

## Directorate for Engineering Advisory Committee Meeting

National Science Foundation  
Alexandria, Virginia  
October 23-24, 2019  
Room 2030

### ENG AdCom Members Present:

Dr. Darryll Pines (Chair)  
Dr. Sarah Rajala (Co-Chair)  
Dr. Tilak Agerwala (Day 1 only)  
Dr. Gilda Barabino (Day 1 only)  
Dr. Bruce Horn  
Dr. Leah Jamieson  
Dr. Mary Juhas  
Dr. Robin Murphy  
Dr. Lance Pérez  
Dr. Maxine Savitz  
Dr. Susan Smyth  
Dr. Stefanie Tompkins  
Dr. Jeanne VanBriesen  
Dr. Jelena Vučković  
Dr. Gregory Washington  
Dr. Yannis Yortsos

### ENG Senior Staff Present:

Dr. Dawn Tilbury (Assistant Director)  
Dr. Filbert Bartoli  
Dr. Linda Blevins  
Dr. Richard Dickinson  
Ms. Graciela Narcho  
Dr. Sohi Rastegar  
Dr. Mihail Roco  
Dr. Robert Stone  
Dr. Kon-Well Wang (Day 1 only)

*Wednesday, October 23, 2019*

The meeting convened at 12:30 p.m.

### CALL TO ORDER

**Dr. Darryll Pines**, chairman of the NSF Directorate for Engineering (ENG) Advisory Committee (AdCom), welcomed everyone to the meeting, including two new members. Members and ENG leadership introduced themselves. The committee approved the minutes of the Spring 2019 meeting.

### DIRECTORATE FOR ENGINEERING REPORT

**Dr. Dawn Tilbury**, NSF Assistant Director for Engineering, described the organization of the directorate and introduced new ENG people and open positions. She described the NSF and ENG budgets over the last few years. She underlined NSF's dedication to protecting research security while maintaining NSF values of openness, transparency, and merit-based competition. She described research and education activities to advance NSF's Big Ideas. She introduced ENG investments for artificial intelligence (AI), convergence, engineering education, and diversity and inclusion. She provided a snapshot of partnership activities, such as graduate student internships (INTERN). She concluded with an update on visioning for

the engineering community and praise for the engineering behind the lithium-ion battery, which was awarded the Nobel Prize in Chemistry.

### **Discussion**

Advisory Committee members supported NSF's interest in partnership opportunities, including with nonprofits. They asked how NSF allocates budgets, and Dr. Tilbury explained that collaboration on Big Ideas helps increase funding for NSF and all its directorates. If an idea has support from other directorates, it gains value.

The Committee expressed concern about inclusion of people in under-represented groups among investigators on large-scale research, such as Engineering Research Centers. Dr. Tilbury noted that ENG Germination workshops help develop diverse leadership. Also, planning grants, mid-scale research opportunities and Big Ideas research might provide an intermediate step that could lead to center-scale activities. Broadening participation remains a challenge for engineering.

### **NSF BUDGET UPDATE**

**Ms. Caitlyn Fife**, Division Director of the NSF Budget Division, provided context about the U.S. federal budget overall. NSF is closing out FY 2019 actuals. The FY 2020 budget is provided under a continuing resolution. NSF is negotiating with the Administration about FY 2021 NSF Request, which is scheduled for release in February 2020. The federal budget cap and deficit may impact future NSF budgets.

### **Discussion**

Committee members asked about the implications of a continuing resolution, and if it would prevent NSF from starting new activities. Ms. Fife explained that NSF has some flexibility, but the general limitation is there for NSF and all of government.

Committee members discussed the growth in engineering enrollment and in the number of engineering colleges, and how that might affect the budget for the NSF Engineering Directorate. NSF looks at funding rates, which can indicate opportunities and what proposals NSF would have funded with more money.

### **REPORTS FROM ADVISORY COMMITTEE LIAISONS**

**Dr. Tilak Agerwala**, liaison to the **Advisory Committee for Cyberinfrastructure (ACCI)**, introduced the big questions about the future posed to ACCI by the NSF Office of Advanced Cyberinfrastructure (OAC). ACCI currently is looking at three main problems: sustainability, reproducibility, and research agenda. Each area has an ACCI working group with plans and deliverables for future meetings. Cyber-infrastructure has and will continue to have a big impact on engineering and engineering research.

