NSB-2022-30
December 1, 2022

APPROVED MINUTES
PLENARY OPEN SESSION
480TH MEETING
NATIONAL SCIENCE BOARD

National Science Foundation (NSF)
Via Videoconference
August 3 - 4, 2022

Members Present:

Dan Reed, *NSB Chair*
Victor McCrary, *NSB Vice Chair*
Sudarsanam Babu
Roger Beachy
Maureen Condic
Aaron Dominguez
Suresh Garimella
Darío Gil
Melvyn Huff
Steven Leath
Matthew Malkan
Julia Phillips
Scott Stanley
S. Alan Stern
Stephen Willard
Heather Wilson

Members Absent:

Consultants Present:

Arthur Bienenstock
W. Carl Lineberger
Emilio Moran
Anneila Sargent

Sethuraman Panchanathan, *ex officio*

There being a quorum, the National Science Board (NSB, Board) convened in Open Plenary Session at 1:00 p.m. EDT on Wednesday, August 3, 2022, in person and via videoconference with NSB Chair, Dan Reed, presiding.

NSB Chair's Opening Remarks

Dan Reed welcomed all Board Members, staff and guests to NSB's 480th meeting. Reed highlighted that both he and Vice Chair Victor McCrary had spent time since the last meeting in May talking to NSB Members and members of Congress and working with the NSF Director and staff. He noted that the CHIPS and Science Act passed and acknowledged the work and supporting roles of the Director and Darío Gil.

Reed outlined the work before the Board including thinking about how to translate appropriations into execution of the Board's Vision 2030 and how to increase the bandwidth of communication between the Board and NSF, in terms of simplifying and streamlining some processes. He concluded his remarks by highlighting his goal of robust and thoughtful dialogue between the Board and NSF on important issues.

NSF Director's Remarks

Director Sethuraman Panchanathan summarized updates and some of NSF's efforts since the May Board meeting including the passing of the *CHIPS and Science Act* which authorizes $81 billion over five years, codifies the Technology, Innovation, and Partnerships (TIP) directorate, and authorizes new activities.

He outlined examples of NSF awards to programs in support of NSF's three major priorities, strengthening established NSF, inspiring the missing millions, and accelerating technology and innovation. The Director shared a video of a student who at one point during her studies, considered leaving her field of study due to a lack of funding but for the NSF Graduate Research Fellowship Program that allowed her to complete her Ph.D. She is currently an NSF astronomy and astrophysics postdoctoral fellow at the Institute for Advanced Study and for the last seven years she has been a member of the consortium that imaged the blackhole at the center of our Milky Way galaxy.

Panchanathan pivoted to presenting examples of early NSF investments and resulting impacts in the form of transfer of technology or in the form of incubation of companies. Along the lines of accelerating technology innovation, the Director talked about a new program under the TIP directorate, Regional Innovation Engines (RIE) to advance use inspired research, entrepreneurship, and workforce development to nurture and accelerate regional industries, promoting a transformational revolution of businesses and growth regionally and nationally. He explained that NSF has undertaken a new approach whereby regional teams are asked to share their NSF Engines ideas, in the form of a concept outline, before formally submitting a letter of intent and a full proposal. As of this meeting, NSF published nearly 700 concept outlines spanning all 50 states and four U.S. territories.

The Director announced that NSF recently signed a memorandum of understanding with the Department of Energy's Office of Energy Efficiency and Renewable Energy to help bolster national energy policy. The partnership prioritizes the workers and communities on the frontlines of the areas most impacted by energy transition and those historically underserved by our energy system. He also announced NSF's joint investment with the U.S. Department of Commerce,

National Institute of Standards and Technology (NIST) of $7.6 million for 20 new projects to help build community and infrastructure resilience to natural hazards.

Cool Science
Assistant Directors Joanne Tornow, Directorate for Biological Sciences (BIO), Margaret Martonosi, Directorate for Computer and Information Science and Engineering, and Kendra Sharp, the Office of International Science and Engineering presented examples of NSF-funded research and impacts. Tornow focused on research addressing the challenge of how organisms interact with each other and their environments, specifically research into biomechanics and physical limitations of ultra-fast organisms. Tornow explained that the research could lead to the design of prosthetics that mimic the broad functionality of the human hand and offers promise in creation of bio-inspired robots. Martonosi presented a couple of examples of ways to improve how people, systems, companies and governments can protect the privacy of personal information in new and existing cyberinfrastructure. Sharp presented the project NATURA which explores nature-based solutions for urban resilience on a changing planet. Sharp explained that this project aligns directly with OISE's strategy to invest in mutually beneficial international collaborations and focus on science-based solutions to meet societal challenges.

