

Summary of the Public Meeting of the President's Council of Advisors on Science and Technology (PCAST) on Friday December 18, 2020

PCAST Members: Kelvin K. Droegemeier, Chair; Cathy Bessant; Shannon Blunt; Dorota Grejner-Brzezinska; Sharon Hrynkow; H. Fisk Johnson; Abraham Loeb; Theresa Mayer; Daniela Rus; A.N. Sreeram; Hussein Tawbi; Shane Wall; K. Birgitta Whaley

Students, Post-Doctoral Scholars, and Early Career Professionals (SPEC) Subcommittee Members: Isabel Agundis, Michelle Burbage, Bryan Changala, Dallas Elleman, Savannah Esteve, Katrina Ferrara, Kiyo Fujimoto, Cassandra Grimes, Pippin Payne, Emily Rinko

Date and Start Time: Friday December 18, 2020, 12:30 PM

Location: Virtual Meeting (Zoom)

PCAST Staff: Edward G. McGinnis, PCAST Executive Director and Designated Federal Officer; Sarah Domnitz, PCAST Deputy Executive Director

Invited Speakers: Michael Kratsios, Chief Technology Officer of the United States; Sethuraman Panchanathan, Director, National Science Foundation

AGENDA ITEM: WELCOME AND OPENING REMARKS

Dr. Kelvin K. Droegemeier, PCAST Chair and Director of the White House Office of Science and Technology Policy

Mr. Michael Kratsios, Chief Technology Officer of the United States

Mr. Edward G. McGinnis, PCAST Executive Director and Designated Federal Officer (DFO), officially opened the virtual meeting by welcoming attendees and describing the format of the meeting. McGinnis also explained that a summary of the meeting would be posted on the PCAST website that is maintained by the Department of Energy (DOE). He then turned the meeting over to PCAST Chair, Dr. Kelvin Droegemeier.

Droegemeier welcomed and thanked PCAST members, the National Science Board liaisons to PCAST, SPEC Subcommittee members, staff, and Federal colleagues. After reviewing the meeting agenda, Droegemeier introduced Mr. Michael Kratsios.

Kratsios thanked PCAST members for their work, specifically their contributions to the agenda for Industries of the Future (IoF). He noted that in the two years since the Quantum Initiative Act was signed in December 2018, many large-scale institutes have launched, such as Quantum Leap Institutes through the National Science Foundation (NSF), the Q-12 initiative, and more. Tremendous progress has been made solidifying into statute the IoF agenda. The first step was the signing of the Quantum Initiative Act followed by an Executive order on Artificial Intelligence (AI). Kratsios said he was hopeful the IoF Act and the National AI Act will become law as part of the National Defense Authorization Act.

Kratsios said key highlights of the IoF Act included a plan to increase the yearly Federal research and development (R&D) investment in IoF to \$10 billion by 2025 and the doubling of AI and quantum R&D

investment by 2022. If the AI Act becomes law, it will be renamed the National AI Initiative, codify the Select Committee on AI into law, and facilitate coordination of AI across Federal agencies for years to come. It would also include the AI Institutes Program at NSF.

Kratsios also noted the good work PCAST has done in its review of the Networking Information Technology Research and Development (NITRD) Program, which would be discussed later in the meeting. He then turned the meeting back over to Droegemeier.

Droegemeier thanked Kratsios for his work and then introduced Dr. Sethuraman Panchanathan.

**AGENDA ITEM: VISION FOR THE FUTURE OF THE NATIONAL SCIENCE FOUNDATION
Dr. Sethuraman Panchanathan, Director of the National Science Foundation**

Dr. Sethuraman Panchanathan thanked Droegemeier and Kratsios for their work and leadership, noting the synergy between PCAST's and the National Science Board's (NSB's) emphasis on how the Nation should move forward in science, engineering, and technology as well as stay competitive globally. He began his presentation by saying that he uses the phrase "Strengthening at speed and scale" to describe his plan for NSF's strategy for the future. He said that as the United States moves forward in science and technology (S&T), activity across the Nation must be energized, and the United States must position itself to be the vanguard of competitiveness globally.

