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The Role of Institutional Leaders in Driving Lasting Change in the STEM Ecosystem

Understanding the ways that leadership generates change and accountability is essential to transform a system built upon historical inequities.

Access and excellence at the University of Texas at El Paso

In 1988, Diana Natalicio became president of the University of Texas at El Paso (UTEP), vowing to prioritize both access and excellence, so that the university, which then had one doctoral program and provided flexible pathways for admission, reflected the demographics of its larger community. Although her ambitions were criticized, Natalicio firmly believed that talent is everywhere. Over the course of three decades, she communicated this belief as a core value.

“One of the reasons I wanted to continue to serve as UTEP’s president is that lasting change takes time,” she said at her retirement in 2019. “I knew that in five years or 10 years, I wasn’t going to get done what needed to be done to achieve our goals of both access and excellence. We had to have doctoral programs. We had to have competitive faculty. We had to have laboratories and equipment and all the rest of it, which created for students to whom we offered admission the opportunity to succeed.”

By 2019, UTEP had achieved the Carnegie R1 designation of “very high research activity” while continuing to offer open admission—the only school among the 131 then in the category to do so. The school had also transformed to reflect its community: 84% of students and 30% of tenured faculty were Hispanic. At the same time, UTEP had achieved academic excellence. The school now has 24 doctoral programs, and it leads R1 universities in the percentage of science, technology, engineering, and mathematics graduate degrees awarded to Hispanic students. The university’s dual focus also paid off for students and the community. A prominent study placed UTEP in the top 10 colleges and universities in the country for social mobility, meaning that significant numbers of students coming from families with incomes in the bottom fifth of US households went on to earn salaries in the top fifth—at least \$110,000 per year.



Despite the success of exemplary public minority-serving institutions (MSIs) in broadening representation in science, technology, engineering, and mathematics (STEM) over the last 30 years, change at the national level has been disappointing. Hispanic, Black, American Indian, and Alaska Native people make up 37% of Americans aged 18 to 34, but they have received only 26% of the bachelor’s degrees in STEM. A recent National Academies of Sciences, Engineering, and Medicine (NAEM) consensus study report on advancing antiracism in STEM points to systemic barriers and racial bias as deeply entrenched impediments to bringing talented people from minoritized groups into STEM and enhancing their social mobility.

In 2018, to accelerate systemic change, the National Science Foundation (NSF) initiated the Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES) initiative, now named the Eddie Bernice Johnson INCLUDES Initiative. Challenging the United States to look beyond isolated programs to create change on a nationwide scale, this initiative aims to catalyze collaboration and build infrastructure to accelerate STEM participation and professional advancement of historically underrepresented groups such as African Americans, Hispanics, Native

Alaskans, Native Americans, Native Hawaiians, Pacific Islanders, persons with disabilities, women and girls, and persons from economically disadvantaged backgrounds.

