FORUM

Issues regularly receives numerous letters from readers responding to our articles. We print some of them here. A complete collection can be found in our online Forum: https://issues.org/section/forum/.

STEPHEN TALASNIK, *Glacial Mapping*, 2023, digitally printed vinyl wall print, 10 x 14 feet.

A SELF-CORRECTING SYSTEM

In "What a Coin From 1792 Reveals About America's Scientific Enterprise" (*Issues*, Fall 2023), Michael M. Crow, Nicole K. Mayberry, and Derrick M. Anderson make an adroit analogy between the origins of the Birch Cent and the two sides of the nation's research endeavors, namely democracy and science. The noise and seeming dysfunction in the way science is adjudicated and revealed is, they say, a feature and not a bug.

I agree. I have written extensively about how scientists should embrace their humanity. That means we express emotions when we are ignored by policymakers, we have strong convictions and therefore are subject to motivated reasoning, and we make both intentional and inadvertent errors. Efforts to curb this humanity have all failed. We are not going to silence those who are passionate about science—nor should we. Why would someone study climate change unless they are passionate about the fact that it's an existential crisis? We want and need that passion to drive effort and creativity. Does this make scientists outspoken and subject to—at least initially—looking for evidence that supports their passion? Of course. And does that same humanity mean that errors can appear in scientific papers that were missed by the authors, editors, and reviewers? Also yes.

There's a solution to this that also embraces the messy and glorious vision presented by Crow et al. And that is not to quell scientists' passion and humanity, but rather to better explain and demonstrate that science operates within a system that ultimately corrects for human frailty. This requires better explaining the

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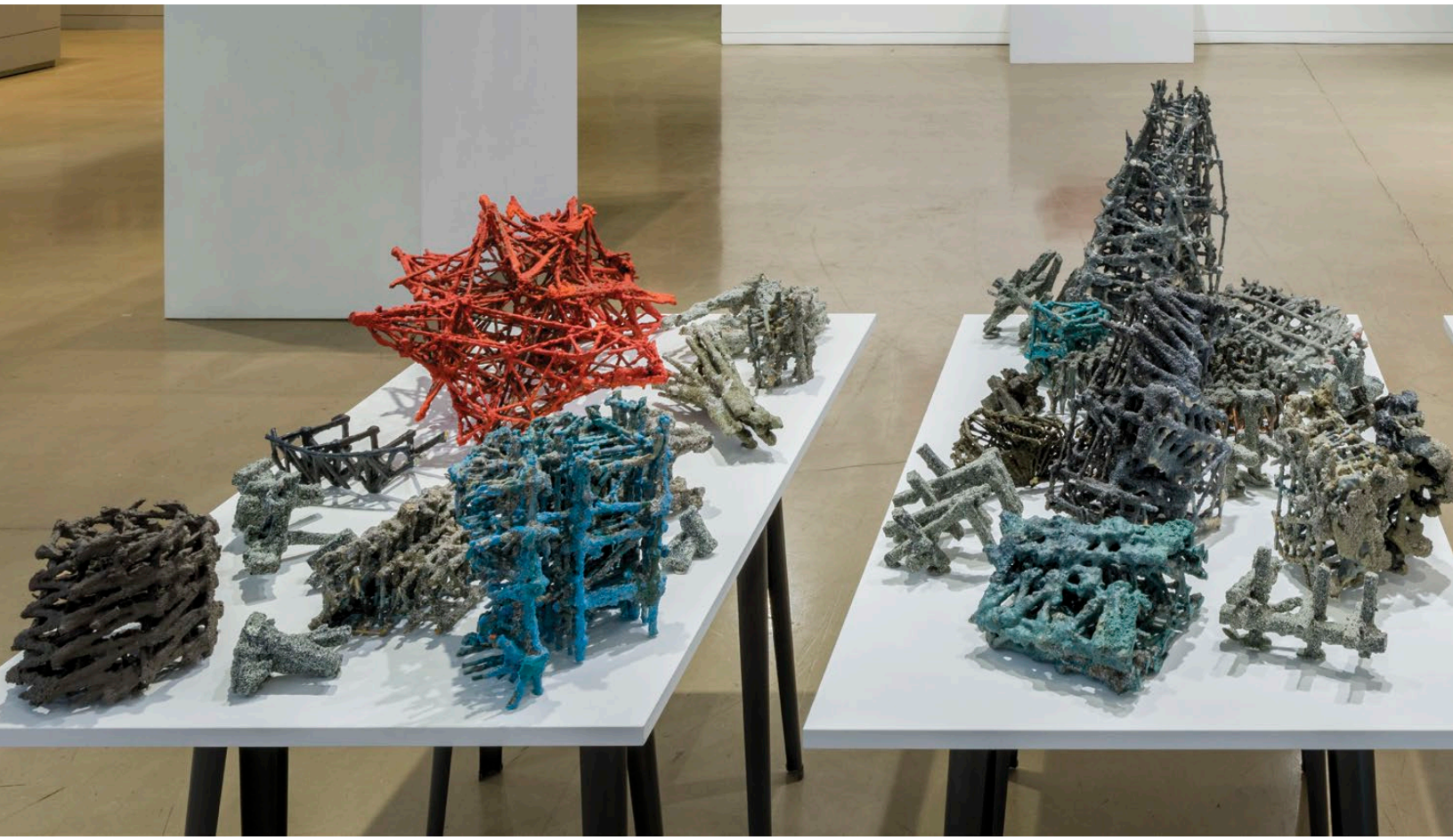
FLOE: A Climate of Risk

The Fictional Archaeology of Stephen Talasnik



STEPHEN TALASNIK, *A Climate of Risk – Debris Field* (detail).

