggests that public attitudes are a relevant criterion for handing down sentences in individual cases. According to Mona, that is an unnecessary doubling of the power of the people. "There are good reasons why we don't have people's courts. Furthermore, with our democratic elections and referenda we have enough mechanisms on a political level for the population to be able to determine the general conditions of the justice system".

Kuhn counters that his surveys are not about getting judges to adapt to the will of the people. "Our goal is rather to show that people are wrong when they claim that the public is widely critical of the leniency of our justice system". In light of these findings, no politician should be allowed to claim the backing of public opinion when

demanding harsher sentences. Kuhn regrets that the political discourse barely takes note of scholarly findings when it comes to criminal justice.

Julia Richter is a freelance journalist.

A. Kuhn: La juste peine selon la population et selon les juges, Résultats d'une triple étude empirique. Tagungsband der Schweizerischen Arbeitsgruppe für Kriminologie (Herbst 2017)
M. Hough and J. Roberts: Sentencing Trends in Britain, Public knowledge and public opinion. Punishment and Society (1999)

The joy of punishment:

In André Kuhn's study, conducted in 2000, 2007 and 2015, a random sample of people from the general public and from amongst judges were asked what sentence they would pass in the following four fictitious cases:

- A car driver who has repeatedly driven down the motorway at 140 miles an hour despite a speed limit of 70 miles an hour
- A burglar with several previous convictions
- A banker who has embezzled a million francs and kept it for himself
- A rapist

The general public was surveyed by telephone, while the judges were asked their questions in writing. While the number of judges was around 200 each time, the numbers of the general public varied from 606 (in 2000) to 959 (2007) and 2,000 (2015). In the first three cases above, some 60 percent of the population passed sentences each time that were milder than those of the judges. Furthermore, the judges and the people passed the harshest sentences in 2015. Age and gender played no significant role in reaching a verdict, neither with the public nor the judges. The population in French and Italian-speaking Switzerland passed harsher sentences than those in German-speaking Switzerland. In the case of the judges, their linguistic region of origin had no impact on the result.

Middle-class losers

The road to hell is paved with good intentions. When the fledgling Swiss welfare state regulated prices, rationed foodstuffs and supported the poor in the years of crisis during and after the First World War, it had a highly negative impact on the middle classes. These are the findings of a team led by Ulrich Woitek, a professor of economics at the Institute for Empirical Research in Economics at the University of Zurich.

In particular, during the dreadful years of 1918 and 1919, the birth weight of middle-class babies dropped noticeably. This fact points to malnutrition in pregnant mothers. The lower and upper classes remained untouched by this phenomenon: the poor because they were supported by the state; the rich because they had the financial means to help themselves.

Woitek and his researchers analysed the birth weight of newborns at the Frauentspital ('women's hospital') in Basel between 1912 and 1920. This dataset is unique in its informative value: it covers over 50 percent of births in Basel and is linked to the social status of the families of origin. It was in fact the middle classes – supposedly the 'backbone' of any nation – who suffered most under the crisis, and this fact was so unambiguous in the data that even Woitek was surprised. Those who lost out were the people who were neither very rich nor sufficiently poor to be eligible for state support.

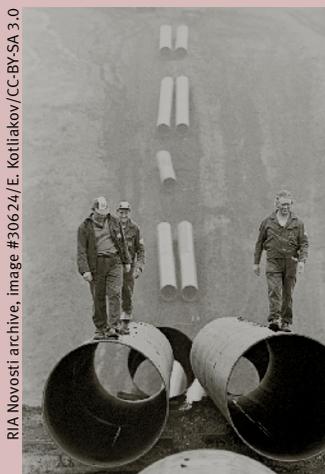
So what conclusions may be drawn from this? "The support measures were linked to an income limit that was too strictly upheld. That was a mistake", says Woitek. A mistake that the welfare state wanted to learn from. Were things done better during the Second World War? That's a question that will require further research. *Claudia Wirz*

Joel Floris et al.: The Benefits of Intervention: Birth Weights in Basle 1912-1920. (University of Zurich, Department of Economics, Working Paper No. 236, 2016)

Joel Floris

Kindermehle Farines pour enfants			
Inhalt Contenance grammes		Brotmarken Coupes de pain blanches	Mehmarken Coupes de pain touteuses
390	Bébé	250 (8 × 50)	200 (11 × 18,5)
350	Berna	350 (7 × 50)	250 (12 × 18,5)
375	Engler	500 (10 × 50)	375 (21 × 18,5)
	Eppecht	325 (8 × 50 + 1 × 25)	250 (12 × 18,5)
		225 (4 × 50 + 1 × 25)	166½ (9 × 18,5)
			250 18

Poorer families were able to use ration cards to get baby food.



