

for the next framework to become “the biggest co-created... programme in the world”⁶. Burgelman emphasizes that co-creation with the scientific community underpins both the new missions and the commission’s approach to open science.

It remains to be seen how successful this model is, and how widely it can cast the net in terms of delivering missions with the engagement of the research community, and of wider society. Some, such as the European Alliance for Social Sciences and Humanities, worry that without a bigger role for these fields, the missions are “doomed”. Others call for more radical models, involving civil society and citizens in the design of ethical, responsible — and distinctively European — approaches to developments in fields such as artificial intelligence.

Science and innovation have not always been at the forefront of Europe’s priorities (see go.nature.com/2jyrvff). But through its emphasis on research that is cosmopolitan, open and mission-directed, the EU is undeniably in the driving seat of global scientific governance. The next European Parliament and European Commission should ensure that research — and its good governance — remains at the top of their agendas for the next five years. This is one arena in which Europe now leads, and others follow. ■

James Wilsdon is professor of research policy at the University of Sheffield, UK. **Sarah de Rijcke** is director of the Centre for Science and Technology Studies at Leiden University, the Netherlands.
e-mails: j.wilsdon@sheffield.ac.uk; s.de.rijcke@cwts.leidenuniv.nl

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Hungarian politics are forcing a move for the Central European University from Budapest to Vienna.

Views from a continent in flux

Nature asked nine leading Europeans to pick their top priority for science at this pivotal point. Love, money, and trust got most votes.

CARLOS MOEDAS Rekindle the love affair

European Commissioner, Research, Science and Innovation.

We live in an age of both scientific discovery and scientific denial. The first black-hole images dominated the headlines. At the same time, many people are willing to trust social media more than science. Populist politicians are attacking research, cutting funding and questioning the value of evidence. People seem to have fallen out of love with science. I strongly believe that Europe must lead the fight back — to encourage our societies to do as climate activist Greta Thunberg urges, and “Listen to Science!”

This needs three things in particular.

First, more openness. Science must no longer be hidden from the public or from other scientists. Open science empowers researchers, fosters interdisciplinarity and levels the playing field for less well-heeled institutes. It also reflects fundamental European values of inclusiveness and respect for the individual. It means giving back to scientists the ownership and control of their work, a bit like the way that Europe’s General Data Protection Regulation (GDPR) allows citizens to control their data. And like GDPR, Europe is setting the standards in open science that the world will follow.

The recent Plan S is a bold step forward on this front, which the European Commission, along with a growing number of national funders, is committed to implement. This will not be easy, as we need to ensure excellence, academic freedom and innovation in scientific publishing. But we must also start to ▶

► enforce open access as a condition of public funding — as the commission is now doing with the current Horizon 2020 programme.

Second, international cooperation. In 1916, when Albert Einstein presented his general theory of relativity, science was a lonely business, conducted by small teams. The first picture of a black-hole event horizon, confirming Einstein's theory, involved more than 200 scientists from 40 nationalities working together, linking telescopes around the world. No single scientist, no single nation, could have done this alone.

As a new wave of nationalism takes hold in many parts of Europe, we can no longer take global cooperation for granted. Openness to the world was heavily debated during the negotiations on the new Horizon Europe programme. I believe we reached the right conclusions. This is something we must keep fighting for in the future. Science is not a zero-sum game; it should know no borders.

Third, public trust in science. In today's era of disinformation, attacks on science are denying people access to life-saving technologies, such as vaccines. We need a new social contract, in which citizens are not just passive recipients of science but active participants (as in the Horizon Europe missions in areas such as cancer, healthy oceans and climate-neutral and smart cities). For this to happen, the great stories of science need to be told by the protagonists, the scientists themselves, in a language everybody understands. Let's rekindle the European love affair with science.

ISABELLE VERNOS

Spain: invest or regret it

Member of the European Research Council Scientific Council, and ICREA Research Professor, Centre for Genomic Regulation, Barcelona, Spain.

Spain was hit hard by the economic crisis that started almost 10 years ago. But despite the importance of science and innovation for the progress of society and the well-being of individuals, investment in these areas has never recovered. Spain spends almost 6% less on science than it did before the crash. Europe invests 22% more and in China, spending has doubled.