Director's Engagements
The Director presented some highlights of his engagements since the May meeting. They included his presentation to The Academy of Medicine, Engineering & Science of Texas, the Council on Competitiveness, and the American Innovation Forum – MerITocracy – and the Global Research Council.

Senior Staff Updates
The Director announced changes amongst senior staff including Dr. Kellina Craig-Henderson, Assistant Director for Social Behavior Economic (SBE) Sciences (formerly the Deputy of SBE); Janis Coughlin-Piester, Chief Financial Officer (formerly the Deputy Officer of the Office of Budget, Finance and Award Management); and Teresa Grancorvitz, Deputy Chief Operating Officer (formerly the Chief Financial Officer). The Director also introduced NSF's new Assistant Director for the NSF's Education and Human Resources (EHR) Directorate James L. Moore, III, formerly the Vice Provost for Diversity and Inclusion and Chief Diversity Officer at the Ohio State University. Lastly, Panchanathan announced the retirement of Joanne Tornow after 23 years with NSF ending her time with NSF as the Assistant Director of BIO.

Panchanathan acknowledged the work of NSF staff for being recognized as the second-best midsize federal agency in the 2021 Federal Employee Viewpoint Survey with two NSF directorates, BIO and EHR, ranked in the top five subcomponents of all federal agencies. He concluded with the announcement of NSF's "Science Happens Here" campaign.

Department of Energy, Under Secretary for Science and Innovation – Geraldine Richmond

Reed and Panchanathan extended a joint invitation to Dr. Geraldine Richmond, former NSB Board member and current Under Secretary of Science and Innovation at the Department of

Energy (DOE) to share her thoughts about opportunities, similarities, differences, and collaboration possibilities between NSF and DOE.

Richmond's portfolio includes fundamental science associated with nuclear physics, high energy physics, and fusion and applied science associated with the electrical grid, solar, transportation, hydrogen, AI, critical minerals and materials and carbon management. She explained that these areas are siloed, and it is her mission to connect these more tightly than ever. She works closely with Jill Hruby, Under Secretary for Nuclear Security and Administrator of the National Nuclear Security Administration and Kathleen Hogan, Principal Deputy Under Secretary for Infrastructure responsible for applied energy and the deployment of the infrastructure bill funding.

Richmond outlined some of the differences between DOE and NSF including DOE's 17 national laboratories of which she oversees 14 and Hruby the remaining three. All the labs take funding from the applied and basic sciences. DOE also supports universities across the country. DOE has 28 user facilities for the purpose of collaborating with NSF and other agencies.

Richmond highlighted Energy Earthshots, DOE's initiative to identify and establish programs targeting the remaining major research and development breakthroughs to be achieved in the next decade that align with the President's goals. Earthshots announced to date include long-duration storage, carbon capture and hydrogen with two more on thermal and offshore wind to be announced in the near future. Richmond described today's DOE as different, energized by leadership and with outreach activities designed to touch every part of the country and the globe and to take basic research through to applied research and deployment. She emphasized the importance of different agencies with different missions collaborating and the need for an "all-hands-on-deck" approach to save the planet.

Questions and Answers

Board members engaged in a question and answer session with Richmond which included questions about whether the *CHIPS Plus Science Act* (CHIPS) provides opportunities for NSF and DOE to work together to expand the pathway for talent to get to the national labs and how NSF might best collaborate with the labs. COVID had a big impact on the workforce of DOE's national labs and DOE's ability to retain and attract new entrants into the workforce. She sees opportunities for working together on outreach to different states and communities and touched on NSF's strength and focus on the missing millions and community colleges to expand and diversify the workforce. She envisions a series of workshops to bring personnel of NSF, DOE and NIST together to talk about and plan future collaborations and to prevent waste and duplicity. Ideas for collaboration could include supply chain issues with critical minerals, AI, microelectronics, workforce issues and training in connection with security issues. Richmond acknowledged difficulties between NSF and DOE in the past, and that it was time to move past that adding that collaborations must have well-defined scopes and be managed in an environment of trust. When asked about how NSF and DOE could jointly engage industry, Richmond offered that DOE has strong connections and relationships with industry and there "might be the possibility" of DOE introducing companies/industry to NSF facilities that are closer in proximity to industry offices and facilities than DOE facilities.