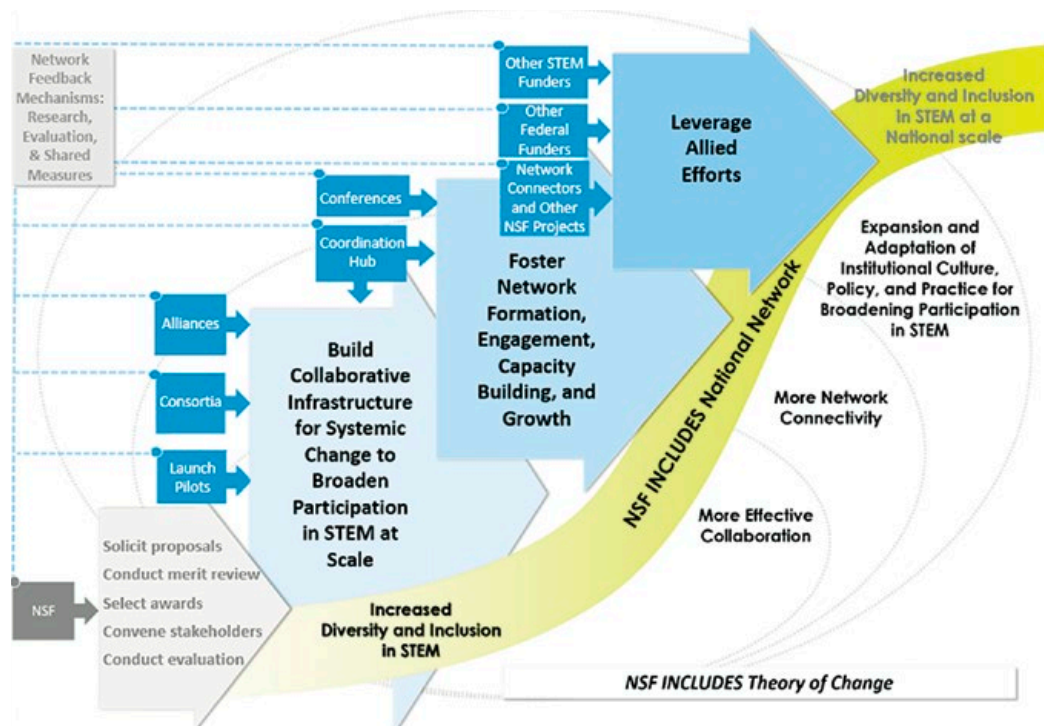
To date, INCLUDES has built a national network of stakeholders from various sectors, including educational institutions from K-12 through universities, community organizations, industry, nonprofit organizations, foundations, and government agencies, driven by common purpose. While the initiative has offered valuable lessons in this process, it is essential that higher education and industry leaders, government and private funders, and other decisionmakers tackle inefficiencies and take on reforms if INCLUDES is to reach its full potential.

By examining some of the exemplary practices of MSIs, as well as the theoretical underpinnings of the INCLUDES model, we have identified some concrete actions to maximize the impact of this initiative and others like it. We argue that revisiting theories of change, understanding the way STEM academic ecosystems work, and fully accounting for the role that leadership plays in driving change and accountability are all necessary to transform a system built upon historical inequities.

In addition, we posit that institutional leaders are key champions of inclusive practices, and it is mainly through

Illustration by Shonagh Rae

Figure 1: THE EDDIE BERNICE JOHNSON INCLUDES THEORY OF CHANGE



Source: NSF Program Solicitation (NSF 22-622).

years of these exemplars' intentional and strategic actions that individuals, including those from minoritized groups, enter STEM fields. Systemic change thus rests on organizational leaders in the STEM ecosystem who have a deep understanding of institutional and historical context. Episodic efforts, or those that are not coordinated, intentional, or mutually reinforcing, have not proven effective. To understand how leaders achieve success—and to build upon the INCLUDES model—requires revisiting how we use and frame theories of change guiding STEM ecosystem work.

Theories of change

The NSF Eddie Bernice Johnson INCLUDES Initiative is guided by the theory of change framework shown in Figure 1. In it, the large blue-gray arrows represent approaches to desired outcomes, which are depicted as paths under the gold wave. Careful examination of the figure reveals that the path toward increased STEM diversity and inclusion at the national scale involves building the collaborative infrastructure at the alliance level that is supported by the Coordination Hub and convenings to establish the INCLUDES National Network.

The diagram draws upon theories of change that focus on cultural and organizational shifts across a larger system with multiple inputs. This theory of change must also recognize the importance of sustained leadership to create, measure, and accelerate movements across organizational structures and emphasize the need for accountability of leadership regarding the success or failure of any part of the whole.

We argue that the ways systemic change happens and the roles of institutional leadership, historical context, and social and economic mobility in propelling change must be examined more closely. We have found inspiration in the work of Damon Williams, Joseph Berger, and Shederick McClendon, who have written extensively on how postsecondary institutions can “embrace a vision where educational excellence is fundamentally and inextricably connected to inclusion.” Their theory of instilling inclusive excellence through organizational structures emphasizes senior leadership and accountability. Thus, with a strong commitment to diversity, equity, inclusion, and accessibility (DEIA), leaders can involve administrators, faculty, staff, students, and other stakeholders in defining and implementing change while aligning bureaucratic structures and workplace norms to support desired reforms. In addition, leaders can hold themselves and the organization accountable by identifying measures of excellence to determine whether improvements in access, equity, and excellence are being achieved. Finally, over the course of time, leadership that is willing to evolve can stay the course even as times, and the institution itself, change.

