“Talent and ideas are democratized in the sense that they are everywhere.”

Illustration by Shonagh Rae

National Science Foundation Director **Sethuraman Panchanathan** talks about his vision for the NSF, keeping the United States at the forefront of global science, and diversity as a driver of innovation.

National Science Foundation Director Sethuraman Panchanathan took the helm of the agency last summer in the midst of the pandemic, leaving behind his position as executive vice president of the Arizona State University Knowledge Enterprise, where he was also founder and director of the Center for Cognitive Ubiquitous Computing (CUbiC). *Issues in Science and Technology* editor William Kearney recently spoke with "Panch," as he's called, about his vision for NSF, keeping the United States at the forefront of global science, and diversity as a driver of innovation.

The federal health agencies got most of the public attention in the pandemic, but how has NSF fit into the US response to COVID-19?

Panchanathan: Good question. First, the fundamental tenet of NSF is supporting curiosity-driven, discovery-based exploratory research. But when you look at all the work NSF has done—in computing, biology, engineering, social and behavioral sciences, mathematical and physical sciences—you find that it all assists in solving the problems of this moment. So while the National Institutes of Health and the Centers for Disease Control and Prevention are rightly charged with addressing much of the immediate situation, let us not forget that NSF has laid the groundwork for us to bring scientific and engineering innovations to the forefront in delivering solutions to the pandemic.

Second, as soon as COVID hit, we immediately supported nonmedical research through our Rapid Response Research program and our Early-concept Grants for Exploratory Research (EAGER) program. This allowed us to quickly pivot and do things that are exceedingly important for this moment. We have added over 1,200 research awards totaling over $200 million, $75 million of which came from the federal CARES Act.

We also partnered with the Department of Energy and industry to develop the COVID-19 High Performance Computing Consortium to give COVID researchers access to powerful computing for pandemic modeling to help gain a better understanding of how the virus behaves and spreads. We established the Societal Experts Action Network (SEAN) to examine how the social and behavioral sciences can work seamlessly with other disciplines to advance understanding of pandemic impacts and empower policymakers with solutions. These are all things that we are accelerating to deliver solutions in the pandemic, but they are also linked to past NSF investments.

When I came to NSF, I wanted to start convening all these fantastic ideas around the umbrella of what I called resilience. How can NSF be much more proactive—and take a leadership role—around resilience to pandemics, resilience to natural hazards, resilience to economic disruptions, resilience to disruptions in education? How might we then configure ourselves around this resilience framework?

Beyond the pandemic, more broadly, how do you think about NSF's mission? How do you both advance science and serve society?

Panchanathan: If you look at Vannevar Bush's early thoughts, and at the mission statement of NSF, both mention three things—promote the progress of science; advance the national health, prosperity, and welfare; and secure the national defense. From that, you can understand the highly symbiotic relationship between fundamental advancement of science and engineering and advancements in technology and solutions that contribute to the advancement of society, national prosperity, and global competitiveness, all at the same time.

I have started to conceptualize this, in my own terminology, in the following way: if you look at the DNA of NSF, one strand is this curiosity-driven, discovery-based exploratory research. That is intertwined with another strand of use-inspired, solution-focused, translational research. These strands are highly synergistic, and that has been the DNA of NSF for all seven of its decades—but people don't realize this. People often look at just the one strand of exploratory research, which is very, very important. Research is the foundation of NSF (no pun intended), but that foundation has been leveraged and continues to be leveraged in multiple ways.

The NSF does genesis, but not just genesis alone. In fact, I would argue that curiosity-driven research inspires use-inspired research; use-inspired research, in turn, also inspires curiosity-driven research. It is not like a pipeline where you do basic research, then applied research, then start a company. That linear thing is not how it works; it's a highly symbiotic, synergistic relationship.

I'm curious how you think about innovation given your experience developing technologies to assist people with physical challenges as the founder of CUbiC at Arizona State University. What lessons did you learn there about how to spur innovation so that it is more than just a buzzword?

Panchanathan: First of all, you have to have an environment that promotes innovation, recognizes

innovation, rewards innovation; that environment—that you embed yourself in—is exceedingly important. The innovative spirit and mindset, I would argue, exists in all of us—and when we're faced with interesting situations, it expresses itself. It's important that we are intentional in investing in creating these innovative environments for students, whether it is K–12, undergraduates, or graduate students. We need to very deliberately create competitions, challenges, hackathons for students, grand challenges for researchers to work together on solving mega challenges, as well as empower individual researchers who are working on the next set of discoveries; it can be all of the above. In addition to serendipity, it's also intentionality and intensity that is required—and partnerships become a huge part of that. All this is required to bring out that innovative mindset that is inherent in all of us.

The most important ingredient, which I have saved for last, is that if you want to have a clearly innovative environment, you have to have diversity—diversity in every form and type: diversity of thought, diversity of experiences, diversity of cultures, diversity of ethnicities. When you have an environment that welcomes diverse perspectives and brings them all together, you find more creative solutions are brought to the table.

Let's talk more about diversity. I know one of the three pillars of your vision for NSF is ensuring accessibility and inclusivity. What do you mean by that and how do you achieve it?

Panchanathan: I want to return to the previous question about CUbiC. When I founded CUbiC, I wanted to make sure that the fundamental work in computer engineering, and the transdisciplinary inspirations we surrounded ourselves with, could help solve challenges and problems faced by humanity and society. I asked myself, how could we have talent that is not limited to people who have a certain background or type of ability, so that ideas are not limited? And I had a second question: how can technology become a companion to help unleash the inherent, latent ideas and talent in individuals with a range of abilities?

