SCIENCE AT THE CROSSROADS: PROMISES AND PERILS

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When I joined the Dutch government, a cartoon appeared in *De Volkskrant*. On a thin ladder, I descended from an ivory tower on a small planet called Princeton into a large black hole titled 'The Hague politics'. How wonderful to have escaped from the black hole and be welcomed back in academia here in Groningen!

What is the state of science?

Leonid Brezhnev was once asked to assess the state of the Soviet Union in a single word. His answer was "Good." Asked what his answer would be with two words, he said: "Not good."

In a single word, the state of science is "good." There are unprecedented opportunities. The previous century gave us the building blocks of reality: the atoms and particles that compose matter; the cells and genes that enable life; the bits and algorithms that form intelligence, both human and artificial.

This century is about what we can create with these building blocks. With powerful, self-learning computers, soon quantum-based, scientists will explore the rapidly expanding universe of artificial materials, life, and intelligence. This prospect both excites and alarms us, not least because the pace of discovery is accelerating. In current technology, a generation can span mere months, as demonstrated by recent AI breakthroughs. The rate of research is predicted to increase tenfold, meaning most of us will witness the end of this century — at least scientifically speaking.

We enjoy an unparalleled worldwide pool of talent, particularly from regions and social strata not previously engaged. Modern technology enables new levels of connectivity, building a truly global community. Intellectual diversity has never been greater.
However, in two words, the state of science is "not good." We witness growing attacks on academic freedom, including physical and online threats, as the space for intellectual exploration contracts. Populists portray universities — once celebrated as essential pillars of democracy — as elitist institutions indoctrinating students with woke ideology. Scientific consensus on topics like climate and vaccines is deliberately undermined by disinformation campaigns, often disguised as legitimate science. So-called alternative facts erode the very foundation of society: our shared perception of reality.

Governments, wielding the power of the purse, increasingly view science through the narrow lens of economic competitiveness, with policies skewed toward predictable short-term goals that miss transformative long-term advances that basic research brings. The humanities and

social sciences are particularly questioned and marginalized, despite their crucial role in understanding how societies adapt to technological change.

Most alarming, in an increasingly inward-looking zero-sum world, international collaboration is reframed as a threat to national security and economic interests, even as humanity's most pressing challenges, from pandemics to technology governance, demand global cooperation. A veteran researcher recently remarked that the current chilling atmosphere is worse than during the height of the Cold War.

Ironically, much political backlash results from the growing impact of research, delivering uncomfortable truths about issues like environmental degradation and public health risks. Science is telling people what they should and should not do. This produces the social equivalent of Newton's Third Law: for every action, an equal and opposite reaction. Science pushes society and society pushes back. In honest efforts to base policies on solid scientific footing, researchers face accusations of political bias. Some say: "If you mix science with politics, you get politics."

But that's an oversimplification. Science and politics have complementary roles and responsibilities. Scientists must acknowledge that facts inevitably intersect with values and political ideas. Politicians must learn to deal with evidence and nuance. Scientists aren't above politics, and politicians aren't above the facts.

All this points to much-needed rethinking of the role of science in society. As Nobel Prize winner Steven Weinberg once said: "In science we usually learn about nature. But sometimes in science we learn about science." This is such a moment of self-reflection. Let me address it at three scales: global, European, and national.

First and foremost, science should deliver on its promise to be an engine of progress by providing real solutions to pressing societal issues. Realizing this tremendous potential requires transdisciplinary research — an ongoing dialogue across academic disciplines and with all stakeholders: policy makers, funders, the private sector and civil society. During the explosive growth of the post-war scientific enterprise, many internal and external walls were built. As currently organized, science often produces too narrowly focused and fragmented knowledge, disconnected from society's immediate needs. As the saying goes: "The world has problems; the university has departments." To which I would add as corollary: "The government has ministries."

Low-income countries often face the hardest policy decisions with the least access to scientific expertise. Open science — the practice of widely sharing research outcomes and datasets — is crucial for making knowledge more equitable and addressing the growing North-South divide. It ensures that science truly serves as a global public good for the benefit of all.

Under current geopolitical pressure, the multilateral system, including the United Nations, faces tremendous strain and is even actively undermined. Therefore, scientists, sitting in the second ring of the global theater — not in the splash zone reserved for politicians — have an important role to play. Where politics divides, science unites. Scientists should play a key part in setting the post-2030 sustainable development agenda.