Panchanathan said the three components of NSF's statutory mission are 1) promote the progress of science; 2) advance national health, prosperity, and welfare; and 3) secure national defense. With more than 70 years of history, NSF has been committed to funding high-risk, high-reward research that will ensure the United States continues to lead in innovative research. With this mission as framing, Panchanathan said he is now laying the foundation for NSF's work for the decades to come.

Panchanathan explained that NSF's vision can be distilled into three main pillars: 1) ensuring accessibility and inclusivity in science, regardless of locale or socioeconomic status; 2) maintaining global leadership in science; and 3) advancing the frontiers of research into the future. These pillars stand on a foundation of partnerships, with innovation as the thread woven throughout. Taken together, this vision captures the essence of what NSF is trying to do moving into the future, i.e., strengthening at speed and scale, Panchanathan said.

Beyond the challenges of COVID-19, this is a defining moment in American history that might be used to enable activation at speed and scale, Panchanathan said. Global competition is propelling the Nation to move with speed and scale. Further, the need to include the "missing millions" in the future of science is critical for realizing the mission. Last, he noted that there is unparalleled bipartisan support for advancing the Nation in science, technology, and engineering.

Building upon the 70 years of performance at NSF, Panchanathan stated that NSF is currently engaged across many areas of S&T, for example: curiosity-driven research; emerging opportunities, which can develop from challenges we face as a Nation; research centers that bring together academia, industry, and other entities; AI in all U.S. states, which currently includes seven NSF AI institutes that partner with industry; a national quantum platform; building resilience into the national fabric; biotech and bioeconomy and their effect on economies of the future; "learning everywhere" that can make education accessible for the "missing millions"; and empowering society to grow through advancement

and innovation at every level. To strengthen these areas at speed and scale, NSF is engaging in intra-agency and inter-agency partnerships as well as partnerships with industry, academic institutions, state and local governments, and non-profit foundations. Additionally, to strengthen emerging talent at speed and scale, Panchanathan said it will be necessary to understand what will inspire new generations, including the “missing millions.” To that end, increasing the number of graduate research fellows that are funded annually can be accomplished through Federal funding and funding from partnerships. He said he is also interested in how to work more successfully with Historically Black Colleges and Universities (HBCUs), tribal colleges and universities, Hispanic-serving institutions, and programs at community colleges.

Panchanathan explained that translating exploratory research into “rich outcomes” is also an important factor for strengthening at speed and scale. Elaborating on the concept that “knowledge leads to action,” he shared examples of NSF programs such as Innovation Corps; CyberCorps®: Scholarship for Service; and Civic Innovation Challenge that foster collaboration between academia and local communities. To strengthen at speed and scale, he said he is interested in developing incubating entities, akin to Bell Labs, in every region that address issues relevant to local communities.

In closing, Panchanathan stated that seven “threads”—outreach, the human element, strategic planning, infrastructure for the future, global leadership, data and analytics, and innovation—hold NSF’s vision together while exploration and translation are the DNA that will propel NSF forward to strengthen at speed and scale.

Droegemeier thanked Panchanathan for his presentation and for his leadership. He noted that a previous meeting between PCAST and NSB was very productive because, even though they have different missions, they share the same goal. Droegemeier also highlighted that working with the NSB liaisons on PCAST reports and planning activities has helped both organizations. Further, he expressed his hope that this collaboration between PCAST and NSB, which began under the Trump Administration, will continue going forward because of the significant role both NSB and PCAST play in the science and engineering research and education enterprise domestically and internationally. Droegemeier then opened the meeting up for discussion.

Discussion

Dr. A.N. Sreeram asked whether NSF could foster more partnerships with all aspects of manufacturing, from infrastructure like steam, cement, and concrete to silicon processing. Panchanathan explained that his presentation did not cover the breadth of interest in terms of manufacturing but that NSF will be looking at every sector, and he will reach out to Sreeram for more input on this topic.