From Russia with love? Workers on the Orenburg Pipeline in 1976.

Holes in the Iron Curtain

The historiography of the Cold War is dominated by the image of two hostile blocks, rigidly separate from each other. "In fact, the Iron Curtain was a lot more porous than hitherto assumed", explains the historian Jeronim Perović. He is an SNSF Professor at the University of Zurich and has been investigating how Russia's energy resources have influenced international power structures. It transpires that the billion-dollar oil and gas business was already shaping relations between the Soviet Union and Western Europe during the Cold War, and created dependencies that continue to this day in the form of international pipelines. Business always ran according to the same pattern: Soviet oil and gas deliveries in exchange for Western technology and hard currency. However, it was not just in the West that these agreements were considered controversial. In Moscow, they were regarded by some as a contribution to world peace and by others as a pact with the devil. As a result, phases of intense trade alternated with isolationist tendencies. "Overall, however, economic interests dominated", sums up Perović.

Energy deals also determined Moscow's relationships with its Eastern Bloc allies. We should revise our notions of the Eastern Bloc being exploited by the Soviet Union, claims Perović. "Moscow provided these countries with cheap oil and gas for decades. When the world market prices rose rapidly in the 1970s, trade with the Eastern Bloc became a losing deal for Moscow, and providing its satellites with subsidised commodities became a financial burden. The Eastern Bloc fell apart in the late 1980s, not least because Moscow was increasingly unwilling to pay for its upkeep". *Nicolas Gattlen*

J. Perović: Cold War Energy. A Transnational History of Soviet Oil and Gas. London: Palgrave Macmillan. (2017)

Louts in the boardroom

Endless meetings are a feature of the everyday working life of many professional people. They know from experience that conference rooms can see all kinds of uncivil behaviour – and sometimes it can be disturbing. "When I tell people that I research into meetings, I always get to hear horror stories", says Cornelius König, professor of work and organisational psychology in Saarbrücken. Together with colleagues from the University of Zurich, König has been conducting the first-ever empirical investigation into impolite behaviour in meetings. They wanted to know what types of impoliteness occur, how they are fostered, and what impact they have on the results of those meetings.

Their conclusion is that inappropriate interpersonal behaviour, and a lack of participation, have a particularly negative impact on the result of a meeting.

For their study, the researchers had 515 employees fill out two different online questionnaires; their participants came from companies of all sizes, and across all the different sectors. The actual number of participants was not as important as keeping the group as broad as possible, explains König. "We wanted to generate statements that would not just apply to a specific type of company". A variety of ways were therefore used by the psychologists to recruit their test subjects. Some came from personal recommendations, while others were identified through printed flyers, websites, phone books and alumni lists.

The researchers have at least been able to reach a hopeful conclusion: employees behave in a consistently politer manner when there are clearly defined rules for holding meetings – even when these rules differ greatly from one company to another. *Luzia Budmiger*

I. Odermatt, C. König und M. Kleinmann: Incivility in Meetings: Predictors and Outcomes. Journal of Business and Psychology (2017)



Clearly defined rules improve the tone at meetings.

Valérie Chérelat

Milk protein catches heavy metals

To tackle the problem of heavy metal contamination in water, an ETH Zurich spin-off turns to whey. This byproduct of cheese production contains a cheap protein that makes for an effective water filter.

Texte: Florian Fisch
Infographie: ikonaut

1 Produce a cheap water filter

Heavy metals like arsenic or gold readily stick to proteins. Sreenath Bolisetty and Raffaele Mezzenga from the ETH Zurich found an abundant source of proteins in whey, the watery leftovers from cheese production. The most abundant whey protein (beta-lactoglobulin) grows into long fibers when heated. The researchers produce a thin paper-like membrane by adding cellulose, for holding everything together, as well as activated charcoal particles for retaining large molecules.