Imagination can be a fundamental tool for driving change. Through creative narratives, we can individually and collectively imagine a better future and, potentially, take actions to move toward it. For instance, science fiction writers have, at times, seemed to predict new technologies or situations in society—raising the question of whether narratives can create empathy around an issue and help us imagine and work toward a desirable outcome.

Philadelphia-born artist Stephen Talasnik takes this question of narratives seriously. He is a sculptor and installation artist whose exhibition, *FLOE: A Climate of Risk*, is on display at the Museum for Art in Wood in Philadelphia, Pennsylvania, from November 3, 2023, through February 18, 2024. Talasnik's work is informed by time, place, and the complex relationship between ideas that form a kind of "functional fiction." Through *FLOE,* Talasnik tells the story of a fictitious shipwreck that was carried to Philadelphia by the glacier in which it was buried. As global temperatures warmed, the glacier melted and surrendered the ship's remains, which were discovered by mischievous local children. The archaeological remains and reconstructions are presented in this exhibition, alongside a sculptural representation of the ice floe that carried the ship to its final resting place. Talasnik uses architectural designs to create intricate wood structures from treated basswood. By building a large wooden model to represent the glacier, the artist evokes a shadowy memory of the iceberg and reminds visitors of the sublime power of nature and its constant, often destructive, search for equilibrium.

"*FLOE* emerged from the imagination of Stephen Talasnik, an artist known worldwide for his hand-built structures installed in natural settings," writes Jennifer-Navva Milliken, executive director and chief curator at the Museum for Art in Wood. "The exhibition is based on a story created by the artist but touches on the realities of climate change, a problem that exposes the vulnerability of the world's most defenseless populations, including the impoverished, houseless, and stateless. Science helps us understand the impact through data, but the impact to humanity is harder to quantify. Stephen's work, through his complex storytelling and organic, fragmented sculptures, helps us understand this loss on the human scale."

For more information about the exhibition and a mobile visitors' guide, visit www.museumfoarartinwood.org.

fact that scientists are competitive—another human trait—and that leads to arguments about data and papers that converge on the right answer, even when motivated reasoning may have been there to start with. It also requires courageous and forthright correction of the scientific record when errors have been made for any reason. Science is seriously falling short on this right now. The correction and retraction of scientific papers has become far too contentious—often publicly—and stigma is associated with these actions. This stigma arises from the perception that all errors are due to deliberate misconduct, even when journals are explicit that correction of the record does not imply fraud.

This must change. The public must experience—and perceive—that science is honorably self-correcting. That will require hard changes in scientists' attitude and execution when concerns are raised about published papers. But fixing this is going to be a lot easier than lowering the noise level. And as the authors point out, that noise is a feature not a bug and therefore should be celebrated.

H. Holden Thorp
Editor-in-Chief of *Science*
Professor of Chemistry and Medicine
George Washington University

RETHINKING ENGINEERING EDUCATION

In "How to Build Engineers for Life" (*Issues*, Fall 2023), Idalis Villanueva Alarcón calls deserved attention to new initiatives to enhance engineering education, while also reminding us of a failure of the profession to keep up with the changes it keeps causing. Engineering is the dynamic core of the technological changes and innovations that are mass producing a paradoxical societal fallout: glamorous prosperity and psychopolitical disorder. It's driving us into an engineered world that is, in

aggregate, wealthy and powerful beyond the ability to measure or imagine, yet in which a gap between those who call it home and those who struggle to do so ever widens.

Villanueva's call for the construction of a broader engineering curriculum and lifelong learning is certainly desirable; it is also something we've heard many times, with only marginal results. It's also unclear how much curriculum reform might contribute to the deeper political challenges deriving from the gap between the rich and powerful and those who have been uprooted from destroyed communities. For many people, creative destruction is much more destruction than creation.

Should we nevertheless ask why such a salutary ideal has gotten so little traction? It's complex, and all the causes are not clear, but it's hard not to suspect that just as there is a hidden curriculum in the universities that undermines the ideal, there is another in the capitalist economy to which engineering is so largely in thrall. And what are the hidden curricular consequences of not requiring a bachelor's degree before enrollment in an engineering school, unlike as is required by schools of law and medicine? If engineering were made a truly professional degree, some of Villanueva's proposals might not even be necessary.

Carl Mitcham
Professor Emeritus of Humanities, Arts, and Social Sciences
Colorado School of Mines

Idalis Villanueva Alarcón aptly describes the dichotomy within the US engineering education system between the driving need for innovation and an antiquated and disconnected educational process for "producing" engineers. Engineers walk into their fields knowing that what they will learn will be obsolete in a matter of years, yet the curricula remain the same. This dissonance, the author notes, stifles passion and perhaps, critically, the very thing that industry and academia are purportedly seeking—innovation and creative problem-solving. This "hidden curriculum" is one of the insidious tools that dehumanize engineering as *not* an option for those who want to innovate, to help others, and to be connected to a sustainable environment. Enrollments continue to decline nationally—are any of us surprised? Engineering is out of step with the values of US students and the needs of industry.