In my view, the result is that my country has no clear political vision on how to address the challenges on many levels that our society faces now and in the future. Science is not on the agenda; it is either considered a luxury or feared as a threat to health, security or the job market.

Today, investment in research and development (R&D) per head in Spain is €302

(US\$338) per year; that is, less than half the European average of €622. Scientists here are therefore extremely worried about funding. The number of grants has been shrinking steadily, as has their size. And bureaucracy seems to grow by the day, reducing our flexibility and efficiency.

Another problem (as in other countries and at EU level) is the increasing pressure to do translational research with immediate impact through intellectual protection, start-up companies or new drug development. Curiosity-driven research is essential to support a knowledge-based society and push forward innovation, as demonstrated by the success of the European Research Council (ERC).

Any country that aspires to be a leading economy with a highly developed society has to support its researchers. Spain must appreciate this before it is too late.

STEPHAN KUSTER

ERA: no time for complacency

Secretary-general of Science Europe, Brussels, Belgium.

The idea of a European Research Area (ERA) — a coordinated system of scientific programmes and policies across Europe — dates back to the 1970s. The ERA is based on the principles of the European internal market, and of 'free circulation of knowledge' enshrined in EU treaties. To harness current opportunities and face today's threats, it needs a strong and renewed commitment by European governments.

The ERA is based on the principle of research cooperation as a means to increase effectiveness and reduce fragmentation, while fostering competition as an incentive for pushing the boundaries of knowledge. It has eased research funding across national borders, forged common standards for working conditions in research careers, and contributed to the coordination of planning and financing large research infrastructures.

Its most famous policy target — binding European governments to increase national science spending to at least 3% of their gross domestic product (GDP) — is its most elusive. Spending has increased in some countries, but 3% is still out of sight for most. The average was 2.06% in 2017. But as long as European governments are serious about seeking prosperity by pursuing knowledge, making fundamental discoveries and encouraging their application for the benefit

of society, Europe will be participating in the global scientific endeavour from a position of strength, and its economies will benefit.

However, recent developments remind us how quickly such commitments can crumble. The intended withdrawal of the United Kingdom from the EU is a significant blow to the ERA. The United Kingdom is a research powerhouse, and even a temporary hiatus in its full participation in European research programmes and policies — not to mention the short-term effects on researchers' mobility — will be a loss. Bilateral research cooperation at project level will continue between the United Kingdom and teams in other European countries. But the long-term contribution to the ERA by one of Europe's most significant scientific and academic systems is in question.

Elsewhere, a rise in inward-looking policies and nationalist sentiment is also a serious threat to European science. Discourses of this type question the value of international cooperation and are hostile to any evidence that contradicts official government narrative. We are seeing a return of nasty infringements on academic freedom in some European countries; these represent a direct threat to the ERA.

Europe produces world-class researchers and science in all fields. It is also a world leader in changing how high-quality science itself is conducted. From introducing open access as the standard for disseminating results to providing federated infrastructure for data sharing, the ERA helps European researchers and their institutions to stay at the forefront. Let's never get complacent.

HELGA NOWOTNY

Austria: Slow but steady

Founding member and former president of the ERC, and professor emerita of science and technology studies, ETH Zurich, Switzerland.

In these troubling times for Europe, the old Habsburg motto of *tu felix Austria comes to mind* (in its entirety: "you lucky Austria marry, while others conduct wars"). Austria is indeed lucky to enjoy the semblance of stability and contentment. The general drift towards right-wing policies manifest in immigration policy and attempts to control the media and consolidate power has so far spared the scientific community.

How come? The answer lies in a perhaps astonishing streak of continuity, based on a highly competent bureaucracy; professional funding agencies; a minister who as a former vice-rector for research knows how universities tick; and a lively, well-connected





Tracking the response to human faces at the University of Veterinary Medicine Vienna's 'clever dog lab'.

KLAUS PICHLER/ANZENBERGER/EVYVINE

scientific community never shy to speak up. The Austrian EU presidency which ended in December 2018 was rightly praised for serving the EU project, moving member states and the commission closer to reaching agreement on Horizon Europe.

So, what needs improvement? Continuity has its price. Needed reforms often come slowly. For example, Austrian universities were only recently allowed to selectively admit students. They were underfunded for years. This began to change in 2013, with an increase of 9.3%. This year, another €1.3 billion was added for the period 2019–21, an increase of 15% towards a total of around €11 billion, and 360 professorships were created. Good news, but too long in coming.