Dr. Abraham Loeb asked Panchanathan how NSF plans to overcome funding challenges for “blue sky” research. Panchanathan stated that blue sky research will not be marginalized, and more resources will be focused on high-risk activities and research. Droegemeier concurred, noting that the annual priorities memo from the Office of Management and Budget and the Office of Science and Technology Policy highlighted the importance of high-risk and high-impact research and that future generations must be inspired to think even bigger than previous generations.

Dr. Sharon Hrynkow asked if NSF is working with developing countries. Panchanathan replied that a recent meeting of the Global Research Council—which includes countries with a range of research

budget sizes—looked at bringing in additional countries that are not on the frontlines of R&D so as to encourage and enable research in more parts of the world.

Dr. Hussein Tawbi asked how NSF will inject speed and scale into the translation aspect of research and connect with those more directly working on societal challenges to fuel reverse translation.

Panchanathan stated that the NSF Office of the Director has a new position that is a special advisor for the translation, innovation, and partnership portfolio. This person's role is to review translational programs across NSF and determine how to introduce new programs, scale and morph current programs at speed, and leverage resources—human resources and financial resources—to have a seamless flow between all of the R&D sectors.

Ms. Cathy Bessant inquired about how NSF and NSB are working to advance the science underlying protecting the United States, particularly as it pertains to technology. Panchanathan stated that NSF plays a significant role in the government-wide effort to promote national security, including partnering with other Federal agencies that are more directly involved in national security.

Dr. Daniela Rus asked Panchanathan to share his vision for how to advance basic science research across disciplines and connect these issues through translation. Panchanathan explained that NSF is focused on increasing the synergy between translational and exploratory research. Further, he stated that resources will be forthcoming due to the national mood that regards growth as essential.

AGENDA ITEM: REPORT ON IOTF INSTITUTES

Dr. Theresa Mayer, PCAST Member

Dr. Dorota Grejner-Brzezinska, PCAST Member

Ms. Emily Rinko, SPEC Subcommittee Member

Dr. Theresa Mayer began by framing an imperative for a new model of American S&T leadership focused on AI, quantum information science, advanced manufacturing, biotechnology, and advanced communications networks—collectively known as lotF.

Mayer explained that despite a longstanding role as a global leader in S&T, American leadership in S&T is being challenged by rising international competition as well as national challenges. With this in mind, PCAST issued the report *Recommendations for Strengthening American Leadership in Industries of the Future* in June 2020. The report reframed these challenges as opportunities and proposed a new paradigm for multi-sector collaboration in the form of lotF Institutes (lotFIs) to strengthen American S&T leadership for decades to come. Since then, PCAST has developed additional input on the proposed lotFIs to serve as preliminary guidance that funders might consider and discussion points for those who may wish to participate. The lotFI model aims to address challenges facing the American S&T enterprise by 1) realizing the full potential of multi-sector engagement; 2) developing and expanding the future science, technology, engineering, and math (STEM) workforce through education, diversity, and inclusion; and 3) investing and leading the way in foundational research that is often considered to be high risk (also referred to as basic research). Foundational research is essential for fostering innovation, sustaining American S&T leadership, improving quality of life, and ensuring future economic security. Further, the vision, mission, and values of the lotFIs would demonstrate a commitment to building a diverse, inclusive, and interdisciplinary community to address S&T challenges and opportunities for the benefit of all Americans.

The key goals of lotFIs would be to:

- Accelerate knowledge advancement through multi-disciplinary, multi-sector, and multi-generational collaborations across the research spectrum, from foundational research to market deployment.
- Cultivate an environment that promotes free-flowing intellectual inquiry and fosters creativity to address societal challenges.
- Design and implement frameworks for the rapid development and deployment of technological innovations.
- Shape future scientists, engineers, and technologists by engaging students and STEM educators.
- Design and offer in-person and virtual educational and experience-based learning programs.
- Contribute to frameworks, policies, and practices for responsible, ethical, and equitable design and use of technologies of the future.