When asked about her thoughts on DOE's support for astrophysics and how DOE and NSF can work together considering the new decadal survey, Richmond felt the collaboration could be stronger. She assured NSB Members that although DOE's focus is on climate and clean energy, all other efforts would not be left behind. She added that DOE just announced OSCAR fellowships that will provide $45K a year. In fiscal year (FY) 2024, DOE is planning to fund 300 OSCARs at $45K per year and $15K per year to the institutions with possible expansion to 500 fellowships in FY 2025. Reed asked Richmond for her thoughts on how best to make the case for the sufficient funding of innovation engines to which Richmond highlighted the Administration's desire for more partnerships and less competition between agencies.

Richmond referred to the national labs as hidden jewels and described them as more team oriented than universities, transformative and a place where basic research is happening next to applied work. She followed by expressing concern about the merit model that consists of counting publications and citations being detrimental and limiting to scientists that want to try something different. She is in favor of focusing on the broader impacts of scientific research.

Antarctic Science Strategy

NSF's Alexandra Isern, Michael Jackson, Roberta Marinelli and Stephanie Short presented NSF's Antarctic Science Strategy. Isern began with a brief introduction to the U.S. Antarctic Program (USAP) and outlined the criteria NSF uses to determine which research projects are deployed to the Antarctic and how NSF develops a research portfolio and strategy. She then provided an example of a high-impact science project and concluded with a discussion of the logistics and operations and how they connect to the research.

Criteria for determining Antarctic research projects include broader impacts and intellectual merit. Projects must also improve the understanding of how the Antarctic links to global systems; help scientists understand processes that are unique to the Antarctic; and use the Antarctic continent as a unique observing platform. These criteria must be addressed in proposals and discussed by review panels. Projects are only deployed when it is determined the Antarctic is the best or only place the research can be done. The next evaluation comes when program officers meet to prioritize research projects and discuss resources needed. Jackson offered that every year, as NSF prepares for the field season, program officers reevaluate resources and number of personnel deployed for projects on the ice.

NSF determines science priorities for the USAP in the same way science is prioritized across NSF using input from the national Academies, professional societies, international and federal partners, committee of visitors, advisory committees, congressional guidance, and priorities of the agency, administration, and NSB. NSF is putting a lot of effort into developing Antarctic science portfolios that are balanced across all disciplines and tied to long-term infrastructure investments needed to support science projects and priorities. The most recent decadal report, released in 2015, identified three science priorities: 1) changing ice sheets; 2) biological adaptation and response; and 3) next generation cosmic microwave background research. In addition to identifying priorities, NSF gains efficiencies by identifying research projects that can work together or be co-located to optimize usage of Antarctic facilities. Another approach is the "survey to synthesis" approach which, while relying on advanced technologies, allows NSF to collect large amounts of data with fewer people.

Isern then presented the project ROSETTA-Ice as an example of one that is aligned with the priority "changing ice sheets" and involves multiple partners and expertise across fields including oceanography, glaciology, topography, instrumentation, and transportation. This project had 34 principal investigators, although only four were actually deployed. Data collected on ice was shared in near real-time with investigators who are not in the field. Such projects provide opportunities for researchers and students that never have to be deployed to the ice.

She also outlined future Antarctic research activities that included searching for the oldest ice on the continent, understanding impacts of carbon cycling in the Southern Ocean on atmospheric CO_2 levels, and continuing cosmic microwave background work. Isern emphasized that remote instrumentation in the Antarctic enabled research to continue during the COVID-19 pandemic. This lesson prompted a workshop with the National Academies in May to look at the next generation of technologies to support Antarctic research by simultaneously reducing the number of researchers deployed and collecting more data.

Isern welcomed the NSB's input on how NSB and NSF can: 1) more effectively support the U.S. government strategy in the Antarctic; 2) collaborate to advance research and infrastructure priorities; and 3) articulate a long-term strategy for investments with budgets that are effectively determined on a short-term basis. She then turned to the Members for their questions.

Julia Phillips inquired how the COVID pandemic has influenced NSF's thinking specifically in connection with infrastructure needed for work on or off ice. Isern outlined three areas: evolving the science lab at McMurdo Station to an electronics workshop and staging area to support more remove instrumentation; using the science traverse (a tractor) to move people and equipment and reduce the schedule risk of weather-related flight delays; and supporting advanced weather forecasting to increase the certainty around needed flights.

Phillips added that she expected to hear more about data. Isern and Short responded by saying that data was definitely a priority investment and provided information on efforts to increase bandwidth through various satellite services for McMurdo and Palmer, and Ross Island Earth Stations. Isern added that even with efforts related to McMurdo and Palmer which doubled the bandwidth, she characterized it as "still meager". She then highlighted planned infrastructure recapitalization investments in the fiscal years 2024 and 2026 to expand bandwidth through a potential new Earth Station in New Zealand and hardware upgrades at South Pole Station. Isern explained that opportunities related to a fiber optic cable include unlimited data from McMurdo Station and NSF could instrument the cable as it crosses the Southern Ocean. Short explained that these investments would advance service at McMurdo Station to "significantly off of meager" but improvements the South Pole station are less certain.