Parallel to this discussion are data from the latest Business Enterprise Research and Development Survey showing that US businesses spent over $602 billion on research and development in 2021. This was a key driver for many engineering colleges and universities to expand "new" partnerships that were more responsive to developmental and applied research. While many were small and medium-size businesses, the majority were large corporations with more than 1,000 employees. Underlying Villanueva's discussion are classic questions in engineering education: Are we developing innovative thinkers who can problem solve in engineering? Conversely, are we producing widgets who are paying their tuition, getting their paper, interviewing, getting hired, and logging into a terminal? Assembly lines are not typically for innovative development; they are the hallmarks of product development. No one believes that working with students is a form of assembly line production, so why does it feel like it is? As access to information increases outside academia, new skills, sources of expertise, and experience arise for students, faculty, and industry to tap. If the fossilization of curricula and behaviors within the academy persists, then other avenues of accessing engineering education will evolve. These may be divergent pathways driven by factors surrounding industry and workforce development.

Villanueva suggests considering a more holistic and integrated approach that seeks to actively engage students' families and social circles. No one is a stand-alone operation. Engineering needs to account for all of the variables impacting students. I wholeheartedly agree, and would add that by leveraging social capital and clarifying the schema for pathways for students (especially first-generation students), working engineers, educators, and other near peers can help connect the budding engineers to a network of potential support when the courses become challenging or the resources are not obvious. Not only would we begin to build capacity within underrepresented populations, but we also would enable the next-generation workforce to realize their dreams and help provide a community with some basic tools to mentor and support the ones they cherish and want to see succeed.

Monica Castañeda-Kessel
Research Program Manager
Oregon State University

MAKING GRADUATE FELLOWSHIPS MORE INCLUSIVE

In "Fifty Years of Strategies for Equal Access to Graduate Fellowships" (*Issues*, Fall 2023), Gisèle Muller-Parker and Jason Bourke suggest that examining the National Science Foundation's efforts to increase the representation of racially minoritized groups in science, technology, engineering, and mathematics "may offer useful lessons" to administrators at colleges and universities seeking to "broaden access and participation" in the aftermath of the US Supreme Court's 2023 decision limiting the use of race as a primary factor in student admissions.

Perhaps the most important takeaway from the authors' analysis—and that also aligns with the court's decision—is that *there are no shortcuts to achieving inclusion*. Despite its rejection of race as a category in the admissions process, the court's decision does not bar

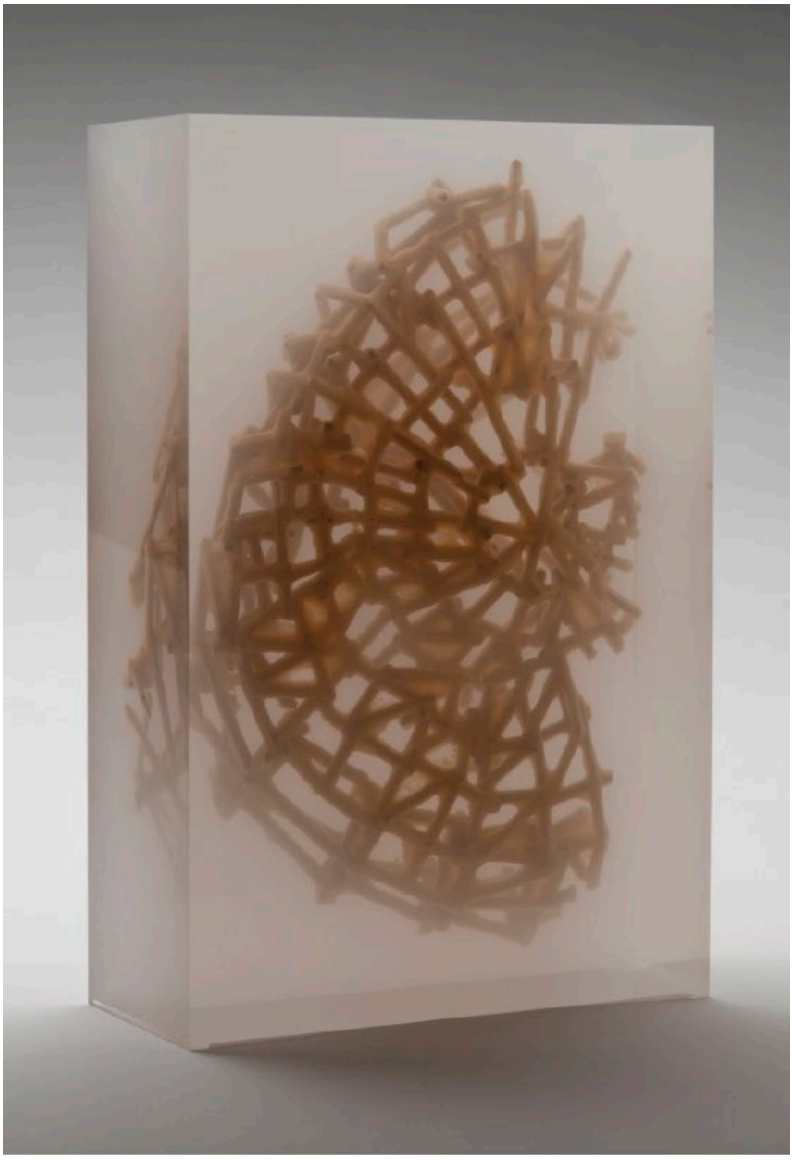
STEPHEN TALASNIK, *Glacier,* 2023, pine stick infrastructure with bamboo flat reed, 12 feet tall with a footprint of approximately 500 square feet.