**Dr. Gilda Barabino**, the liaison to the **Committee on Equal Opportunities in Science and Engineering (CEOSE)**, reminded that CEOSE is congressionally mandated to produce reports every two years. Its most recent report, for 2017-2018, focuses on inclusiveness as a means to increase participation of underrepresented groups in STEM and improve science and engineering, and it recommends that NSF

include more diverse voices through community-driven projects. CEOSE has been helping disseminate the report and learning about opportunities and challenges in STEM for people with disabilities.

**Dr. Mary Juhas**, liaison to the **Subcommittee for the Small Business Innovation Research/Small Business Technology Transfer Program (SBIR/STTR)**, introduced the SBIR/STTR program and subcommittee. Subcommittee members reflect diversity in industry sectors, geography, demographics, and innovation experience. The focus is on ecosystem development, whether topical or regional, and on emerging industries.

Dr. Pines moved the report on Advisory Committee for Environmental Research and Education activities until after the NSF Director's visit in the interest of time.

## **SCIENCE AND SECURITY**

**Dr. Rebecca Keiser**, Head of the NSF Office of International Science and Engineering, emphasized that NSF's perspective continues to be that international collaboration is essential to science. When NSF talks about security, we mean actions that compromise this collaboration. The need for openness and transparency and the need to widely disseminate results are supported by many administration and National Academies studies. NSF works worldwide, which is only possible with partners. Our most frequent international partner for artificial intelligence research, for example, is Canada. International talent in the US is also important. NSF wants to protect this ecosystem for basic research.

There are three types of risks to US science and security in a global research ecosystem: national security, economic security, and research integrity. Research integrity is the focus of NSF because we fund basic research. This means conflicts of interest/commitment, the confidentiality of merit review process, and protection of pre-publication data. NSF's approach emphasizes disclosure and assessment of risk. NSF is working to clarify existing policy about disclosure and respond to the variety of understandings in the community. NSF engaged a JASON group to look at risks to NSF-funded research. NSF is taking several other actions to ensure the integrity of basic research. In summary, NSF's focus is on research integrity and continuing international collaboration.

### **Discussion**

Advisory Committee members expressed concerns about international students and their ability to get visas. In engineering, a large proportion of graduate students come from China. In the past, many of these students have stayed in the US to work after getting their advanced degrees; it is important to ensure this continues. Dr. Keiser responded that NSF is concerned about the whole research environment, including competition for international students and the workforce. NSF's data, which lags a bit, show the stay rate for international students is very high, as much as 80% in some fields. This data is important, and NSF is sharing such information and working in partnership with other agencies.

The committee asked to what extent has research integrity been compromised. Dr. Keiser said that assessing scope of the issue is challenging, because much is due to nondisclosure (for example, conflicts of commitment). Cases are reported in the semiannual reports of the NSF Inspector General.

The Committee remarked on unintended effects of NSF actions on certain groups, such as alienation of Chinese students. As the distance and time between basic and applied research gets smaller, questions about when to treat research differently will become more important. Continuing communication with universities at multiple levels is a priority for NSF.

#### **PREPARATION FOR DISCUSSION WITH THE DIRECTOR'S OFFICE**

Advisory Committee members discussed the engineering visioning effort, science and security, diversity and inclusion, and grand challenges and NSF Big Ideas. They decided to share these topics with the NSF Director.

#### **PERSPECTIVES FROM THE DIRECTOR'S OFFICE**

**Dr. France Córdoba**, NSF Director, described NSF's good relationship with the Office of Science and Technology Policy (OSTP) and NSF's high level of involvement on the National Science and Technology Council (NSTC) and its committees and subcommittees. The NSTC Joint Committee on Research Environments (JCORE), which NSF co-chairs, coordinates work on several topics, one of which is research security. JCORE is very interested in research itself, in areas such as quantum science and engineering. NSF continues to be active internationally; in Sweden last week, for example, we discussed the future of work and the future workforce.

**Dr. Fleming Crim**, NSF Chief Operating Officer, described his visit to the University of Florida's Terraformer wind tunnel, part of the NSF National Hazards Engineering Research Infrastructure (NHERI). NHERI's capacity for fundamental research and use-inspired questions is an example of how NSF research infrastructure makes a difference locally and nationally.