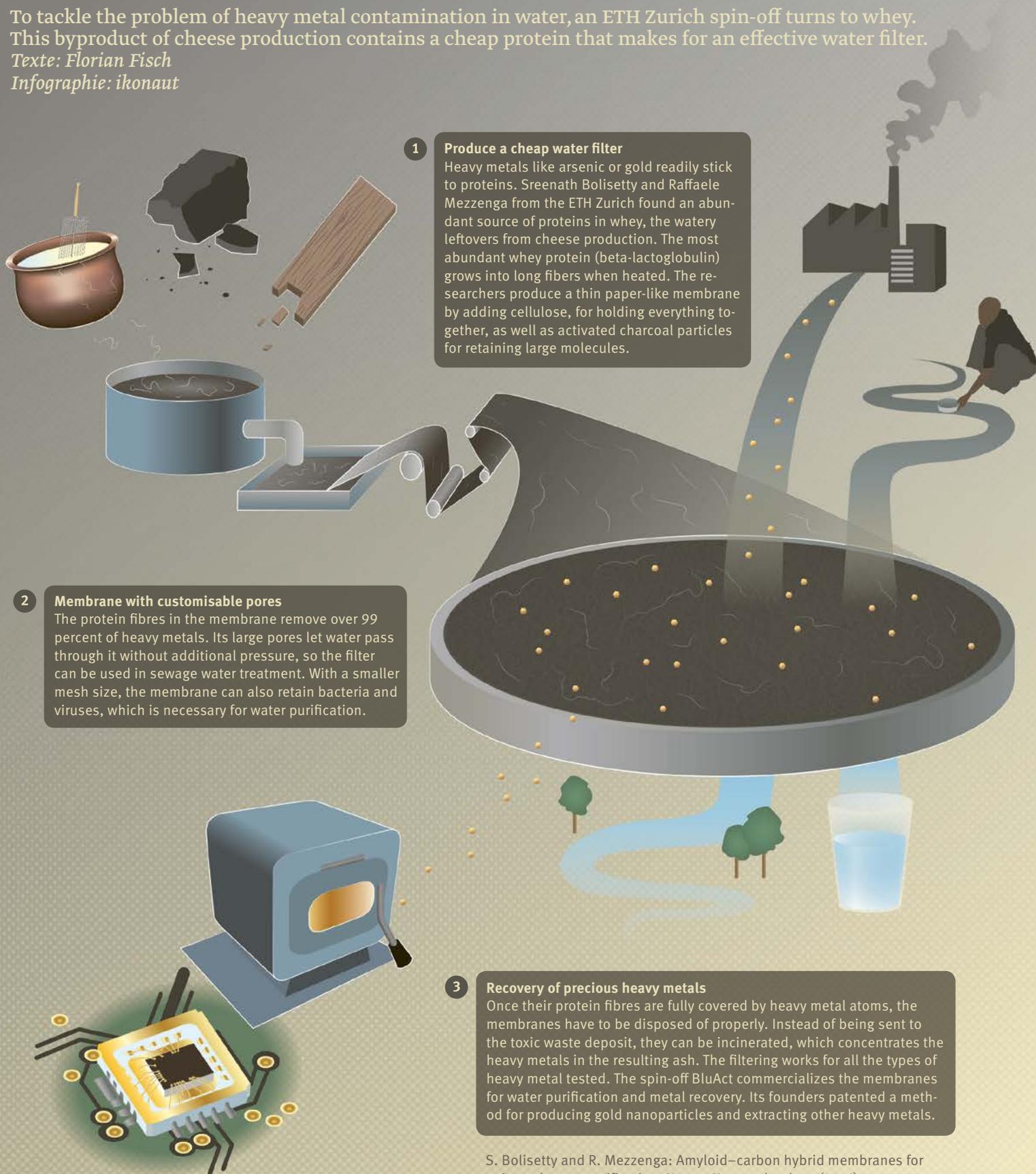
2 Membrane with customisable pores

The protein fibres in the membrane remove over 99 percent of heavy metals. Its large pores let water pass through it without additional pressure, so the filter can be used in sewage water treatment. With a smaller mesh size, the membrane can also retain bacteria and viruses, which is necessary for water purification.

3 Recovery of precious heavy metals

Once their protein fibres are fully covered by heavy metal atoms, the membranes have to be disposed of properly. Instead of being sent to the toxic waste deposit, they can be incinerated, which concentrates the heavy metals in the resulting ash. The filtering works for all the types of heavy metal tested. The spin-off BluAct commercializes the membranes for water purification and metal recovery. Its founders patented a method for producing gold nanoparticles and extracting other heavy metals.