universities from considering race on an individualized basis. Chief Justice John Roberts maintained that colleges can, for instance, constitutionally consider a student's racial identity and race-based experience, be it "discrimination, inspiration or otherwise," if aligned with a student's unique abilities and skills, such as "courage, determination" or "leadership"—all of which "must be tied to *that student's* unique ability to contribute to the university." This individualized approach to race implies a more qualitatively focused application and review process.

The NSF experience, as Muller-Parker and Bourke show, also underscores the significance of qualitative applications and review processes for achieving more inclusive outcomes. Despite the decline in fellowship awards to racially minoritized groups starting in 1999, when the foundation ended its initial race-targeted fellowships, the awards picked up and even surpassed previous levels of inclusion as the foundation shifted from numeric criteria to a holistic qualitative evaluation and review, for instance, by eliminating summary scores and GRE results and placing more importance on reference letters.

Importantly, the individualized approach to race will place additional burdens on students of color to effectively make their case for how race has uniquely qualified them and made them eligible for admission, and on administrators to reconceptualize, reimagine, and reorganize the admissions process as a whole. Students, particularly from underserved high schools, will need even more institutional help and clearer instructions when writing their college essays, to know how to tie race and their racial experience to their academic eligibility.

In the context of college admissions, enhancing equal access in race-neutral ways will require significant changes in reconceptualizing applicants—as *people* rather than numbers or categories—and in connecting student *access* more closely to student *participation*. This will require significant resources and organizational change: admissions' access goals would need to be closely integrated with participation goals of other offices such



STEPHEN TALASNIK, *Tunneling*, 2007–2008, wood in resin, 4 x 8 x 12 inches.

as student life, residence life, student careers, as well as with academic units. Universities would need to regularly conduct campus climate surveys, assessing not just the quantity of diverse students in the student body but also the quality of their experiences and the ways by which their inclusion enhances the quality of education provided by the university.

These holistic measures are easier said than done, especially among smaller teaching-centered or decentralized colleges and universities, and a measurable commitment to diversity will be even more patchy than is currently achieved across higher education, given the existence of numerous countervailing forces (political, social, financial) that differentially impact public and private institutions and vary significantly from state to state. However, as Justice Sotomayor wrote in closing in her dissenting opinion, "Although the court has stripped almost all uses of race in college admissions … universities can and should continue to use all available tools to meet society's needs for diversity in education." NSF's story provides some hope that this can be achieved if administrators are able and willing to reimagine (and not just obliterate) racial inclusion as a crucial goal for academic excellence.

Gwendoline Alphonso
Professor of Politics
Cochair, College of Arts and Sciences, Diversity, Equity and Inclusion Committee
Fairfield University

SHIFTS IN GLOBAL KNOWLEDGE PRODUCTION

In Australia, the quality and impact of research is built upon uncommonly high levels of international collaboration. Compared with the global average of almost 25% cited by Igor Martins and Sylvia Schwaag Serger, over 60% of Australian research now involves international collaboration. So the questions the authors raise in "An Age of Disentangled Research?" (*Issues*, Fall 2023) are essential for the future of Australian universities, research, and innovation.

While there are some early signs of "disentanglement" in Australian research—such as the recent mapping of a decline in collaboration with Chinese partners in projects funded by the Australian Research Council—the overall picture is still one of increasing international engagement. In 2022, Australian researchers coauthored more papers with Chinese colleagues than with American colleagues (but only just). This is the first time in Australian history that our major partner for collaborative research has been a country other than a Western military ally. But the fastest growth in Australia's international research collaboration over the past decade was actually with India, not China.

At the same time, the connection between research and national and economic security is being drawn more clearly. At a major symposium at the Australian Academy of Science in Canberra in November 2023, Australia's chief defense scientist talked about a "paradigm shift," where the definition of excellent science was changing from "working with the best in the world" to "working with the best in the world who share our values."

Navigating these shifts in global knowledge production, collaboration, and innovation is going to require new strategies and an improved evidence base to inform the decisions of individual researchers, institutions, and governments in real time. Martins and Schwaag Serger are asking critical questions and bringing better data to the table to help us answer them.

As a country with a relatively small population (producing 4% of the world's published research), Australia has succeeded over recent decades by being an open and multicultural trading nation, with high levels of international engagement, particularly in our Indo-Pacific region.