Session 2 **(August 4, 2022, 9:00 a.m. – 10:05 a.m.)**

NSB Chair's Welcome and Remarks

Reed opened the meeting by welcoming everyone to day two of NSB's 480th meeting and turned the floor to the Director for his remarks.

NSF Director's Remarks

The Director introduced Drs. Dilma DaSilva and Irina Dolinskaya who will lead the Division of Computing and Communications Foundation as the division director and deputy division director. He then introduced Drs. Michael Littman and Wendy Nilsen who will lead the Division of Information and Intelligent Systems as the division director and the deputy division director. The Director also announced that Dr. Peggy Hoyle will step away from her position as General Counsel and will serve as senior advisor in the Office of Equity and Civil Rights. Ms. Ona Hahs has agreed to serve as acting General Counsel. Panchanathan closed his remarks by calling NSB members' attention to the update from the Office of Legislative and Public Affairs in the NSB Diligent Board book.

Committee and Working Group Reports

Committee on Oversight

Committee Chair Stephen Willard reported that the committee met on July 29, 2022, for the first meeting of this term. The committee agenda consists of eight pillars including data, the Merit Review Digest, broader impacts, EPSCoR, enterprise risk management, diversity, equity, inclusion and accessibility (DEIA), the Racial Equity Task Force and maintaining a good working relationship with NSF staff. Members received a presentation from NSF and engaged in discussion about demographic data collection efforts, received updates from the Inspector General Allison Lerner and Assistant Inspector General Mark Bell on work related to EPSCoR, and from the Chief Financial Officer and Performance Improvement Officer Teresa Grancorvitz on financial and performance topics.

Committee on External Engagement

Committee Chair Darío Gil reported that the Committee Members met on August 3, 2022, to discuss ideas for a long-term strategy for engagement and near-term actions to convert authorizations to appropriations. Members discussed how the Board could activate constituencies beyond academia such as the business community, the national security community and those connected to regional economic development activities as well as the timing, messaging and methods of engagement. Members also discussed the need to select just a few things targeting specific audiences and for disciplined and consistent messaging for maximum impact. Gil said that the committee would be looking for assistance to select those targeted items and develop a consistent and powerful message using data where possible to make a case for funding. Committee Members will share the details of the strategies and plans as they are developed.

During the report out, other members pointed out that both the Committees on Oversight and External Engagement will require some assistance from NSF to be effective advocates and that NSB and NSF should make optimal use of Geri Richmond's assistance and willingness to collaborate. Panchanathan offered NSF's assistance as needed. Reed pointed out connections between the issues raised and discussed during Committee meetings from workforce and equity issues to missing millions and national security. He also pointed out the need for NSF and NSB to make the case clearly and precisely and that it be data driven. Reed added that Suresh Babu and Victor McCrary will lead the planning of the September Board retreat which will include these very issues.

Committee on Science and Engineering Policy
Committee Chair Maureen Condic reported that the committee is looking ahead to new Board members and the upcoming *Indicators* cycle. Committee priorities include seeking input and co-creating committee products as the full Board pursues shared goals outlined in Vision 2030. The committee discussed ways in which the 2024 *Indicator* cycle could increase its value to stakeholders especially around issues of competitiveness, critical and emerging technologies, supply chain and STEM workforce, and advanced engineering materials through reports or standalone releases or policy products. Condic also noted that the committee will aim to keep the overall Indicators material at a management level avoiding unreasonable expansion of the thematic reports.

During the SEP meeting, members also heard from the National Center for Science and Engineering Statistics (NCSES) about the new America's DataHub Consortium which is a component of the NCSES mission to provide policy neutral statistical data on U.S. Science and Engineering. Committee Members also discussed recently released and developing policy items beginning with an update of the Board's brief on international STEM talent that was released in May. Members were pleased to see how much attention this message received in the public and expressed the desire to continue to highlight the issue moving forward.

Potential new topics and ideas for consideration over the coming months were discussed. They included coordinating with ESKE on impacts of early education on STEM pathways, considering data needs in research security topic areas, and NSB's concern about high levels of student debt and the impact on graduate careers in STEM.

