Illustration by Shonagh Rae

"The currency of power is increasingly becoming science and technology."

During a career leading corporate and public research efforts, Darío Gil has been able to assess the strengths and direction of the US science and technology enterprise and develop proposals for shaping its future.

Darío Gil, senior vice president and director of research at IBM Research, leads one of the largest corporate research labs in the world, directing innovation and research efforts in artificial intelligence, hybrid cloud, quantum computing, and exploratory science. A native of Spain, Gil completed high school at Los Altos High in California and earned his PhD in electrical engineering and computer science at the Massachusetts Institute of Technology (MIT). He is a member of the National Academy of Engineering.

Gil is chair of the National Science Board (NSB), the entity that oversees the National Science Foundation, giving him a unique vantage point from which to contemplate the strength and direction of the US research enterprise and develop proposals for how to shape its future. An advocate for collaborative research models, he cochairs the MIT-IBM Watson AI Lab, which advances fundamental AI research, and also helped found and cochairs the executive board of the International Science Reserve, a global network of open scientific communities that provides specialized resources to prepare for and help mitigate urgent, complex global challenges. In an interview with *Issues* editor Molly Galvin, Gil discusses the biggest challenges facing the research enterprise today, the growing influence of science and technology in geopolitics, and his ideas for reimaging the way science and research is done.

You grew up in Spain and are fluent in several languages. How did you get interested in science?

Gil: Perhaps it's a contrast with my family, which is very artistic. I'm the youngest of four brothers. They are more in the world of architecture and design, and my uncle was a painter. I was always good at math and science. So part of my interest grew from finding a different path that wasn't so much in the family.

And then over time, this interest got reinforced by having teachers and faculty members that were inspiring and drove me that way. In Europe, it's very common that when you're as young as 14 you have to choose tracks—are you going into the science and engineering track, or are you going more in the liberal arts track? I wanted to find my own space in something that I liked.

You recently became chair of the National Science Board. How does NSB fit into the science enterprise, and where would you like to see it be a leader?

Gil: The National Science Board has two core missions. First, NSB helps make the National Science Foundation successful by partnering with the NSF director and leaders to provide oversight on critical responsibilities. The NSF is a jewel in our science and technology ecosystem. We want that fantastic and cherished institution to continue to thrive and have impact.

But NSB's second mandate is to advise the administration and Congress on good policies in science, engineering, and education—policies that make the whole US enterprise in science and engineering better. One aspect of this mandate is to provide more evidence and analytical clarity on how the landscape of R&D in our nation has changed. The NSF and NSB got started 75 or so years ago. We need to recognize a new context in which we have to learn how to adapt and thrive for the next 75 years.

For nearly 80 years, Vannevar Bush's* Science: The Endless Frontier *report has acted as a blueprint for US science policy, promoting a centralized approach to government-sponsored research. But you recently coauthored an editorial saying that Bush's model is "increasingly irrelevant." What kind of vision do we need for the next 75 years, and how are the roles of industry and government shifting?

Gil: Our statement about irrelevancy was intended to shake the tree a little bit—to provoke us to not be complacent. In that editorial, we also said that what got us here is not going to get us to where we need to go.

One important characteristic of the research enterprise is its scale—something like $800 billion a year is invested in the research enterprise. Of that, some $600 billion is invested in R&D by the business sector. If we go back 15 years, that number was more like $300 billion. So there's been a dramatic acceleration of investment in R&D from the business sector, which we should celebrate.

But that of course does not substitute for the importance of the federal government in supporting research at federal agencies. That is an indispensable foundation. The role that philanthropy plays is also critical for pursuing really exploratory work.

To do anything that is of great ambition as a country, we are going to need to learn and work across sectors. And here lies one of the challenges—it's already fairly hard to coordinate across different federal agencies. But we do that through an interagency process. We have mechanisms like the White House Office of Science and Technology Policy to help.

But when we think about coordinating across sectors, who sits at the table? The actors include philanthropy, the university ecosystem, state and federal government, and of course also the business sector. Clearly, when we talk about the model of the past not being the model of the future, this is an example. How can we make sure that we stack investments to accomplish great things?

A key component of the research enterprise is a strong STEM workforce. You note that there is bipartisan interest in improving education and workforce development, starting with K–12. What role do you see the federal government playing?

Gil: We need the people and infrastructure to carry out the work, along with sustainable funding models. This is the heart of all of science and technology efforts. On the people side of the equation, we have unique strengths as a nation in being able to attract extraordinary people, but we also have challenges in retaining them. That speaks to policies around how we should attract international talent.