Many welcome the initiatives begun under the previous government. The country report of December 2018 from the Organisation for Economic Co-operation and Development (OECD) praised Austria's achievements in research, technology and innovation policies while laying bare some of the vulnerabilities in a quickly changing world. Among these is the country's low funding for competitive basic research, given its wealth: per capita Switzerland spends five times as much; Finland, Sweden, the Netherlands and the United Kingdom three to four times; and Germany 50% more. The government intends to use the analysis and recommendations in designing its strategy for 2020–30.

Last August, the government announced a Future Offensive for Research, Technology and Innovation. Among the plans is a much-awaited excellence initiative to increase competitive funding for basic research. Another important component is a new law for securing long-term financing of research (*Forschungsfinanzierungsgesetz*). There is likely to be a major restructuring of funding agencies for more efficiency. The aim is to close the glaring gap between one of the highest R&D investments in Europe

and a moderate output. But a summit, originally scheduled for May, to present concrete budget figures for the measures, was recently postponed to autumn, raising concerns about the financing.

Continuity definitely has advantages. The Austrian scientific community is well connected within the EU framework programmes and beyond. It is aware and responds to global and societal challenges. The government's latest initiatives will go in the right direction, if enough money can be found. The question remains whether the world around us will continue to tolerate our continuity.

ANDREA SALTIELLI

Save science from itself

Professor at the Centre for the Study of the Sciences and the Humanities, University of Bergen, Norway, and visiting fellow, Open University of Catalonia, Barcelona, Spain.

Europe must tackle the complex crisis affecting the relationship between science, technology and society. It must resist the extreme manifestations of the same crisis seen in the United States.

Today, all that is controversial and relevant — from overexploited fisheries to collapsing insect populations, from populism to the atomization of society, from reckless military technology to the hacking of political elections, of minds and of genes — operates simultaneously in science, technology, economics, law and policy. Diseases old and new are the occasion for new battles in which science, ideology and special interests collide. And social media gives this cocktail

unprecedented reach and acceleration.

In Italy, my home country, even fighting a pest of olive trees has been severely delayed because of opposition from residents who distrust evidence from research and whose voices are amplified by echo chambers. But what is this science that we should defend from doubters?

In Europe, as elsewhere, different images of science coexist. Prudent science and technology are at odds with their use for corporate or military interests. Science to inform policy decisions has its nemesis in science lending a veil of rationality to the same decisions. Science as a source of emancipation and flourishing has its antithesis in science as the currency of lobbies. The advent of artificial intelligence and big data fosters the rise of inequality and power asymmetries in platform and surveillance capitalism.

Old wars between the natural and the social sciences are reappearing, together with new ones, such as the political use of the reproducibility crisis to weaken environmental and health regulations in the United States. We must prevent this infection from extending to Europe. A resistance movement is needed, in which scientists and technologists join citizens, human-rights advocates, humanists and lawyers, to act urgently on the present convulsions, defending science from both the “vote for science” politicians as well as from the depredations of the anti-science movement.

ALINA MUNGIU-PIPPIDI

Romania: study enemies of trust

Professor of democracy studies, Hertie School of Governance, Berlin, Germany.

As an Eastern European living in Berlin, I am concerned about the scant academic interest in the gulf between the northwest of Europe and the rest of the continent. As a scholar of governance, I'm puzzled that two-thirds of Europeans think that connections, not merit, explain success in our common market. As a Romanian, I wonder how a country such as mine can plan its European future when its main export is, and will remain, brainpower.

But problematic as these issues are, the future of democracy is my biggest concern. In countries such as Romania or Ukraine, the public sphere was a battle between trolls and humans even before social media, because only a minority of the old media was about informing people — the rest was in the business of blackmail, influence peddling and advertising, like the Western media in the nineteenth century. Meanwhile, political parties in our new democracies have not yet managed to become anything more than

special-interest groups. Before social media, we had some hope of solving these problems gradually, as problems in development. Can we still hope to do so?

We know that party membership is generally correlated with membership of civic associations, and both were below 10% in my country even before people moved to Facebook for their socializing. I doubt we can have democratic politics and generate a consensus on social welfare without any representative associations and with citizens (in Ukraine) who elect as president a soap-opera comedian who played a president because online influencers tell them to do so.