Increasing geostrategic competition is creating new risks for international research collaboration, and we need to manage these. In Australia in the past few years, universities and government agencies have established a joint task force for collaboration in addressing foreign interference, and there is also increased screening and government review of academic collaborations. But to balance the increased focus on the downsides of international research, we also need better evidence and analysis of the upsides—the benefits that accrue to Australia from being connected to the global cutting edge. While managing risk, we should also be alert to the risk of missing out.

Paul Harris
Executive Director, Innovative Research Universities
Canberra, Australia

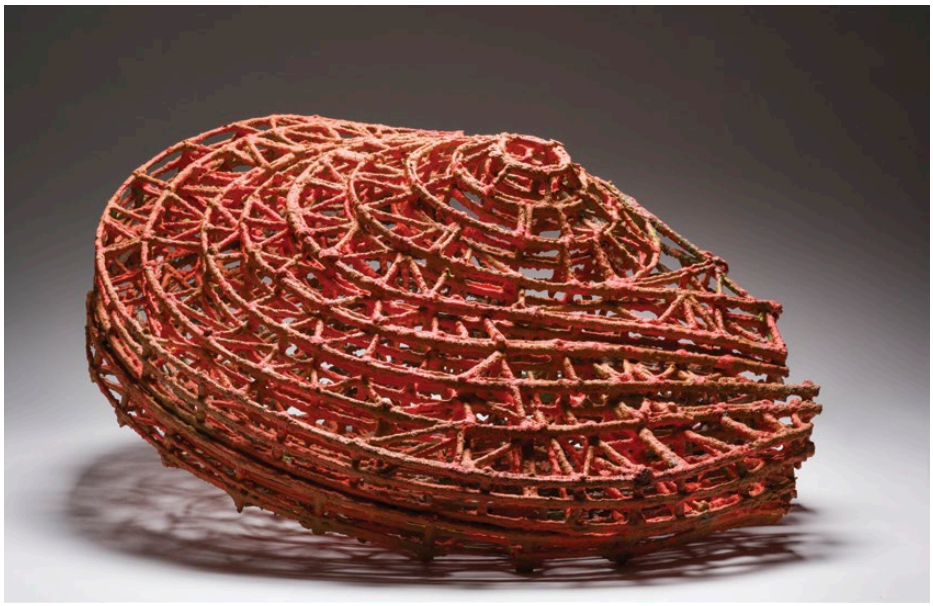
MEANINGFUL PUBLIC ENGAGEMENT

As Kevin Finneran noted in "Science Policy in the Spotlight" (*Issues*, Fall 2023), "In the mid-1950s, 88% of Americans held a favorable attitude toward science." But the story was even better back then. When the American National Election Study began in 1948 asking about trust in government, about three-quarters of people said they trusted the federal government to do the right thing almost always or most of the time (now under one-third and dropping, especially among Generation Z and millennials). Increasing public trust in science is important, but transforming new knowledge into societal impacts at scale will require much more. It will require meaningful public engagement and trust-building across the entire innovation cycle, from research and development to scale up, commercialization, and successful adoption and use. Public trust in this system can break down at any point, as the COVID-19 pandemic made painfully clear, robbing at least 20 million years of human life globally.

For over a decade, I had the opportunity to support dozens of focus groups and national surveys exploring public perceptions of scientific developments in areas such as nanotechnology, synthetic biology, cellular agriculture, and gene editing. Each of these exercises provided new insights and an appreciation for the often-maligned public mind. As the physicist Richard Feynman once noted, believing that "the average person is unintelligent is a very dangerous idea."

The exercises consistently found that when confronted with the emergence of novel technologies, people were very consistent regarding their concerns and demands. For instance, there was little support for halting scientific and technological progress, with some noting, "Continue to go forward, but please be careful." Being careful was often framed around three recurring themes.

First, there was a desire for increased transparency, from both government and businesses. Second, people often asked for more pre-market research



STEPHEN TALASNIK, *Leaning Globe*, 1998–2023, painted basswood with metallic pigment, 28 x 40 x 22 inches.

and risk assessment. In other words, don't test new technologies on us—but unfortunately this now seems the default business model for social media and generative artificial intelligence. People voiced valid concerns that long-term risks would be overlooked in the rush to move products into the marketplace, and there was confusion about who exactly was responsible for such assessments, if anybody. Finally, many echoed the need for independent, third-party verification of both the risks and the benefits of new technologies, driven by suspicions of industry self-regulation and decreased trust in government oversight.

Taken as a whole, these public concerns sound reasonable, but remain a heavy lift. There is, unfortunately, very little "public" in the nation's public policies, and we have entered an era where distrust is the default mode. Given this state of affairs, one should welcome the recent recommendations proposed to the White House by the President's Council of Advisors on Science and Technology: to "develop public policies that are informed by scientific understanding and community values [creating] a dialogue … with the American people." The question is whether these efforts go far enough and can occur fast enough to bend the trust curve back before the next pandemic, climate-related catastrophe, financial meltdown, geopolitical crisis, or arrival of artificial general intelligence.