Research collaborations build lasting relations among nations, particular in times of crisis. When the International Science Council's predecessor was founded in the 19th century, it was noted that scientific contacts often predate economic and political ties. This insight rings truer than ever. Does the global science community have the imagination and determination to build new partnerships that can push back against these dividing geopolitical forces?

Europe also stands at a crossroads. While the United States shoots itself in the foot and China tightens its authoritarian screws, there's a unique opportunity for Europe to lead in science. Modern science was Europe's gift to the world — born from a fertile ecosystem blending competition with collaboration, cultural plurality with global connectivity. It should also be its future.

Recent analyses, particularly the brutally honest Draghi report, reveal one simple truth: In Europe, the whole is often less than the sum of its parts. National efforts are needlessly fragmented and divergent. Scale must be central to any future European strategy. In today's knowledge economy, productivity growth concentrates in products and services that effortlessly transcend borders — adding a million streaming subscribers is far easier than selling a million cars. Yet European companies stumble against internal barriers that stifle rapid scaling and restrict access to investment capital. The greatest scientific and technological challenges, from quantum computing to drug discovery to strengthening our defense, recognize no borders and demand collective action.

Europe must evolve into a true research and innovation union, organized around key strategic themes requiring continental scale — whether for scientific breakthroughs, societal transformation, or economic competitiveness. European instruments should act as powerful magnets aligning the wobbly compass needles of national policies. Smart specialization can eliminate wasteful duplication and close critical gaps.

One way forward would be establishing European "sector plans": strategic matrices mapping key research goals against each partner's intrinsic strengths, then optimizing horizontally and vertically through give-and-take in an atmosphere of mutual trust. Each country and institution can focus on their intrinsic strengths while ensuring no region is left behind through distributive networks.

Europe must embrace the worldwide competition for top researchers. In science, talent attracts talent. Scale enables world-class research centers and facilities beyond any single nation's financial reach — like CERN's success as the world's center of particle physics and potentially

our own Einstein Telescope in gravitational waves. Europe's oft-criticized complexity and inertia can become a feature instead of a bug. The European Union creates stability by averaging out national political volatility, and its longer financial planning horizon provides much needed continuity — essential conditions for scientific excellence.

Collaboration remains Europe's forte. Its architecture enables flexible partnerships, with the EU-27 forming an inner core surrounded by rings of like-minded nations. This open nature attracts innovation-driven countries seeking dependable research alliances in a world of superpower rivalry.

For European leadership in science and technology, research investments of member states and in Brussels must increase dramatically. To set the level of ambition: America's top five tech companies alone spent more than $250 billion on R&D last year — twice all EU public expenditure combined.

Ultimately, values may be Europe's strongest asset. To enhance competitiveness, we must cultivate a research environment championing academic freedom, inclusivity, transparency, and integrity, while empowering the next generation of scientists. These "soft" cultural forces may prove as decisive as budgets and programs. Also in science, politics is downstream from culture.

Finally, what can we do at national and local level?

The next government should embrace an ambitious research and innovation agenda with much needed investments finally reaching the Lisbon target of 3% of GDP.

But there is a challenge for science too. It is deeply worrying that society's increasing polarization follows along educational fault lines. Traditional broad-based support for scientific institutions is eroding and concentrating among university graduates. This transforms science from a unifying force into a symbol of privilege. Scientific literacy is becoming a cultural identity marker rather than a shared foundation for democratic decision-making.

There is an urgent need to reestablish the social contract between science and society that has proven so successful in the past: citizens fund research; science delivers medicines, technology and knowledge for the benefit of all. We need to reach out to those who have tuned out. Scientists must become comfortable being uncomfortable. The academy needs not just ivory towers but marketplaces where the fruits of research are displayed for everyone.

There are many arguments for such broad engagement. The public deserves to be informed about the outcomes of their investments. Widely shared knowledge is a fertile ground for innovation and economic growth. And well-informed citizens can make better choices facing "wicked problems" like nuclear power or vaccinations.

But there is a higher goal: society benefits from embracing the scientific culture of truth seeking, critical inquiry, healthy skepticism, respect for facts and uncertainties, and profound wonder at the richness of nature and the human spirit. Science is a precious public good and our most reliable source of optimism. We need that more than ever.