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The Williams, Berger, and McClendon theory of change aligns with the idea of social transformation as outlined by Freeman Hrabowski, former University of Maryland, Baltimore County (UMBC) president, and Peter Henderson, a former director of the Board on Higher Education and Workforce at NASEM. During Hrabowski's three-decade tenure at UMBC, the commuter school became a first-class research institution and the country's top producer of Black undergraduates who go on to earn PhDs in STEM. Systemic change, write Hrabowski and Henderson, requires a multifaceted approach that emphasizes high expectations, strong community commitment, academic success, research experiences, financial support, and rigorous program assessment. This approach creates an empowering campus culture that encourages and champions minority student achievement within a broader institutional change process focusing on transforming campus culture to emphasize inclusion and excellence.

As Williams, Berger, and McClendon write, transformation of open-admission institutions requires finding new models: “Many of the traditional values, norms, and structures found in higher education are barriers to realizing the benefits of inclusive excellence and must be undone for these efforts to become a sustainable reality on campuses.” In this atmosphere, the onus of determining markers for access and excellence, as well as achieving them, falls upon leadership. Although there are a variety of ways to incentivize change, we believe that, ultimately, stakeholders—including those from industry, nonprofits, and governmental entities—must be held accountable. And, to transform current systems, funders must also be a part of this accountability.

Leadership's role in systemic change

We are not the first to argue that institutional leadership is central to accelerating change and that external interactions must be mutually informed. As the NASEM report *Transforming Trajectories for Women of Color in Tech* affirms, “Higher education leaders (e.g., presidents, provosts, and deans) set the tone for inclusion through their own behaviors and expectations.”

Inclusion involves changing the institution to welcome diverse students, rather than expecting them to assimilate to the school's existing conditions. When DEIA is supported for only the purposes of grantsmanship, diversity posturing, or performative inclusion, these initiatives may engender harm, particularly to historically marginalized communities. And, although checklists can serve as starting points, they do not lend themselves to the intentionality required to build meaningful partnerships among stakeholders.

By contrast, effective leaders work tirelessly to recognize, interrupt, and repair barriers to inclusivity, as education scholars Lorri Santamaria and Andrés Santamaria have written. In part, these leaders introduce equity to legacy systems by using historical contexts and quantitative data to inform decision-making, rather than relying solely on simplistic metrics of exclusivity, such as proportion of applicants admitted, which do not account for the complexity of inclusivity. "I think the story of US higher education is distorted by its focus primarily on the flagships and the Ivies," UTEP president Natalicio told a reporter from the *Texas Tribune* in 2013. What that story leaves out, she said, was "the kind of journeyman institutions that serve very large numbers of our population, particularly in urban areas" and have stories that are "so rich." Within the richness of UTEP's story was Natalicio's conviction that standard metrics did not adequately reflect the role of the school in the community.

When legislators refused to give funds to the university or critics said its low four-year graduation rates were a problem, Natalicio was willing to have difficult conversations, challenge what she saw as unfair, and endure backlash. She rejected the four-year graduation metric, insisting that other measures—such as the doubling of total graduates over a ten-year period—should be used to judge success in UTEP's student population. "Not all data are good, not all data are meaningful, and you can do a lot of things with data that will mislead people. Much more sophisticated analyses are required," she told the *Tribune*. As this example shows, systemic inequities are often reinforced by inappropriate or outdated measures of success, and effective leadership can articulate a moral vision that pushes back against such barriers, creating change both within and outside the institution.

The STEM inclusive excellence ecosystem

A further, and underappreciated, role for leadership comes in connecting and translating the mission of building inclusion outside of the institution itself through the STEM ecosystem. In particular, MSIs are positioned to play a significant part in driving change across the larger STEM community. In addition to producing STEM graduates, MSIs build research and infrastructure capacity critical to regional and national innovation in bolstering economic mobility.

With this in mind, efforts to improve the connectivity of the STEM ecosystem have become the focus for several current

Transformative engagement at North Carolina Agricultural and Technical State University

Under the leadership of Chancellor Harold Martin, North Carolina Agricultural and Technical State University (A&T) has become the nation's largest school among historically Black colleges and universities (HBCUs) and one of the three most productive public research universities in North Carolina. Martin, formerly chancellor of Winston-Salem State University, has boosted enrollment by 27% since he began his tenure at A&T in 2009, while doubling four-year graduation rates and raising six-year graduation rates from 44% to 57%. Research funding grew by 62% over the same period, and the school now boasts numerous new academic programs, including a PhD in applied science and technology with eight different concentrations and a PhD in agricultural and environmental sciences.