Condic reminded members about their obligation to review and provide input on the thematic reports. She offered that the committee would be working on developing a convenient, electronic dashboard consisting of all tasks and dates for input during the detailed narrative outline stage so Members can better plan and devote time to the review. She emphasized that the detailed narrative outline is where NSB Member input is most needed and can directly influence the content, structure, the organization, and presentation of data.

Phillips acknowledged the productive relationship between NSB and NCSES staff and their initiative to looking at new data and sources as well as data-only reports or products from which the Board may wish to springboard and consider related policy implications. As *Indicators* is streamlined, items taken out of the report could become standalone products.

Socioeconomic Status
Phillips outlined the origin of the socio-economic status working group (SES), which stems from discussions around the release of the *Indicators* summary report in January 2022 and from priorities articulated in Vision 2030 including missing millions. At that time there was collective realization that the missing millions does not capture all the missing potential STEM talent. And that another huge cut of that missing population is from low SES background. Many of those people fit into NSB's definition of the missing millions, but many do not. Phillips explained that she is now leading the SES working group and reported that the group met once since the May Board meeting.

Phillips highlighted that the need to expand the geography of innovation is now. She talked about the strong connection between TIP and the call to develop STEM talent for America and how that includes individuals from low SES backgrounds. Those who grow up in poverty face barriers in their pursuit of STEM education and those barriers have become even higher over time as the cost of public education has increased. Phillips called on the Board to shed light on the barriers, identify potential solutions, develop clear messaging around these issues, and tie them to other board and NSF priorities. Phillips expects to regularly release relevant data and policy recommendations that call attention to this issue in the boarder context of the Science and Engineering enterprise. SES hopes to work with NSF to discuss and explore ways that the foundation can increase accessibility and persistence in STEM for those from low SES backgrounds.

The SES working group will begin with existing datasets to help inform near-term work. Phillips described building on the one-pager on financial barriers faced by the missing millions, those from underrepresented racial and ethnic groups in this country. The group is interested in assessing the representation of low SES students in STEM at both the undergraduate and the graduate levels using and tracking new data as they are released at a time when college enrollments are down and exploring reasons for that. The group also wants to identify the gaps in the data and options to meet them, including NSF data and other datasets that NCSES can help NSB get access to.

Bienenstock offered that the recent authorization bill should lead to an expansion of NSF funding for EPSCoR institutions which represents an opportunity to expand and diversify the STEM workforce. He asked that the Board pay attention to two things - the Office of Inspector General's report that seven out of 10 EPSCoR institutions had findings and that during NSB's exploration of skilled technical workforce issues the Board heard that faculty were not well-supported administratively in their research. He suggested that these institutions will need support to be able to expand the STEM workforce. Panchanathan responded that NSF's Growing Research Access for Nationally Transformative Equity and Diversity (GRANTED) program aims to help provide funding for administrative assistance but recognized that that alone will not be sufficient.

Session 3 **(August 4, 2:05 p.m. – 2:30 p.m.)**

NSB Chair's Activity Summary

Reed reported on his activities since the May meeting. Activities included joining Vice Chair Victor McCrary, for meetings with Hill staffers and the Office of Science Technology and Policy to talk about congressional and administration priorities. Reed also drafted a memo outlining key items to be addressed by the Board over the next two years consistent with those of the Director. Reed also spent time with the Director discussing ways to streamline NSF and NSB collaborations and committee meetings. Finally, Reed reported that he participated in a fireside chat at the Academy of Medicine, Engineering & Science in El Paso, Texas, with the Director.

NSB 2023 Meeting Dates Vote

Reed brought a vote on the draft 2023 NSB meeting schedule. The motion passed with no dissent. The NSB 2023 meeting schedule is as follows:

- Board Meeting, February 15-16, 2023
- Board Meeting, May 9-10, 2023
- Board Meeting, August 15-16, 2023
- Board Retreat, October 11-12, 2023
- Board Meeting, November 29-30, 2023

Approval of Prior Open Meeting Minutes

Reed presented the minutes of the May 2022 Open Plenary session for approval. The minutes were approved as presented.

NSF Director's Closing Remarks

Panchanathan thanked the Chair and Vice Chair and all Members for a successful meeting.

NSB Chair's Closing Remarks

Reed asked NSB Member if there were any additional comments or questions before bringing the meeting to a close. Darío Gil commented that the dialogue and the format of the meeting was an improvement. Reed expressed his gratitude for the collaboration and participation throughout the meeting.

There being no further business, the meeting was adjourned at 2:01 p.m. EDT.

12/5/2022

X Andrea I. Rambow

Andrea I. Rambow

Signed by: ANDREA I RAMBOW

Executive Secretary to the National Science Board