David Rejeski
Visiting Scholar
Environmental Law Institute

AN EVOLVING NEED FOR TRUSTED INFORMATION

I read "Informing Decisionmakers in Real Time" (*Issues*, Fall 2023), by Robert Groves, Mary T. Bassett, Emily P. Backes, and Malvern Chiweshe, with great interest. It is hard to remember the early times of COVID-19, when everyone was desperate for answers, and questions popped up daily about what to do and what was right. As a former elected county official and former chair of a local board of health, I valued the welcome I received when appointed to the Societal Experts Action Network (SEAN) the authors highlight. I believe that as a nonacademic, I was able to bring a pragmatic on-the-ground perspective to the investigations and recommendations.

At the time, local leaders were dealing with a pressing need for scientific information when politics were becoming fraught with dissension and the public had reduced trust in science. Given such pressure, it is difficult to fully appreciate the speed at which SEAN operated—light speed compared with what I viewed as the usual standards of large organizations such as its parent, the National Academies of Sciences, Engineering, and Medicine. SEAN's efforts were nimble and focused, allowing us to collaborate while addressing massive amounts of data.

Now, the key to addressing the evolving need for trusted and reliable information, responsive to the modern world's speed, will be supporting and replicating the work of SEAN. Relationships across jurisdictions and institutions were formed that will continue to be imperative not only for ensuring academic rigor but also for understanding how to build the bridges of trust to support the value of science, to meet the need for resilience, and to provide the wherewithal to progress in the face of constant change.

Linda Langston
President, Langston Strategies Group
Former member of the Linn County, Iowa, Board of Supervisors
Supervisor and President, National Association of Counties

CONNECTING STEM WITH SOCIAL JUSTICE

Nilanjana Dasgupta's article, "To Make Science and Engineering More Diverse, Make Research Socially Relevant" (*Issues*, Fall 2023), inspired reflection on our approach at the Burroughs Wellcome Fund (BWF) to promoting diversity in science nationwide along with supporting science, technology, engineering, and mathematics education, specifically in North Carolina. These and other program efforts have reinforced our belief in the power of collaboration and partnership to create change.

For nearly 30 years, BWF has supported organizations across North Carolina that provide hands-on, inquiry-based activities for students outside the traditional classroom day. These programs offer a wide range of STEM experiences for students. Some of the students "tinker," which we consider a worthwhile way to experience the nuts-and-bolts of research, and others explore more socially relevant experiences. An early example is from a nonprofit in the city of Jacksonville, located near the state's eastern coast. In the program, the city converted an old wastewater treatment plant into an environmental education center where students researched requirements for reintroducing sturgeon and shellfish into the local bay. More than 1,000 students spent their Saturdays learning about environmental science and its application to improve the quality of water in the local watershed. The students engaged their families and communities in a dialogue about environmental awareness, civic responsibility, and local issues of substantial scientific and economic interest.

For our efforts in fostering diversity in science, we have focused primarily on early-career scientists. Our Postdoctoral Diversity Enrichment Program provides professional development support for underrepresented minority postdoctoral

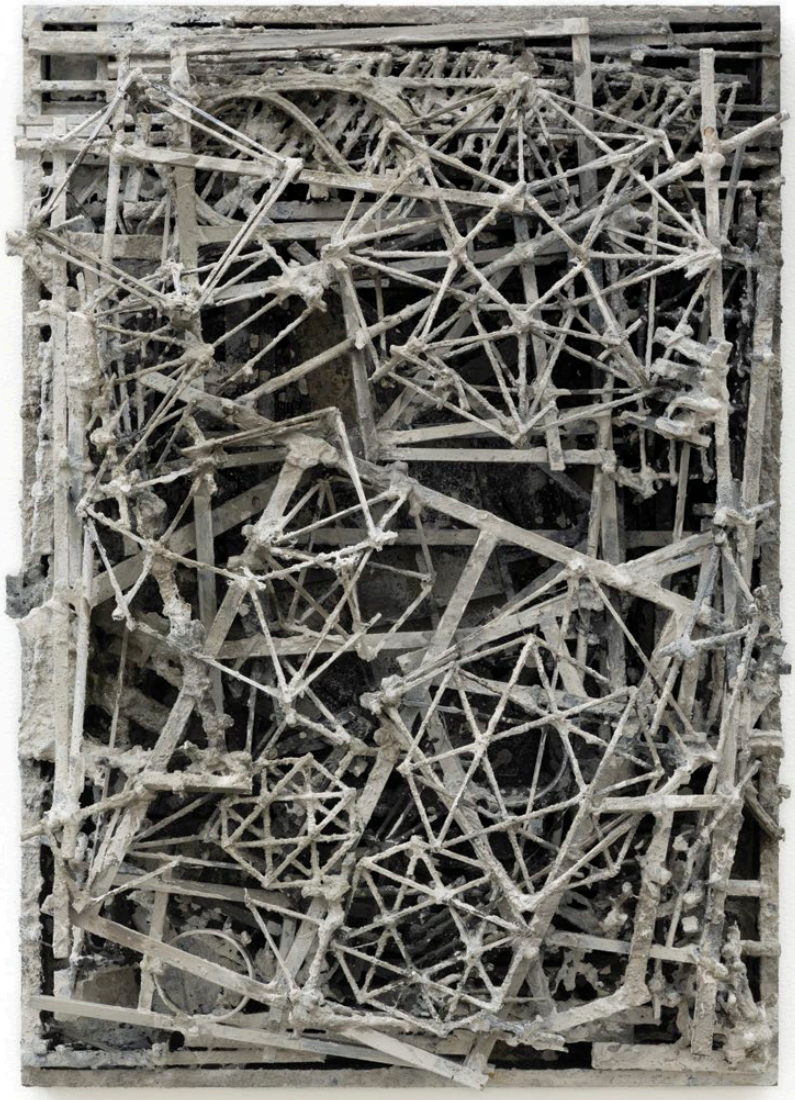
fellows. The program places emphasis on a strong mentoring strategy and provides opportunities for the fellows to engage with a growing network of scholars.