Without question, we have an urgent task in front of us to strengthen domestic education in STEM and critical areas. The area that is blinking red is K–12 education. Of course, education is fundamentally a responsibility for state and local governments. But if we look back to the National Defense Education Act (NDEA), which was enacted after Sputnik, that effort created mechanisms to incentivize everything from the first federal loan programs to education infrastructure.

It is time for a National Defense Education Act 2.0—a version which reflects our current reality. A new NDEA should aspire to support, accelerate, and expand good programs that are happening at the state and local level. This might come from matching grants and support for those institutions with these programs, investing directly in STEM students and teachers, or investing directly in the infrastructure that makes it happen.

There could also be incentives to allow cross-sector participation with businesses and other institutions that require that talent pool for their future success—easing the routes for those investments. Later in people's careers, there could be apprenticeship programs and other continuing education initiatives.

Drawing on the success of the past NDEA, let's design the future together. We have some ideas of what a NDEA 2.0 could accomplish, but this is the beginning of engaging with the community and policymakers to think about how to do this.

What would you say to those who are skeptical of investing more federal and state tax dollars in this kind of infrastructure for education?

Gil: No one can debate that the pace of technological change is accelerating and that we want our country to be the global leader. Technology has been elevated to the same level of geopolitical importance as things like trade or military alliances. It's actually the new currency of power, of economic prosperity. And our national security increasingly depends on our ability to deliver differentiated technology, to make better products and services, and to drive employment and well-being in our communities.

We also have geopolitical rivalries and challenges. Perhaps the most salient and obvious one that we all talk about is competing with China. In this context, the talent input to this equation is arguably the most important.

I think there is a powerful opportunity for a broad constituency to see themselves and their priorities reflected in education as a national good. Different people and entities will approach this from different angles. For a state, economic development and employment are going to be everything. At the federal level, if you're in charge of national security, how do we make sure we're going to have technological superiority in defense? Or how are we going to deal with the great power competition and rivalry with China? For others, investment in science provides equity and the opportunity for students themselves to transcend, for example, limitations in a socioeconomic background.

> "The NSF and NSB got started 75 or so years ago. We need to recognize a new context in which we have to learn how to adapt and thrive for the next 75 years."

Does taking this approach require a different way of doing science and developing technology?

Gil: Yes. You could take an approach where it's very ivory tower: We scientists know best, and therefore the agenda for the nation should reflect that. And I'm not minimizing the role of curiosity and intuition. That's really powerful.

But compared to the past, there is no doubt that we want more citizen input in the practice of science and technology in its own right. What are the problems that they want to solve with science and technology? What's relevant to their communities? What are their aspirations that they have on behalf of people who are practicing science and technology?

Secondly, we have to think about how we do science collaboratively across sectors. For example, you can assume a very linear model—you do fundamental work in universities that eventually industry turns into products and development. But on closer inspection, that linear model has never really been true, and it's not the way things actually work. We need greater care and consideration of how to work across institutions and sectors to accomplish truly ambitious things.

You were instrumental in establishing the International Science Reserve, a body that operates across institutions and serves as a global network of scientific communities. How did that come about, and why do we need it?

Gil: The idea of the International Science Reserve originated in a project that I helped co-start during the pandemic called the COVID-19 High Performance Computing Consortium. We were dealing with this global pandemic, so why couldn't we aggregate the best supercomputers in the world and make them available to scientists who are trying to understand the virus and how we should respond to it?

But who has the supercomputers? It's the federal government, the private sector, universities, and some international partners. So we created this consortium, aggregated the computing resources, and made it free to scientists.

That led to the idea of creating the National Strategic Computing Reserve—the equivalent of an airlift reserve or oil reserve, for example. And that idea led to the International Science Reserve, which would be less about supercomputers and more about the scientists.

During the pandemic we found that there will be a subset of scientists and engineers who, given the opportunity, will say, "I want to help." So we created it in partnership with the New York Academy of Sciences, and now there are 15,000 scientists all over the world who are part of this reserve. They are dealing with a variety of issues such as scenario planning, crisis response, and mobilization.

The aspiration is to hold dual identities in our own profession: I work at IBM, but I'm also a reservist. I choose to contribute when it's needed and when appropriate. So that's an idea of a network-style institution that doesn't require a new building or a new thing, but it requires the activation of a community. We can be more creative in how we think about and create institutions.

Along these lines, you have also floated the idea that we should create a NATO-style institution for global science. What do you mean by that?