**Dr. Leah Jamieson** described the engineering visioning effort getting underway and its connections to the National Science Board visioning effort, the National Academy of Engineering's Grand Challenges, National Academies decadal studies, and NSF Big Ideas. These can unify the broad engineering community, attract public support, and inform NSF. The Committee is glad that NSF Engineering took this on. Dr. Crim is interested to learn about promising models that can achieve synchrony among people throughout engineering.

**Dr. Stefanie Tompkins** expressed the Committee's interest in science and security and their appreciation for NSF's focus on research integrity. The community has many concerns, such as: the difficulty of defining basic research and sharing that understanding across government; the accelerating time cycles of maturation; and the different implications of convergence in different fields. We hope NSF can help bring clarity. Dr. Córdoba sees progress in sides coming together. University leaders are understanding the issue differently than they did a year ago and trying to move forward. NSTC JCORE and OSTP want agencies to coalesce around a common set of principles, which will benefit the community.

**Dr. Jeanne VanBriesen** stated that both previous topics intersect with diversity and inclusion. People have many identities, and we want to attend to how these identities affect people's desire to be engineers. It is critical to think about people's sense of belonging. **Dr. Gilda Barabino** stressed the

importance of inclusion, which goes beyond representation, to do better science. Diversity and inclusion are needed at all levels of leadership, such as Vice Presidents of Research and center directors, and environments that support them. Dr. Córdova responded that one of the three goals of the White House plan for STEM education is inclusion, and many agencies are collaborating and sharing practices. Regarding leadership, the strategy for NSF INCLUDES began with a letter to presidents of universities inviting them to be involved. Such a leadership commitment lends force and momentum. We have an opportunity now for assessment.

**Dr. Yannis Yortsos** asked about NSF's interest in grand challenge research in comparison to discovery research. He noted that grand challenge questions attract more women and under-represented minorities, who want to impact society. Dr. Córdova replied that NSF is interested in both — imagination is big enough for all kinds of approaches. Engineering brings a unique and valuable perspective to collaborations.

**Dr. Pines** thanked Dr. Córdova and Dr. Crim for joining the meeting. With Dr. Córdova's term as Director ending, he thanked her on behalf of the Committee for her leadership of NSF and the US science and engineering community, and for the inspiration she provided to many young people.

#### **REPORTS FROM ADVISORY COMMITTEE LIAISONS (continued)**

**Dr. Jeanne VanBriesen**, liaison to the **Advisory Committee for Environmental Research and Education (AC-ERE)**, introduced herself as the new liaison to AC-ERE, which is now chaired by Dr. Andres Clarens and will meet in November.

#### **Discussion**

Committee members asked if ACCI has found reproducibility to be a technical issue or a human issue. Dr. Agerwala explained that there are technical issues and significant social impacts; culture and values come into picture as well. Both parties are competent, but their eyes opened as they learned about each other. Convergence requires a level of trust between the communities involved.

#### **NSB VISIONING**

**Dr. Jamieson** described the National Science Board (NSB) work to develop a vision that will help guide the NSB and the NSF through changes in the science and engineering (S&E) landscape during the decade of 2020 to 2030. She participated in one of several NSB listening sessions over the past few months. NSB asked about changes, challenges and opportunities in S&E practices, capabilities, credibility and relevance, diversity and inclusion, and other areas. NSB expects to publish the report in 2020.

#### **Discussion**

Committee members noted that broader impacts, credibility, and ethics are often intertwined.

## **ENGINEERING VISIONING SUMMIT AND BEYOND**

**Dr. Deborah Crawford** of George Mason University and **Dr. Lance Davis** of the National Academy of Engineering (NAE) co-chaired an Engineering Research Framework Visioning Summit, held in July 2019 and hosted by the American Society for Engineering Education. The summit had 44 participants from academia, industry, NAE, and engineering societies. The charge was to look at structures, models and tools to help the community identify long-term research directions that position our nation to realize a better future, that respond to emerging opportunities and areas of national need, and that help NSF better shape and drive research. Participants were very engaged and encouraged to think big.