Recently, BWF has become active in the "civic science" movement led by the Rita Allen Foundation, which describes civic science as "broad engagement with science and evidence [that] helps to inform solutions to society's most pressing problems." This movement is very much in its early stages, but it holds immense possibility to connect STEM to social justice. We have supported fellows in science communication, diversity in science, and the interface of arts and science.

Another of our investments in this space is through the Our Future Is Science initiative, hosted by the Aspen Institute's Science & Society program. The initiative aims to equip young people to become leaders and innovators in pushing science toward improving the larger society. The program's goals include sparking curiosity and passion about the connection between science and social justice among youth and young adults who identify as Black, Indigenous, or people of color, as well as those who have low income or reside in rural communities. Another goal is to accelerate students' participation in the sciences to equip them to link their interests to tangible educational and career STEM opportunities that may ultimately impact their communities.

This is an area ripe for exploration, and I was pleased to read the author's amplification of this message. At the Burroughs Wellcome Fund, we welcome the opportunity to collaborate on connecting STEM and social justice work to ignite societal change. As a philanthropic organization, we strive to holistically connect the dots of STEM education, diversity in science, and scientific research.

Louis J. Muglia
President and CEO
Burroughs Wellcome Fund



STEPHEN TALASNIK, *House of Bones*, 2015–2023, wood and mica, 32 x 24 x 6 inches.

BUILDING THE QUANTUM WORKFORCE

In "Inviting Millions Into the Era of Quantum Technologies" (*Issues*, Fall 2023), Sean Dudley and Marisa Brazil convincingly argue that the lack of a prepared workforce is holding back this field from reaching its promising potential. We at IBM agree. Without intervention, the nation risks developing useful quantum computing alongside a scarcity of practitioners who are capable of using quantum computers. An IBM Institute for Business Value study found that inadequate skills is the top barrier to enterprises adopting quantum computing. The study identified a small subset of quantum-ready organizations that are talent nurturers with a greater understanding of the quantum skills gap, and that are nearly three times more effective than their cohorts at workforce development.

Quantum-ready organizations are nearly five times more effective at developing internal quantum skills, nearly twice as effective at attracting talented workers in science, technology, engineering, and mathematics, and nearly three times more effective at running internship programs. At IBM Quantum, we have directly trained more than 400 interns at all levels of higher education and have seen over 8 million learner interactions with Qiskit, including a series of online seminars on using the open-source Qiskit tool kit for useful quantum computing. However, quantum-ready organizations represent only a small fraction of the organizations and industries that need to prepare for the growth of their quantum workforce.

As we enter the era of quantum utility, meaning the ability for quantum computers to solve problems at a scale beyond brute-force classical simulation, we need a focused workforce capable of discovering the problems quantum computing is best-suited to solve. As we move even further toward the age of quantum-centric supercomputing, we will need a larger workforce capable of orchestrating quantum and classical computational resources in order to address domain-specific problems.

Looking to academia, we need more quantum-ready institutions that are effective not only at teaching advanced mathematics, quantum physics, and quantum algorithms, but also are effective at teaching domain-specific skills such as machine learning, chemistry, materials, or optimization, along with teaching how to utilize quantum computing as a tool for scientific discovery.

Critically, it is imperative to invest in talent early on. The data on physics PhDs granted by race and ethnicity in the United States paint a stark picture. Industry cannot wait until students have graduated and are knocking on company doors to begin developing a talent pipeline. IBM Quantum has made a significant investment in the IBM-HBCU Quantum Center through which we collaborate with more than two dozen historically Black colleges and universities to prepare talent for the quantum future.

Academia needs to become more effective in supporting quantum research (including cultivating student contributions) and partnering with industry, in connecting students into internships and career opportunities, and in attracting students into the field of quantum. Quoting Charles Tahan, director of the National Quantum Coordination Office within the White House Office of Science and Technology Policy: "We need to get quantum computing test beds that students can learn in at a thousand schools, not 20 schools."

Rensselaer Polytechnic Institute and IBM broke ground on the first IBM Quantum System One on a university campus in October 2023. This presents the RPI community with an unprecedented opportunity to learn and conduct research on a system powered by a utility-scale 127-qubit processor capable of tackling problems beyond the capabilities of classical computers. And as lead organizers of the Quantum Collaborative, Arizona State University—using IBM and other industry quantum computing resources—is working with other academic institutions to provide training and educational pathways across high schools and community colleges through to undergraduate and graduate studies in the field of quantum.