S. Bolisetty and R. Mezzenga: Amyloid-carbon hybrid membranes for universal water purification. Nature Nanotechnology (2016)



On the spot

By Maurice Campagna

Back in the days when Asea Brown Boveri (ABB) was still called Brown, Boveri & Cie., the company was already sending its employees from north to south, east to west, and vice versa in both cases. By 1988 at the latest, after its merger and change of name, ABB began to attach increasing priority to 'best practices' on the ground



Valérie Chételet

and 'peer education' in different cultural environments.

Many large, globally active companies in the financial and pharmaceutical sectors did the same in order to break down prejudices against local cultures and at the same time to build trust in organisations that had been newly created through international mergers. In the

past 30 years, the mobility of employees has become increasingly important across all industries and sectors.

It has often happened that the new experiences gained by such 'wandering' employees have enabled them to undergo an attractive change in their career path, whether in academia or in different social spheres. At a younger age, it can be especially appealing to experience change within a new organisation - and it's also easier to cope with it if you haven't yet started a family. Later, the hurdles to change become higher. This is also why early internships can be beneficial - and not just for students.

At present, however, I am observing a contrary tendency. Despite swift, free, borderless communication and a global market, the underlying conditions have worsened for the upcoming generation of students and those young people who are in training. For example, since 2014 Switzerland has only been able to participate indirectly in the European educational programme Erasmus Plus. But student exchange programmes and similar measures are in fact highly relevant for young Swiss citizens whose environment is in any case already multicultural. We have to meet these challenges together with our neighbours, and find common solutions.

“Student exchange programmes are highly relevant for young Swiss citizens whose environment is already multicultural”.

It is important that we can progress to full association quickly, by 2021 at the latest. This would open up the doors not just to our European neighbours and the USA, but also to the East and to Asia.

Maurice Campagna is the President of the Swiss Academies of Arts and Sciences.

18 September 2017

Manipulating wild populations

Public symposium on the possibilities and limits of the disputed 'gene drive' technology.

[Ittigen](#)

21 and 22 September 2017

Annual conference for science communication

Researchers and communication specialists meet at ScienceComm under the motto 'Show Me Science'.

[Landhaus Solothurn](#)

23 October 2017

Prize-winning science journalism

The Swiss Academies of Arts and Sciences award the Prix Média for exceptional contributions in the Swiss media.

[Lucerne](#)

7 and 8 November 2017

'Shaping the future of mobility'

The mobility of the future is the topic of this year's annual conference of European Parliamentary Technology Assessment.

[Lucerne](#)

until 19 November 2017

Future bodies

The exhibition 'Corps-concept' investigates our relationship to our body in the early stages of the increasing hybridisation of human beings and technology.

[Maison d'Ailleurs, Yverdon-les-Bains](#)

22 and 23 November 2017

Personalised health

Personalised health is the focus at this year's Swiss Public Health Conference.

[Congress Center Basel](#)

until July 2018

In the head

This exhibition shows the neurological fundamentals of perception, illusion and memory.

[Musée de la main, Lausanne](#)

Letter to the editor

Tamiflu and shikimic acid

In "The world of small things" (Horizons 113, p. 36), it is incorrectly stated that shikimic acid is the active compound in Tamiflu. It should have referred to oseltamivir, which can be manufactured from shikimic acid through a series of chemical transformations.

Matthias Weiss

Democracy specialist appointed managing director

Corina Maria Steiner



As of 1 November 2017, Elisabeth Ehrensperger will assume the management of TA-SWISS, the Centre for Technology Assessment of the Swiss Academies of Arts and Sciences. She will succeed Sergio Bellucci, who will retire at the end of November after being in the post for 20 years. Elisabeth Ehrensperger was most recently Executive Secretary of the National Advisory Commission on Biomedical Ethics. Before that, she conducted research into the function of national ethics commissions at the University of Zurich.

Guidelines for medics

Doctors make numerous decisions every day. Various guidelines and 'Choosing Wisely' lists offer them a means of orientation. The Swiss Academy of Medical Sciences (SAMW) has had recommendations drawn up as to how to set good guidelines and how experts can deal with conflicts of interests.