Martin is keenly aware of the historical significance of underfunding at land-grant HBCUs. A recent article in the *Greensboro News and Record* reported that he is expecting to see 2023's state budget "reflect an incremental closing of the gap" between funding for A&T and North Carolina State, the state's other land-grant university and a historically white, R1 institution, "based on his conversations with state leaders" and proposals to the governor. Some states, including North Carolina, provide extra money to universities with notable research strengths, which becomes a self-fulfilling prophecy since it is historically higher funding that has enabled them to build research capacity over the years. Martin's efforts focus on addressing both the equity issue and A&T's research classification. "Our students," he says, "deserve the same level of funding, irrespective of what level of institution ours is versus NC State." Closing the gap, he acknowledges, is "not going to happen all in one year, because it's big dollar amounts." But state leaders are now in support of A&T's plan to achieve R1 status, an effort that will benefit from the increased funding. "We have the capacity to be Research 1," he emphasizes, so "fund us at that level."

initiatives. A central aspiration of the Eddie Bernice Johnson INCLUDES Initiative is to create the INCLUDES National Network. The nodes of the network can be institutions of higher education, nonprofit organizations, governmental entities, companies or corporations, and other entities, and a node can also represent an alliance, which is itself a network. A similar conception of an inclusive STEM ecosystem is envisioned by the White House Office of Science and Technology Policy, which announced more than 90 initiatives from federal agencies, universities, industry, and philanthropies in 2022.

While changing the culture of a single institution requires careful attention and strategy, creating systemic change across an ecosystem is an extraordinarily complex, multifaceted effort involving multiple organizational structures as well as different norms and timelines. This scope of change requires multiple levels of understanding, involving individuals, groups, STEM organizations, and historical and societal context.

We envision an ecosystem centered on inclusive excellence, which we call an “inclusive excellence ecosystem.” Recalling the inclusive excellence framework that Williams, Berger, and McClendon have articulated, we posit that such an ecosystem,

At the institutional or micro level of an inclusive excellence ecosystem, leadership must use organizational structures to initiate and sustain the process of building new capacity, both for the institution and the students. This new capacity includes a holistic focus on curricular and co-curricular programs that prepare students who have the knowledge, skills, and abilities to thrive in a competitive workforce, but also provide opportunities to innovate and participate in developing user-inspired, translational solutions.

A further important role for leadership in DEIA work is creating policies and procedures to reward and recognize efforts to improve the preparation of individuals to flourish at their organizations. During President Natalicio’s tenure at UTEP, employees hired at any level (staff, faculty, and administration) were expected to understand the mission of the university and its culture of care; this expectation continues today. Natalicio led this messaging, which then became ingrained in and across the institution. In doing so, she positioned UTEP to sustain its core values long after she left.

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operating across varied contexts with a shared goal of driving change in the demographics of STEM, requires experienced leaders; mutually reinforcing partnerships; the involvement of local, regional, and national communities; crosscutting organizational structures and behavior (e.g., norms, consensus building, models of collegiality, defined core values) to support students; and the intentional development of future leaders. In addition to all of these components, the ecosystem must have processes and procedures, as it develops, for continuous refinement and improvement based on new knowledge gained.

At the macro level of an inclusive excellence ecosystem, leaders must bring a high level of contextual awareness to leverage their efforts across these interlocking organizations. High-functioning ecosystems are characterized by trust, knowledge- and resource-sharing, and mutual commitments to long-term investment horizons. Examining the larger landscape can reveal common interests and missions, but it also exposes differences and nuances. Higher education, professional associations, philanthropies, nonprofits, and industry stakeholders, for example, often operate in different time frames and under different measures of impact, which can make collaborations challenging. Awareness of this context at the leadership level is necessary to navigate systemic change within an ecosystem of partnerships and alliances.

Change requires that leaders assess norms and policies within their own organizations, departments, and teams. Simply identifying norms that are limiting change is not sufficient. Instead, internal processes and infrastructure must be adjusted and driven by leadership and action that recognize and reward inclusive and equitable practices.