To shape a social media that would be the fabric of cooperation that Alexis de Tocqueville described as civil society — and not some lab of populism and fascism — we need transparency to study it. Facebook shared data with commercial companies such as Cambridge Analytica, but has only recently opened the door to academic researchers.

Doing nothing is not an option any more. Eastern Europe must learn from how others — from Germany to India and even China — are attempting to regulate online activity. The philosopher Confucius once said that a nation can dispense with military equipment and survive; not so, trust in government. Let that vanish, and the state will follow.

JAN WOUTER VASBINDER & DANIEL R. BROOKS Climate change above all

Director, Para Limes, Valkenburg, the Netherlands (J.W.V.); Visiting senior fellow, Institute of Advanced Studies, Kőszeg, Hungary (D.R.B.).

Europe's strengths, weaknesses, structures and spats seem trivial in the face of global climate change. Why this isn't the primary focus of every research programme throughout Europe, and globally, is baffling to us.

We have become a technological species clustered in urbanized, sedentary and high-density settings susceptible to shortfalls in food production, shortages of drinking water and pandemics. The number and intensity of disruptions, and their global impact, will increase as a result of the accelerating development and impact of technology; the growing dependence of our trading and support systems on the integrity of cyberspace; increased energy needs and decreased resource security; the failing global financial system and our vulnerability to terrorism and populism.

We have been living beyond our means



YVES HERMAN/REUTERS

Energy futures: wind turbine among the tulip fields in the Netherlands.

in our technological niche, and the bill is now due. Human population — urban density and global numbers — must decrease if we are to survive as a technological species, but by more gentle ways than wars, famine, drought and pandemics.

The time is short, the danger is great, and we are largely unprepared — but we can change that by refocusing European initiatives and programmes such as Horizon Europe and the ERC Grand Challenges Network towards this, the grandest challenge of all.

Science has not been primarily about raising questions that are relevant for society. Now it must be. The scientific community has developed its own pace and priorities, producing an increasing number of disciplines largely disconnected from society. This has led to a sluggish and unfocused response to global climate change.

Science must step off its treadmill, explore beyond the familiar boundaries of disciplines, and collaborate with non-science entities that know how to translate plans into action. We must prioritize activities designed to buy time for survival, fit the knowledge we have to the problems we see, create applications that work, and focus on proactive, not reactive, policies.

PATRICK CUNNINGHAM Ireland: More money please

Professor of animal genetics, Trinity College Dublin, Ireland.

Ireland needs to spend more on R&D. But I appreciate how hard a case that is to make. During five challenging years as chief scientific adviser to the Irish government, I was regularly asked why a small country should spend scarce taxpayer money on R&D, when every extra euro is borrowed from the next generation. The question contains its own

answer. The purpose of today's R&D investment by the state is the welfare of present and future generations.

Ireland currently spends 1.5% of its GDP on R&D, below the average for the EU. Just over one-quarter comes from the government, and almost one-half from the business sector. Policy for public R&D investment is mainly focused on economic goals, but addresses social, environmental and other issues, too. The linkage of publicly funded research with the broad, diverse, and globally connected industrial sector is strongly encouraged.

Government R&D budgets in Ireland had been steadily increasing in the years leading up to the financial crash. Peaking in 2008, they declined until 2013, plateaued for three years, and are now rising again. The current target is to reach 2.0% of GDP by 2024. Most public funds for R&D are channelled through three major agencies. Supported research is carried out in the eight universities and in government institutes, much of it in collaboration with national and international business partners.

The six key priorities for science investment set out in the 2015 policy document Innovation 2020 have now been refined for the period up to 2023. They are: information and communication technology; health and well-being; food; energy, climate action and sustainability; manufacturing and materials; and services and business processes.

Translating these plans into action is the real challenge. Although the Irish economy has recovered strongly in recent years, investment in science has not kept pace. The latest OECD index of R&D intensity (gross domestic expenditure on R&D as a percentage of GDP) shows Ireland down by 19% on a decade ago, whereas the average for the EU is up by 16%. Happily, other OECD indicators point to better times ahead. Real GDP growth in Ireland is forecast to be the highest in the EU, and 54% of our 25–34 year olds have completed tertiary education, again the highest in the EU member states. ■