### **Discussion**

Committee members discussed challenges to conducting visioning exercises that encompass all fields of engineering. While there are commonalities, and engineering is frequently interdisciplinary, a visioning exercise for biomedical might be very different from mechanical engineering. Yet, NSF Directorates mobilized together behind the NSF Big Ideas. When it comes to innovation, the best thing an engineer can do is talk to someone orthogonal. Being too prescriptive or starting with an endpoint can create problems. Many of today's challenges are sociotechnical. Dr. Crawford added that mechanisms can support that process of ideation, build on the ideas, and make more possible.

**Breakout groups** discussed four questions, and Dr. Thompkins, Dr. Jamieson, Dr. VanBriesen, and Dr. Murphy reported the group responses:

### **What are the next critical steps that the Engineering Directorate should consider?**

NSF should clarify the nature of the desired vision or challenge or other outcomes. NSF could try a variety of topics and models/tools, because some combinations might work better than others or have more resonance in certain geographical regions. NSF should also clarify who is the engineering community and where are its edges, as well as who are the audiences.

### **How should the Engineering Directorate more widely engage different communities?**

NSF should consider a variety of tools and methods to stimulate ideas from the bottom up, such as workshops, "shark tanks," Ideas Labs, catalyst programs, and online platforms for ideation and community building. An intentional effort is needed to engage trade groups, government, or others who use engineering research but who aren't always part of the conversation.

### **What are the components of an ideal organization?**

The organization's role is to facilitate and ensure timelines and methods are working. At the same time, it will promote creativity with the overarching goal to make world a better place. The organization also will have a convening role and function as a hub for communication and dissemination. Dedicated leadership, credibility and accountability are critical for the organization. It needs to represent the full range of careers and all people, even if not all are there.

### **How can NSF ensure sure this organization speaks with one voice for the Engineering community?**

The organization and the community need a shared understanding of the value proposition, overarching goals, and what "one voice" means. People need to feel included and able to join the conversation. The

process for creating visions and incorporating many ideas (and addressing dissenting ones) must be trusted and transparent.

### **Discussion**

Committee members discussed the potential for unintended consequences if, for example, a vision is not embraced by NSF. They also discussed the impacts of the Computing Community Consortium (CCC) on the computer science community. Dr. Tilbury thanked the committee for all their input.

Dr. Pines thanked the Committee and adjourned the meeting for the day at 5:55 p.m.

*Thursday, October 24, 2019*

The meeting resumed at 8:30 a.m.

## **DIVISION OF CHEMICAL, BIOENGINEERING, ENVIRONMENTAL AND TRANSPORT SYSTEMS (CBET) OVERVIEW**

**Dr. Richard Dickinson**, CBET Division Director, introduced the CBET mission and how it supports multiple fields of engineering. He described the division budget and areas supported by each of the division's four clusters. He noted special investments, such as Signals in the Soil, microgravity research, and sustainable urban systems, as well as CBET contributions to NSF's 10 Big Ideas and NSF research centers. CBET is active in many international research opportunities and in partnerships with other agencies.

### **Discussion**

Committee members asked about relative levels of funding for different clusters. Dr. Dickinson responded that clusters are about even, and their communities get additional support via initiatives. RAPID awards support research related to natural disasters, including a few for wildfires.

## **CBET COMMITTEE OF VISITORS (COV) REPORT**

**COV co-chair Dr. Christopher Roberts** of Auburn University acknowledged the excellent work of COV chair Dr. Jennifer S. Lewis and the COV members. The COV reviewed CBET programs and activities during the four prior fiscal years. He summarized COV findings on the quality and effectiveness of the merit review process, selection of reviewers, and management of the program, and the resulting portfolio of awards. He noted that reviewers had confusion about broader impacts and differentiating between intellectual merit and technological impact, and CBET could look for ways to prepare them better. CBET could involve more reviewers from industry and national labs and describe efforts to ensure diversity among reviewers. Program management is collaborative and responsive to opportunities. The portfolio supports national priorities, is balanced among topics, has good geographic distribution, and could use a greater variety of institutions. The COV has some concern about CBET award size. They encourage CBET to perform more long-term planning and outcomes assessment.

## **DIVISION OF CIVIL, MECHANICAL AND MANUFACTURING INNOVATION (CMMI) OVERVIEW**

**Dr. Robert Stone**, CMMI Division Director, shared the origins and current organization of CMMI. He described the division budget and areas supported by each of the division's four clusters. He noted CMMI's leadership in interdisciplinary areas, such as the Navigating the New Arctic and Future of Work at the Human-Technology Frontier Big Ideas, and Disrupting Operations of Illicit Supply Networks. CMMI supports the mid-scale, multidisciplinary research opportunity, LEAP HI, and the NSF National Hazards Engineering Research Infrastructure.