Mayer explained that achieving these goals requires a model that reaches beyond existing R&D organizations and that has minimal administrative burden and regulatory processes. Further, the model must leverage the synergy of multiple lotF fields, have operational and management agility, and allow researchers to shift focus easily. Other key elements include involving all sectors as integral partners and utilizing diverse funding sources beyond Federal support while having a simple, customizable, flexible, and reasonable intellectual property (IP) framework. Mayer stated that lotFIs would be unique because they would have core partners from each sector and activities that span the entire innovation spectrum. She then turned the presentation over to Dr. Dorota Grejner-Brzezinska.

Grejner-Brzezinska reviewed the proposed governance and operational management of lotFIs, each of which would have their own organizational structure, a lean leadership structure, and balanced partnership between the participating organizations and R&D sectors. Also, there would be a National lotFI Office to enable and facilitate cross-fertilization and synergy among the lotFIs. While prioritizing diversity and the recruitment of both domestic and international talent, personnel and staffing would include individuals from multiple disciplines, sectors, and backgrounds and span all career stages. They would be given the flexibility to move seamlessly between their home institution and the lotFI. In addition, it would be important that lotFIs compensate interns, students, and fellows sufficiently to enable participation regardless of individual socioeconomic status. Grejner-Brzezinska then turned the presentation over to SPEC member, Ms. Emily Rinko.

Rinko stated that SPEC members are eager to have opportunities for mentorship woven throughout their education and career. Fortunately, she said, lotFIs would provide a unique mentorship experience, due to having multi-sector, cross-disciplinary, and multi-generational participants. Rinko noted that research has shown mentorship plays a role in retaining students in STEM fields. Mentorship is also linked to increased job satisfaction, career success, organizational commitment, and higher job performance for mentors. For these reasons, it is critical that protected time for mentoring be built into lotFIs from the start and that mentees have the option to choose their mentor(s). Rinko then turned the presentation over to Grejner-Brzezinska.

Grejner-Brzezinska stated that lotFIs, designed to carry out an innovative research agenda, would provide education, training and professional development opportunities to all members at every career stage and organizational level. Further, lotFIs would support local communities with outreach and inclusion efforts.

The most appropriate business structure for the lotFIs may be Limited Liability Corporations (LLCs), which would provide flexibility for financial support and potential business income, Grejner-Brzezinska said. Most likely, multiple Federal agencies would provide seed funding while the bulk of funding for the long term would come from participating organizations. It is expected that funding profiles would be tailored to each lotFI's focus. She added that the lotFIs would also be able to choose to set up separate but parallel 501(c)(3) charitable foundations.

Grejner-Brzezinska said PCAST gave special attention to IP management and recommended lotFIs establish an IP master agreement framework to allow for innovative methods for participation and contribution. PCAST also recommended that IP protection for AI-related assets be enhanced while also ensuring that information and capabilities could be shared easily. For example, a neutral third party could manage and protect complex data sets.

Grejner-Brzezinska explained that program evaluation and success should be based on whether the lotFIs generate new knowledge and practical deployment of technology benefitting all Americans, while also having a low administrative burden so researchers' time can be focused on conducting research. Further, PCAST recommended that lotFIs develop a 10-year strategic plan and a bi-annual business plan.

In closing, Grejner-Brzezinska stated that PCAST believes lotFIs could fill important gaps in the U.S. R&D landscape and serve as a proving ground for new approaches to governance, operational management, IP management, and innovative research. Grejner-Brzezinska noted that the framework PCAST is putting forward is meant to be broad and inspirational. To advance this innovative concept, PCAST recommended obtaining input from the research community and any others who could be potential participants. She then turned the meeting back to Droegemeier who thanked the presenters and stated that much more detail is available in the report. He also thanked the NSB liaisons who contributed to the report's development.

Discussion

Droegemeier opened the meeting up for discussion. Sreeram said that lotFIs would be concerned about driving success for all of the innovation sectors (e.g., academia, industry, National and Federal laboratories, and non-profit organizations), which would require flexibility and customization. Droegemeier added that lotFIs would be a solution for the overlapping themes of lotFs. Rus concurred and explained that lotFIs would accelerate the development of new knowledge, business innovation, and the translation of ideas. They also would enable new public-private partnerships and create a space to develop a framework for responsible and equitable use of technology and training programs.