Gil: If the currency of power is increasingly becoming science and technology, how are we going to handle that? For example, if you work in semiconductors or AI or quantum, you know already there are a lot of export controls and other restrictions on where you can do work, what you can do, where you can sell, and where you can collaborate.

"Without question, we have an urgent task in front of us to strengthen domestic education in STEM and critical areas. The area that is blinking red is K–12 education."

As a result, we're starting to see an emergence of new arrangements for science diplomacy and even technology diplomacy. For example, even if allies pass export restrictions, they can still trade with each other freely. So you're starting to see some elements of alliances and boundaries. And of course, the military sphere has a precedent for what that looks like.

So for example, in the case of the United States and Europe, when the Transatlantic Trade and Investment Partnership was created, it provided a mechanism to resolve technology-related disputes about exports. But that's insufficient: Technology is not owned by governments, but is mostly in the hands of the private sector. So again, that raises questions about who sits at the table, and how do these questions get decided?

The NATO of science and technology or the G20 of S&T—I think it's another thing that needs to be invented.

It seems like a really important idea to explore given today's shifting geopolitics, especially because science is so global.

> "Technology is not owned by governments, but is mostly in the hands of the private sector. So again, that raises questions about who sits at the table, and how do these questions get decided?"

Gil: Core exploratory science is highly international. As much as possible, we want to keep it an international endeavor that contributes to the advancement of knowledge worldwide. But sometimes we use the words science and technology interchangeably. When I was talking about exports, that really relates to technology. But as NSF director Sethuraman Panchanathan often says, science and technology are like the DNA helix. They are intertwined, so it depends on which lens you look through. But somehow in this equilibrium, we have to maintain the power of a global scientific network that collaborates and advances knowledge for all mankind, while also balancing legitimate concerns about where we set boundaries on technologies.

As cochair of the Vision for American Science and Technology Task Force, what priorities would you like the incoming administration to address in terms of strengthening science and the scientific enterprise?

Gil: Historically, science and technology have been an area where we have seen a lot of bipartisanship. For example, the National Quantum Initiative Act in 2018 passed with huge bipartisan support. Even more recently, we saw bipartisan support for the CHIPS and Science Act. We've got to continue to strive to make sure that both parties—and more broadly the American public—care deeply about making sure we succeed in science and technology as a nation.

We should be open-minded in listening to good ideas. And making sure that in the context of unleashing more investment, we invest in our people, in attracting the best, and in the infrastructure that we need for the future. As a country, that triangle is what we need, and we should approach it with as much bipartisanship as possible.

You can imagine a variety of approaches, such as R&D tax credits for institutions. And then also facilitating this idea of stacking dollars across stakeholders to accomplish things that they couldn't do on their own. So I think there will be different vehicles, but fundamentally, unleashing more investment in science and technology in R&D would be good for the nation.

Coming from IBM Research, one of the world's largest corporate laboratories, where do you see opportunities in the lab right now, and how do you think the corporate lab fits into our research ecosystem?

Gil: I'm incredibly proud that next year, IBM Research celebrates its 80th anniversary. Over that time, we have published over 100,000 scientific publications, and six IBMers have won Nobel Prizes. There have been fundamental contributions to mathematics, to physics, to chemistry, and to building the first quantum computers.

We see examples of labs we've lost, like Bell Labs, which I know we're all sad about. But also we've seen others that have endured, like IBM Research, and new labs like Google Research. Our industrial laboratories are also jewels of the nation, and we should celebrate them as such, just like we celebrate our best universities.

I think this is the most exciting time in computing since the 1940s, when we saw the emergence of the first programmable computers. The transistor was invented in 1947. Claude Shannon and Alan Turing created information theory and the building blocks of the whole computing and communications revolution.

Look at what's happening right now in the 2020s: I summarize it as bits plus neurons plus qubits. We're pushing the limits of semiconductors, high precision computation, AI, quantum. And then bring them in all together. We're going to see more change in the world of computing in the next five years than we've seen in the last 40 or 50 years.

This shows the tremendous amount of creativity and investment in the industrial research laboratories, particularly in this world of computing. We need to celebrate all the dimensions of science and research—ranging from philanthropic science investments to universities and the federal government. And even state governments are increasingly investing in science and technology because they want economic development. My goal is not to pit one against the other, but to say: This is our reality. How do we work with each other to accomplish big things?

Let's learn about doing ambitious work together. That is the path to driving incredible accomplishments over the decades to come.