In working at CUbiC on those technologies, the people who devised the best, most innovative solutions were people who had a form of disability—because they understood the problem very well. Their life experiences made them think about the real solutions and concrete innovations that made a difference. For example, an assistive note-taker designed by a visually impaired student gave sighted students enhanced abilities to take notes as well. Diversity, therefore, is about not only bringing up the problems that people face in diverse situations, but also engaging them so that they become the creators and innovators who solve those problems.

To foster innovation you must welcome not only new ideas and new inspirations, but also problem domains that people have seen firsthand. All of that makes possible unbelievable innovations as we move into the future. Having watched people from a variety of socioeconomic and geographic backgrounds come into this melting pot of an ecosystem we had at CUbiC, I have seen firsthand that you are not defined solely by your grades during your K–12 experience. Rather, you are defined by the intellect, the innovative potential, and the creative mindset that you bring when you come into the university.

Global science leadership is not the mindset that we are leaders and others are followers. We lead by our scientific values of openness, transparency, reciprocity, respect for research integrity, respect for intellectual property.

There's nothing wrong with being an A+ student of course, but we shouldn't limit ourselves by judging everything through that lens.

In our nation right now, too many people are being left behind; they are not in a position to make fundamental contributions to make a better nation, a prosperous nation at the vanguard of global competitiveness. And we cannot have these disparities from one state to another, or urban versus rural. Talent and ideas are democratized in the sense that they are everywhere. It is our responsibility to create ecosystems that bring out that talent and those ideas in full force. NSF has been doing a good job launching a number of pilot projects on diversity, some of which, I believe, have produced unbelievable results. But they have to be scaled.

The tagline for my vision for NSF is strengthening at speed and scale, so that we unleash innovations that make our economy, our society, and humanity a much better place.

I am so grateful to this amazing country that gave me the opportunities and the fundamental spirit of meritocracy, which I cherish every day. I am where I am because of the way this country welcomes global talent. But global talent cannot be a substitute for domestic talent. We cannot afford

to have our domestic talent left behind; it's got to be brought to its full capacity, and then augmented with global talent. We need both of them functioning at full scale, so that we might compete with greater intensity than ever before—because our competition is now starting to make huge strides.

Are you worried about China in particular?

Panchanathan: Global science leadership is not the mindset that we are leaders and others are followers. We lead by our scientific values of openness, transparency, reciprocity, respect for research integrity, respect for intellectual property. Those partners who respect all this are truly our partners in advancing this global science imperative. And for big problems like climate change, we need global partnerships.

Do I worry about China? I spend more time thinking about how to stay at the vanguard of global science, and I think about it the following way: we need people to play by the rules; that's what I call a defensive posture. No question that we have to protect the ideas that we think are translatable into innovations and then into products, so we need intellectual property protection—we cannot be lax about that. At the same time, I'm thinking about how to balance a defensive posture with an offensive one. We cannot afford a defensive posture in fundamental research. We all know that in most areas of fundamental research global collaboration, competition, and cooperation is good. Since when has competition done anything other than bring out the best ideas, making us more innovative and challenging us?

That is why the United States is at the forefront, because we always step up to the challenge. We will partner with other federal agencies to protect our universities, but that must not slow us down.

In 2017 NSF launched its 10 Big Ideas to guide investments in bold, long-term, interdisciplinary research areas. How are the ideas progressing, and because they cut across all the NSF directorates, do you think any reorganization is needed to overcome silos that could inhibit the convergence that the ideas are intended to catalyze?

Panchanathan: Excellent question. I was on the National Science Board, chairing the committee on strategy, when the 10 Big Ideas were conceptualized, and I thought it was a fantastic idea. We're making great progress, but we have to be constantly looking for big ideas, big ideas, big ideas! That's the first point. Secondly, I have said that the foundation of my vision for NSF is partnership, and when you are talking about partnership, it starts at home. You might think of the NSF directorates as vertical pillars, verticals of unbelievable intellectual progress in all these various disciplines. But don't think of them just as discrete pillars; think of them overlapping with each other in a multidimensional space—that's the reality of NSF today.

Several horizontals cut across all the directorates. Take the work on artificial intelligence, for example; it involves all the directorates. Or look at the Education and Human Resources Directorate—you can think of it as a vertical, but to me the education component is a horizontal that cuts across every directorate. Efforts like the 10 Big Ideas and our Convergence Accelerator Program really bring together these interwoven, transdisciplinary concepts and make people want to collaborate even more. The culture inside the agency now is highly porous.

The Endless Frontier Act introduced in Congress last year would put an emphasis on the technical application of research at NSF by, among other things, creating a new Technology Directorate and even changing the name of the agency to the National Science and Technology Foundation. Does the act align with your vision for NSF?

Panchanathan: I cannot talk about pending legislation. But the concept of the Endless Frontier Act is no different from what you have heard me speaking about in this interview. This interwoven nature of NSF means that it is not necessarily one versus the other or one beside the other; we are talking about highly dynamic interactions. This is the twisted strand, the real DNA of NSF. Because there is no technology without science and there is no science without technology. That's why I'm thrilled by the concept of what this represents and the bipartisan support for science and technology that I see in my interactions with Congress. I can tell you there is complete bipartisan enthusiasm for making science and technology the platform for advancing our nation into the future and ensuring a robust society and economy.

What about at the other end of Pennsylvania Avenue? What have your early experiences been like dealing with the new Biden administration?

Panchanathan: Fantastic! I continue to have multiple meetings and we are in strong alignment on the need for science to move this country forward.