Dr. Shannon Blunt stated that the Bell Labs model provides a way to spur intellectual collaboration for reverse translation and that feedback is critical for that process. Droegemeier commented that while it is often difficult to work across sectors, lotFIs would provide a way for people to move outside the traditional administrative framework. He also commented that although institutions generally train their students to be professors, the lotFI framework seeks to expose students to careers beyond academia. Loeb added that bringing the lotFI participants together would allow for generation of new ideas and expose leaders to cutting edge research opportunities, which has been missing between academia and the private sector. Tawbi noted that the presenters did a wonderful job in relaying the spirit of innovation, careful listening, and dedication lotFIs would bring to knocking down barriers.

Hrynkow commented on the role lotFIs would play in supporting workers that need upskilling or reskilling to work in STEM. Rinko reiterated the importance of protected time for mentorship and stated her appreciation for the report's recognition of financial barriers for student involvement in STEM. Droegemeier added that mentoring the mentors at lotFIs would be needed so they understand the value of mentoring.

Droegemeier said that a certificate and letter of thanks would be sent to all SPEC members to show their value to PCAST.

Vote

Droegemeier called for a vote, noting the report would be subject to copyediting. [*The report was unanimously approved.*]

Droegemeier said the meeting will go to a break, and McGinnis—in his capacity as DFO—will reopen the meeting at 2:45 PM.

At 2:25 PM, the meeting recessed for a break and reconvened at 2:45 PM.

McGinnis reopened the meeting and introduced Mr. Shane Wall.

AGENDA ITEM: NETWORKING AND INFORMATION TECHNOLOGY RESEARCH AND DEVELOPMENT (NITRD) PROGRAM ASSESSMENT

Mr. Shane Wall, PCAST Member and NITRD Assessment Lead

Mr. Shane Wall stated that networking and information technology (NIT) in the United States is supported through the NITRD Program, which was established by the passage of the High-Performance Computing Act of 1991, with the intent of coordinating all Federal R&D efforts, minimizing duplication, and sharing best practices. The Next-Generation Internet Research Act requires periodic evaluations of NITRD by an advisory committee; since 2005, PCAST has filled this role.

The NITRD Program consists of the NITRD Subcommittee of the National Science and Technology Council, interagency working groups (IWGs), and the NITRD National Coordination Office. PCAST's assessment of the NITRD Program included reviewing all three of these program components. The resulting NITRD assessment report was organized into the following sections: overview, program efforts since PCAST's last review in 2015, emerging NIT trends relevant to the NITRD Program, and findings and recommendations for the NITRD Program.

Wall described the five recommendations that PCAST developed based on their evaluation:

1. NITRD Program Overall Effectiveness: The NITRD Program should continue as constituted, with a few modifications. For example, program component areas (PCAs) (i.e., topical groupings that convey budget information) and IWGs should continue to be reviewed regularly, but perhaps at least every three years—rather than the current 5 to 6 year timeframe—due to the rapid evolution of NIT. In addition, when the NITRD Program launches new IWGs and PCAs, the history should be shown for how a new IWG or PCA derives from elements of older IWGs or PCAs.

2. Emerging Trend – Multi-sector Partnerships: The NITRD Program should identify opportunities for greater multi-sector engagement in its activities (e.g., amplify multi-sector outreach and engagement efforts) and do more to track and engage with international efforts that are similar to the NITRD Program.
3. Emerging Trend – IoT: The NITRD Program should identify opportunities for improving coordination in IoT areas related to NIT R&D.
4. Emerging Trend – Microelectronics: The NITRD Program should incorporate microelectronics R&D explicitly into its coordination activities through new or existing IWGs and include stronger coordination between the NITRD Program and the National Nanotechnology Initiative.
5. Emerging Trend – NIT-related Workforce and Training: The NITRD Program should further examine how it can facilitate coordination among its participating agencies to support STEM education and programs at the intersection of computational science and other fields, retraining and upskilling the non-technical workforce, diversity and inclusivity, and efforts to attract international talent.