### **Discussion**

Committee members asked about interactions between CMMI and the Manufacturing USA Institutes. Dr. Stone responded that ENG program directors sit on their advisory boards and encourage investigators to look at Manufacturing USA for translation opportunities.

## **CMMI COV REPORT**

**COV chair Dr. Delcie Durham** of the University of South Florida appreciated the excellent COV group and support by CMMI. The COV reviewed CMMI programs and activities during the four prior fiscal years. She summarized COV findings on the quality and effectiveness of the merit review process, selection of reviewers, and management of the program, and the resulting portfolio of awards. CMMI receives many proposals and consistently provides good panel summaries. She noted that CMMI reviewers had confusion about broader impacts, and consistent documentation is needed. The CMMI portfolio is balanced, and the division should continue growing LEAP HI, its mid-scale research opportunity. The COV encourages more use of data for benchmarking and outcomes analysis.

## **DISCUSSION ON CBET AND CMMI COVS**

Committee discussion centered on challenges to understand and evaluate broader impacts, which were present in the CBET and CMMI COV reports. This is a longstanding issue that needs serious attention by investigators, reviewers and NSF. It might help to provide more guidance on the review template itself, such as including strengths and weaknesses, or breaking out technical merit and technical impacts. More training is needed; not every institution can provide assistance or guidance for broader impacts. Investigators are not held accountable for broader impacts claims.

They also discussed the connections to visioning for engineering, right-sizing budgets, and demands placed on junior faculty.

The Advisory Committee voted unanimously to accept the CBET COV report.

The Advisory Committee voted unanimously to accept the CMMI COV report.



## MID-SCALE RESEARCH INFRASTRUCTURE

**Dr. Stephen Meacham**, Section Head for Integrative Activities, NSF Office of Integrative Activities is eager to engage on how to advance engineering research through the provision of mid-scale research infrastructure. We have a history of new tools making new discoveries possible. Mid-scale RI fills the gap between NSF funding for Major Research Instrumentation and Major Research Equipment and Facilities Construction.

Mid-scale RI is one of the “Enabling” NSF Big Ideas. It would not create centers, but Mid-scale RI facilities and infrastructure could be used by a center. Mid-scale RI will be important for training future leaders in technological innovation and involves special expertise to design and operate the infrastructure and handle the interdisciplinary aspect of research.

Recently, NSF has published two solicitations to support different sizes of NSF investment within the Mid-scale RI spectrum. Some awards have been made, with more to come in FY 2020 and FY 2021. NSF welcomes ideas on what mid-scale research infrastructure would serve the engineering community, and how to prepare engineering to participate in the opportunity.

### Discussion

Dr. Meacham was joined for the discussion by Dr. Paul Lane and Dr. Usha Varshney, program directors from the NSF Division of Electrical, Communications and Cyber Systems who help manage the Mid-scale RI program.

Committee members asked about NSF directorate support for different projects, many of which appear cross-disciplinary with strong engineering components. Dr. Meacham explained that, as one of NSF’s 10 Big Ideas, Mid-scale Research Infrastructure uses a stewardship model with a central pot of money that serves NSF and the community as a whole.

Committee members asked how the proposed mid-scale research infrastructure are expected to relate to existing centers, engage users, and plan for sustainability. NSF program directors explained that Mid-scale RI projects are distinct from centers but could be located within a center or existing infrastructure and could become the nucleus for a new center in the future. Projects could be physical equipment or virtual. The user base and impacts on the wider community are important. The solicitations ask about project management; we expect to see a range of approaches and degrees of sophistication, and we encourage groups to consult with colleagues who have it in their background. All proposals provide anticipated operations and management costs and a model for sustainability for a defined lifetime.

Committee members supported having design awards available, which will help bring teams together. NSF can fund exploration via programs or Mid-scale RI. Usually projects do not proceed from concept right to construction — discussions with community about needs and approaches happen in between.