Building inclusive STEM identities calls for far more than simply recruiting diverse students or educators, it requires building a culture where all team members are supported, heard, and respected. One of us (Payton) remembers entering a lab that was highly competitive, where the principal investigator (PI) pitted students against each other, effectively isolating them from one another: “I was not the norm and failed to fit into the mental model of who was a student in a tech discipline. I was often assumed to be on the ‘wrong’ floor of the building.” Experiences like these affect career trajectories by determining conference attendance, publication, and professional association engagement which bears on how the whole field thrives. As the NASEM report on antiracism in STEM underlines, gatekeepers, such as PIs and those in higher ranks, must be intentional about creating conditions to support positive team performance outcomes, reduce power asymmetries among team members, and reduce instances of interpersonal bias.

Partnerships and community: Southwestern Indian Polytechnic Institute

In March 2023, Tamarah Pfeiffer became the president of Southwestern Indian Polytechnic Institute (SIPI), a community college that first opened its doors in 1971. SIPI serves 466 students, has open admission, and embraces a mission to prepare “our culturally diverse Native American students as lifelong learners through partnerships with tribes, employers, and other organizations.”

As a leader, Pfeiffer has worked with, advocated for, and inspired Indigenous students for over 40 years, having served as acting president of Haskell Indian Nations University and chief academic officer at the US Bureau of Indian Education. Pfeiffer sees education as a springboard to prepare individual students for successful and prosperous careers to better contribute to the larger community. As she assumed her role at SIPI, Pfeiffer said, “My primary focus will be to build upon the college’s strengths from the perspective of a growth mindset. We must prioritize SIPI’s partnerships with surrounding Tribal communities, colleges, and universities, both public and private, so we can seamlessly transition SIPI students to four-year studies.”

SIPI plays a crucial role in providing more pathways, opportunities, and support for Native American students entering STEM fields. SIPI offers associate degrees and certificates in computer-aided drafting and design, geospatial information technology, natural resource management, and pre-engineering, along with liberal arts, business, and education. SIPI has reported retention rates for male and female engineering students combined of 44%, with a 67% rate for female engineering students alone.

Although SIPI’s graduation rates doubled between 2016 and 2019, in the aftermath of the COVID-19 pandemic, its graduation rates have fallen. The college’s strategic plan recognizes that “success is not a default outcome, but must be carefully and deliberately planned.” Systemic change requires being mindful of long-term outcomes, accounting for impactful events such as the pandemic, and not limiting measurement of success to a single metric, such as graduation rates.

Creating lasting change

Beyond the valuable lessons being learned from the Eddie Bernice Johnson INCLUDES Initiative, there are remaining issues that leaders must address to create long-standing change through the program. The areas that require a deeper look are the amount of time required to achieve lasting change, genuine partnerships that lead to mutually reinforcing activities, and reimagining the reward system for adopting or adapting shared resources. Leaders should give careful thought to the following recommendations to better support change across the STEM inclusive excellence ecosystem and beyond.

Recognize the value of leadership and longevity.

Systemic change requires leadership that is in place for decades to influence and build a campus climate of inclusive excellence. Natalicio was president of UTEP for 31 years; Martin has been chancellor of North Carolina A&T for 14 years and has significant time in the University of North Carolina system in a myriad of roles; and Pfeiffer brings extensive experiences to SIPI, with more than 40 years serving Indigenous students in higher education. A sense of embedded and inclusive excellence must be very deliberately created, so that it is not an artifact but an explicit part of educating and involving the whole individual at MSIs. Leaders are very important as storytellers who provide consistent messaging centered on the core mission and values of the institution.

Commit time and money to achieve change. Given the length of time required for systemic change, funders should prepare to support efforts at higher levels and for longer time frames. Systemic change is difficult to achieve in the five-year horizon specified for INCLUDES alliances. Furthermore, alliances often require more time because they are challenged by extra work to create the collaborative infrastructure needed to execute proposed activities.