Our hope is that these actions will prove to be only part of a broader effort to build the quantum workforce that science, industry, and the nation will need in years to come.

Bradley Holt
IBM Quantum
Program Director, Global Skills Development

GETTING THE MOST FROM NEW ARPAS

The Fall 2023 *Issues* included three articles discussing several interesting dimensions of new civilian organizations modeled on the Advanced Research Projects Agency (ARPA) at the Department of Defense. One dimension that could use further elucidation starts with the observation that ARPAs are meant to deliver innovative technology to be utilized by some end customer. The stated mission of the original DARPA is to bridge between "fundamental discoveries and their military use." The mission of ARPA-H, the newest proposed formulation, is to "deliver … health solutions," presumably to the US population.

When an ARPA is extraordinarily successful, it delivers an entirely new capability that can be adopted by its end customer. For example, DARPA delivered precursor technology (and prototype demonstrations) for stealth aircraft and GPS. Both were very successfully adopted.

Such adoption requires that the new capability coexist or operate within the existing processes, systems, and perhaps even culture of the customer. Understanding the very real constraints on adoption is best achieved when the ARPA organization has accurate insight into specific, high-priority needs, as well as the operations or lifestyle, of the customer. This requires more than expertise in the relevant technology.

DARPA uses several mechanisms to attain that insight: technology-savvy military officers take assignments in DARPA, then return to their military branch; military departments partner on projects via co-funding; and often the military evaluates a DARPA prototype to determine effectiveness. These relations with the end customer are facilitated because DARPA is housed in the same department as its

military customer, the Department of Defense.

The health and energy ARPAs face a challenge: attaining comparable insight into their end customers. The Department of Health and Human Services does not deliver health solutions to the US population; the medical-industrial complex does. The Department of Energy does not deliver electric power or electrical appliances; the energy utilities and private industry do. ARPA-H and ARPA-E are organizationally removed from those end customers, both businesses (for profit or not) and the citizen consumer.

Technology advancement enables. But critical to innovating an adoptable solution is identification of the right problem, together with a clear understanding of the real-world constraints that will determine adoptability of the solution. Because civilian ARPAs are removed from many end customers, ARPAs would seem to need management processes and organizational structures that increase the probability of producing an adoptable solution from among the many alternative solutions that technology enables.

Anita Jones
Former Director of Defense
Research and Engineering
Department of Defense
University Professor Emerita
University of Virginia

In "How I Learned to Stop Worrying and Love Intelligible Failure" (*Issues*, Fall 2023), Adam Russell asks the important and provocative questions: With the growth of "ARPA-everything," what makes the model succeed, and when and why doesn't it? What is the secret of success for a new ARPA? Is it the mission? Is it the money? Is it the people? Is it the sponsorship? Or is it just dumb luck and then a virtuous cycle of building on early success?

I have had the privilege of a six-year term at the Department of Defense Advanced Research Projects Agency (DARPA), the forerunner of these new efforts, along with a couple of years helping to launch the Department of Homeland Security's HSARPA and then 15 years at the Bill & Melinda Gates Foundation running and partnering with international development-focused innovation programs. In the ARPA world, I have joined ongoing success, contributed to failure, and then helped launch new successful ARPA-like organizations in the international development domain.

During my time at the Gates Foundation, we frequently asked and explored with partners the question, what does it take for an organization to be truly good at identifying and nurturing new innovation? To answer, it is necessary to separate the process of finding, funding, and managing new innovations through proof-of-concept from the equally challenging task of taking a partially proven innovative new concept or product through development and implementation to achieve impact at scale. I tend to believe that Russell's "aliens" (described in his Prediction 6 about "Alienabling") are required for the early innovation management tasks, but I also believe that they are seldom well suited to the tasks of development and scaling. Experts are good at avoiding mistakes, but it is a different challenge to take a risk that is likely to fail and is in your own field of expertise, where you "should have known better" and where failure might be seen as a more direct reflection of your skills.

Adding my own predictions to the author's, here are some other things that it takes for an organization to be good at innovation. Some are obvious, such as having sufficient human capital and financial resources, along with operational flexibility. Others are more nuanced, including:

- An appetite for risk and a tolerance for failure.
- Patience. Having a willingness to bet on long timelines (and possibly the ability to celebrate success that was not intended and that you do not directly benefit from).
- Being involved with a network that provides deeper understanding of problems that need to be and are worth solving, and having an understanding of the landscape of potential solutions.
- Recognition as a trusted brand that attracts new talent, is valued as a partner in creating unusual new collaborations, and is known for careful handling of confidential information.
- Engaged and effective problem-solving in managing projects, and especially nimble oversight in managing the managers at an ARPA (whether that be congressional and administrative oversight in government or donor and board oversight in philanthropy).
- Parent organization engagement downstream in "making markets," or adding a "prize element" for success (and to accelerate impact).

To a large degree, these organizational attributes align well with many of Russell's predictions. But I will make one more prediction that is perhaps less welcome. A bit like Anna Karenina's view of happy and unhappy families, there are so many ways for a new ARPA to fail, but "happy ARPAs" likely share—and need—all of the attributes listed above.

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