In closing, Wall thanked the staff at the IDA Science and Technology Policy Institute for their assistance in developing the report. He then turned the meeting over to McGinnis.

Discussion

McGinnis thanked Wall for his presentation and turned the meeting over to Droegemeier who had rejoined the meeting via phone. Droegemeier opened the meeting up for discussion.

Blunt noted the importance of the discussion of wireless spectrum in the NITRD assessment report, which may come to the forefront of what the NITRD Program will have to address in the future. Wall concurred. Rus added that she appreciated that the report identified new areas of activity that the NITRD Program should address, rather than solely evaluating what the NITRD Program has done in the past.

Vote

Droegemeier called for a motion to approve the report. [*The report was unanimously approved.*]

AGENDA ITEM: REFLECTIONS ON SPEC SUBCOMMITTEE

Droegemeier explained that PCAST had created a subcommittee—known as “SPEC”—consisting of 10 individuals at various early stages of their scientific careers. This had never been done by PCAST before. He stated that SPEC members had contributed greatly to the work of PCAST and asked PCAST and SPEC members to reflect on the subcommittee’s contributions.

Rinko (SPEC co-chair) stated that she had learned a great deal working with experts to strengthen policy. Hrynkow (SPEC co-chair) thanked Droegemeier and his team for developing SPEC and acknowledged the significant contribution SPEC made to PCAST’s work.

Ms. Isabel Agundis noted how much she learned about policy as a SPEC member. Dr. Michelle Burbage highlighted her positive experience as a member of SPEC. Dr. Bryan Changala thanked the co-chairs for ensuring that everyone's input was respected and included. He noted that PCAST is working not just for, but also with, students and young scientists. Ms. Savannah Esteve appreciated the adaptability of the team and the opportunity to serve on SPEC. She also noted her growing interest in public policy as a result of being a member of SPEC. Dr. Katrina Ferrara expressed her gratitude for including the voice of SPEC members in the reports. Ms. Kiyo Fujimoto concurred, adding that the mentorship gave her meaningful opportunities outside of the lab. Dr. Cassandra Grimes echoed the gratitude shared by her fellow members of SPEC and added that the SPEC concept is an incredible platform for students. Mr. Pippin Payne appreciated the platform as well. Mr. Dallas Elleman agreed with his colleagues, adding that because of his involvement in SPEC, he will pursue AI for his graduate work.

Hrynkow invited PCAST members to provide their thoughts on SPEC. Bessant praised the concept of SPEC and the energy and unbridled creativity of the subcommittee. Loeb congratulated SPEC members and asked them about their concerns regarding academia post-COVID-19. Esteve stated she sees opportunities to grow the workforce with the shift toward online learning, which is becoming more accessible and affordable. Elleman concurred. Payne added that he thinks student debt—rather than COVID-19—is the real obstacle to learning. He added that he believes online learning may encourage entrepreneurship. Tawbi noted that New York University is going to start covering tuition for those who attend its medical school, which would be a great model for higher education in general. He added that the recommendations from SPEC on mentorship are incredibly important and give a voice to STEM professionals who have been frustrated by not having enough protected time to provide mentorship. Rus wished SPEC members great success and asked them how their personal experience on SPEC can be multiplied. Rinke stated that she has become more active in relevant professional societies and setting an example of involvement.

Droegemeier stated that beyond changing the direction of research in the United States, he is committed to shaping the lives of the next generation and including them in leadership. He thanked SPEC members, adding that he was heartened by their involvement and passion.

AGENDA ITEM: PUBLIC COMMENT

McGinnis opened the public comment session; as there were no comments from the public, he advanced to the next agenda item.

AGENDA ITEM: SUMMARY AND CLOSING REMARKS

Dr. Kelvin K. Droegemeier

Droegemeier thanked everyone for their work and stated that PCAST's contribution will endure. McGinnis added that the reports discussed during the meeting and the meeting minutes will be available in the coming weeks on PCAST's website hosted by the Department of Energy.

The meeting adjourned at 3:52 PM.