An excellent example of farsighted planning in action is the \$1.5 billion Freeman Hrabowski Scholars Program, which the Howard Hughes Medical Institute (HHMI) launched in 2022. As described by *Inside Higher Education*, the program “will select 150 early-career scientists over the next decade, appointing 30 every other year.” Support for them is extensive: “Each selected scholar will receive \$8.6 million over a 10-year period, including full salary and benefits, a research budget, scientific equipment, mentorship training, and professional development. Scholars will be appointed to five-year terms with the possibility of renewal.” According to HHMI’s description, the program “advances diversity in academic science by supporting early career faculty with potential to become leaders in

their research fields and effective mentors of trainees from races and ethnicities currently underrepresented in US science.” By developing and investing in leaders over the long term, this program will inevitably bring changes to the wider ecosystem as they mature. Thus, its institution-centered programming will increase inclusivity while challenging organizational norms and practices.

Understand the history and context of MSIs to build research capacity. Stakeholders who seek to partner with MSIs need to recognize that each institution has a unique history and context, particularly as those characteristics persist in its infrastructure and assets. HBCUs, for example, were long denied access to federal funding for infrastructure and STEM research facilities that were made available to historically white land-grant universities. This inequity reduced HBCUs’ ability to access federal research funding and develop research capacity over time.

To build this research capacity, funders should shift from supporting participation or recruitment of individuals to broadening equity by, for example, funding development of up-to-date research infrastructure and facilities. This shift would address and support funding mechanisms that center on building research and institutional capacities at historically underfunded institutions. We contend that research capacity extends beyond a single scientific project. Rather, it includes investments in institutional research infrastructure (laboratories, data storage and retrieval systems, libraries, and talent), faculty development and ongoing support, external partnerships with other stakeholders including industry, and leadership succession at all levels across the institution.

Funders should also recognize that the effects of historical inequities can and do impact future projects. For example, industry-academia partnerships require a shift in the way “business as usual” is conducted, measured, and supported. As STEM project durations vary, so should definitions of impact, return-on-investment, and other key metrics.

Build initiatives on MSIs’ successes. Funders and stakeholders should build and improve on initiatives already in progress, putting MSIs in a position to lead partnerships. For example, the NSF Computer and Information Science and Engineering Minority-Serving Institutions (CISE-MSI) Research Expansion Program bolsters inclusion by working with existing federal agencies’ processes and structures. The CISE-MSI initiative involved years of community listening sessions and visioning workshops with HBCUs, Hispanic-serving institutions, and tribal colleges and universities, with the later addition of the American Society for Engineering Education. With this bottom-up development approach, the CISE-MSI program launched in 2020 with the intent of building systemic research capacity at MSIs rather than just counting who

participates. The question is not simply one of changing the capacities of MSIs; NSF program directors who are leading such efforts must be committed to advocating inside their agencies. With proper support infrastructure, MSIs are well poised to fully own their cocreation processes, and they have unique knowledge that can improve the ecosystem as a whole.

Build trust and mutual respect between partners. The CISE-MSI program demonstrates another fundamental principle: the importance of building relationships based on trust and mutual respect with MSIs, while putting MSIs in a position to lead core research pilot initiatives. Productive partnerships are based on a keen and well-communicated understanding of variances in timeline, impact, and vision of success, and trust is critical to navigating these complexities. Leaders at funding institutions must model how program officers and others can gain trust and establish relationships with MSIs. The program’s fundamental tenets include engagement with the community during initial stages of development, commitment to MSIs’ leading internal organizational and external stakeholder partnerships, and expansion to reinforce pilots to the fundamental core initiatives to support building research capacity. For example, one CISE-MSI project leverages partnerships with seven HBCUs and three national research laboratories to support artificial intelligence and cybersecurity research, with Hampton University serving as the lead principal investigator.

The Eddie Bernice Johnson INCLUDES National Network is in the early stages of driving systemic change. However, achieving its goals requires much more commitment and collective, intentional strategies and action across all sectors. Achieving the program’s goal of inclusive excellence across the United States will have benefits that go far beyond individual people, specific schools, or even whole communities; indeed, it promises to transform the outcomes of science itself. At the end of her long career, Congresswoman Eddie Bernice Johnson explained the far-reaching benefits of the vision she embedded in years of legislation as well as in the landmark CHIPS and Science Act: “Talent can be found anywhere, and we don’t want to miss that talent. We want to broaden opportunities, decentralize, so that inclusiveness can be felt in every part of the country. The more inclusion we have in science, the better outcomes we’ll get.”

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