The Committee discussed outreach about the program and encouraged a concerted communication effort, in part because the relationship between NSF infrastructure programs is not obvious by their names. Ideas included messages to presidents and/or deans, webinars, and workshops.

## STOPPING HARASSMENT

**Mr. Robert Cosgrove**, Compliance Program Manager of the NSF Office of Diversity and Inclusion (ODI), explained that his office ensures that NSF awardee comply with civil rights laws, and the one that gets the most attention is Title IX. He introduced Title IX and agency roles in receiving complaints and enforcement.

To help ensure compliance, each year NSF performs site reviews, during which we interview faculty, inform the institution/department how they are doing, and serve as a resource. A second NSF activity is to respond to discrimination and harassment complaints. A third NSF activity is the recent term and condition about notifying NSF when someone is put on administrative leave. To help us fine-tune the term and condition, NSF requested comments via the Federal Register, and we received about 200 responses. When NSF is notified, we discuss with the university what happened as a result of the administrative leave and any potential impacts on students and research.

**Ms. Rhonda Davis**, Head of ODI, added that NSF is evaluating the term and condition, including its implementation by NSF and its impacts on culture. NSF will apply whatever we learn. ODI is very interested in hearing from the community.

### Discussion

Committee members asked what changes NSF is considering now that the term and condition has been out for a year. Ms. Davis noted that universities are reporting things that are not required, because they happened before the term and condition became effective; NSF is responding to these cases, and this may not warrant a change to the term and condition. However, NSF does want to address gaps for small businesses and participants in Research Experiences for Undergraduates (REU) sites, for example.

The Advisory Committee noted that confusion about reporting to NSF remains. Universities do not necessarily want to pull a person from grants and harm the faculty member and their research without a finding from their investigation. Dr. Davis said that the term and condition is based on the university's code of conduct, and NSF doesn't necessarily require anything more. NSF looks for continuity of work while the researcher is on leave and cannot perform their research responsibilities. NSF treats administrative leave for harassment differently than other situations when an investigator cannot perform research (such as illness); this difference enables NSF to be notified when leave is less than 90 days and to encourage discussion with the university. Safety and security are paramount for NSF. Committee members noted that more outreach and training about the NSF term and condition is needed. They expressed concern that some institutions may handle allegations differently for high performers.

Advisory Committee members asked about the connection between stopping harassment and ensuring research integrity. NSF responded that the agency keeps research misconduct, such as fraud and plagiarism, separate from Title IX issues. Several groups are working on research integrity, including safe and inclusive environments. NSF is active in the National Science and Technology Council Joint Committee on Research Environments and the interagency working group on Title IX. These groups are

looking at what else we can do in this area and how to coordinate if multiple agencies are funding the same investigator.

## **ROUNDTABLE ON STRATEGIC RECOMMENDATIONS FOR ENG**

**Dr. Pines** reminded the committee of the meeting's four main topics: engineering visioning, COV reports, mid-scale research infrastructure, and stopping harassment.

On visioning, the committee expressed interest in continuing to provide ideas and support.

Regarding the COV reports, questions about intellectual merit and broader impacts go beyond engineering. More training for the community, panelists and program directors is needed. Impacts and outcomes are important, and we can reexamine the questions and data we use to evaluate them. The committee can contribute to the larger conversation by identifying things that are unique about engineering with respect to broader impacts.

On mid-scale research infrastructure, the committee encouraged more and better communication about the opportunity and ways to build communities around infrastructure. Impacts of infrastructure investment could take decades to appear.

For stopping harassment, the committee advised NSF to do more outreach to ensure universities understand the term and condition, to work with partner agencies to ensure consistent messages/guidance, and to address the needs of REU students and small businesses.

Members were concerned about how universities' desire to protect confidentiality in cases of potential harassment may allow the behavior to continue, either at the original university or at a new one (if the investigator changes institutions). When vetting candidates, some universities and search firms are using new questions that preserve confidentiality yet allow the respondent to answer truthfully, such as, "Has this person ever done anything that would cause embarrassment to the institution?" When a high performer is dismissed confidentially, others in the community may still want to recognize or honor that person, and it is difficult to prevent that. Public reporting and data are inadequate.

## **CLOSING REMARKS AND WRAP-UP**

**Dr. Pines** and **Dr. Tilbury** thanked the committee members and the NSF team.

The meeting adjourned at 12:30 p.m.