Willy R. Gehrler, new President of SATW

SATW



The Swiss Academy of Engineering Sciences (SATW) has a new President. In May, Willy R. Gehrler succeeded Ulrich W. Suter, who led the Academy for six years. Gehrler studied electrical engineering and worked for many years for Siemens Switzerland, most recently as CEO for energy and transportation systems.

Interactive energy research

Animated infographics on the SNSF website offer an overview on energy research in Switzerland. These animations show who is researching in what fields. Other infographics on p3.snf.ch offer a detailed picture of the SNSF's funding activities: grants awarded, project names, scientific disciplines, funding instruments and home institutions.

Open research data: a guideline for applications

The SNSF has issued comprehensive guidelines setting out the criteria to be met by researchers when writing a data management plan (DMP). As of October 2017 the DMP will be an integral component of applications for project funding. The guidelines on the website list examples of non-commercial digital data archives. The SNSF is organising workshops for applicants to promote an exchange of information on the topic.

European Code of Conduct for Research Integrity



With support from the Swiss Academies of Arts and Sciences, experts from the All European Academies (ALLEA) have written a new European Code of Conduct for Research Integrity. It will be binding for all researchers who receive funding from the European Research Framework Programme. In Switzerland, too, this Code is intended to become an important point of reference.

Looking for the best doctoral thesis

The Prix Schlöfli is awarded by the Swiss Academy of Sciences (SCNAT) to the four best doctoral theses in the natural sciences. Applications can be submitted online up to 31 October 2017.

The profile of the SNSF

In 2016 the SNSF supported 3,200 research projects by more than 14,000 researchers at universities, universities of applied sciences, pedagogical universities and technical universities. Its annual report 'Profile 2016-17' offers these and other figures and presents current and future projects, also in the field of Open Science.

Horizons

The Swiss magazine for scientific research is published quarterly in German and French. Volume 29, No. 114, September 2017. www.snf.ch/horizonte

Publisher

Swiss National Science Foundation (SNSF)
Communication Department
Wildhainweg 3
PO Box
CH-3001 Bern
Tel. 031 308 22 22
abo@snf.ch

Swiss Academies of Arts and Sciences
Haus der Akademien
Laupenstrasse 7
PO Box
CH-3001 Bern
Tel. 031 306 92 20
info@akademien-schweiz.ch

Editors

Daniel Saraga (dsa), Chief Editor
Florian Fisch (ff)
Pascale Hofmeier (hpa)
Marcel Falk (mf)
This Rutishauser (tr)

Graphic design, photography

2. stock süd netthoevel & gaberthüel,
Valérie Chételat
Illustration: Gregory Gilbert-Lodge

Translation and proofreading

Max Crisp, Chris Walton, Interpreters' and Translators' Association, Zurich

Printer and lithographer

Stämpfli AG, Bern and Zurich
Climate neutral, myclimate.org
Paper: Refutura FSC, Recycling, matt
Typography: FF Meta, Greta Text Std

Distribution

37,380 copies in German,
16,920 copies in French.

© All rights reserved.

Please obtain the approval of the Editor prior to reproducing any part of this publication.
ISSN 1663 2710

Subscription is free. Distribution of the paper version is usually restricted to Switzerland and foreign organisations.

The opinions in the articles are those of their authors and do not necessarily reflect those of the SNSF and/or SA. Research presented is generally supported by the SNSF.

The SNSF

The SNSF is the principal body for furthering scientific research in Switzerland. It is mandated by the Confederation to promote basic research and each year distributes some CHF 800 million amongst more than 3,200 projects involving about 14,000 scholars.

The Swiss Academies

Also mandated by the Confederation, the Swiss Academies of Arts and Sciences are committed to an open dialogue between science and society. They are on the side of science, each specialising in a respective domain, yet also acting in an interdisciplinary way. Being anchored to the scientific community rewards them with access to the expertise of around 100,000 researchers.

“We can’t write everything we would like to”.

A researcher, speaking
about his work in Turkey. page 30

“In everyday life, our activity level
rarely exceeds four times the
intensity of lying or sitting down”.

Abdul Dulloo page 39

“Experience is paramount;
I don’t wear a white coat”.

Graham St John page 44



Demand determines price.
In 1623 one bulb of the
Semper Augustus tulip cost
1,000 guilders; in 1637 it was
30,000 guilders for three
bulbs. Today, a bunch of 20
tulips can cost as little as
ten francs.