

# NSF Directorate for Engineering Advisory Committee Meeting

National Science Foundation  
Alexandria, Virginia  
April 25-26, 2023  
Hybrid

## **ENG AdCom Members Present:**

Dr. Leah Jamieson (Chair)  
Dr. Robin Cogger (Co-Chair)  
Dr. Gretchen Baier  
Dr. Charles Bott  
Dr. Bika Carter  
Dr. Karina Edmonds  
Dr. Cynthia Furse  
Dr. Kimberly Jones  
Dr. Ann Kelleher  
Dr. Gregory Keoleian  
Dr. Tsu-Jae King Liu  
Dr. James R. Martin II  
Dr. Franklin (Lynn) Orr  
Dr. Ismael Pagán-Trinidad  
Dr. Lance Pérez  
Dr. James Thompson  
Dr. Bruce Tromberg

Not present:

Dr. Danielle Merfeld

*Tuesday, April 25, 2023*

The meeting convened at 10:00 a.m.

## **CALL TO ORDER**

**Dr. Leah Jamieson** called the meeting to order and welcomed everyone. Advisory Committee Members and ENG leadership introduced themselves. The committee unanimously approved the minutes of the Fall 2022 meeting. **Dr. Susan Margulies** reviewed the agenda with the committee members.

## **DIRECTORATE FOR ENGINEERING REPORT**

**Dr. Susan Margulies**, NSF Assistant Director for Engineering, described the organization of the directorate and introduced new staff and open positions. She gave an overview of the NSF budget and ENG budget and how activities that are funded by ENG have been woven into the NSF FY24 budget request. She described ENG activities and investments in terms of the directorate's strategic goals and priorities, including supporting research on clean energy, climate change adaptation and mitigation, bioeconomy and biomanufacturing, and next-generation microelectronics and wireless; opportunities for people, such as investments in workforce development, broadening participation in engineering, support for early and mid-career researchers, and expanding access to research infrastructure; and partnerships through ENG center awards and collaborations with federal agencies and other entities. She announced the new investment areas for the Emerging Frontiers and Research and Innovation Program, which includes one new topic area on Engineering Organoid Intelligence and an Ideas Lab on Personalized Learning for Engineering Education.

### **Discussion**

The committee inquired about the details of ENG partnerships in areas of workforce development and climate change mitigation and adaptation, including partnerships with other directorates at NSF, other federal agencies, and international collaborations. They spoke about the benefit of partnering with other agencies to provide training fellowships and the possibility of expanding these opportunities at additional federal agencies. The committee discussed the low competitive funding rate for ENG and how this may affect early career researchers. They spoke about ways to broaden participation of applicants to ENG, such as increasing awareness of the CAREER award for early career researchers and supplements that are available for existing grant holders.

### **NASEM REPORT ON ADVANCING ANTIRACISM, DIVERSITY, EQUITY, AND INCLUSION IN STEMM ORGANIZATIONS: BEYOND BROADENING PARTICIPATION**

**Dr. Gilda Barabino**, NASEM Committee Co-Chair, and President, Olin College of Engineering, gave an overview of the NASEM Consensus study report, "Advancing Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations," published in February 2023. The report arc includes the historical context of racism and bias in STEMM organizations, the demographic composition of the United States, exploring lived experiences, how individuals experience racism, and how gatekeepers perpetuate racism. The report also includes information on supporting diverse teams, how leadership can advance organizations, and ends with an agenda of priorities for future investments in research.

There will be a hybrid workshop on May 17-18 which will focus on issues raised by the report.

Dr. Barabino emphasized that the lived experiences presented in the report were well received and that more needs to be done in the space of connecting around lived experiences and histories. She encourages everyone to make use of the report and engage with it.

### **Discussion**

The committee discussed how the engineering community can respond to report recommendations through taking a closer look at policies that are in place in departments and institutions and whether they are promoting inclusive excellence. Dr. Barabino brought up the importance of including members

of marginalized groups in these discussions and the necessity for them to be a part of institutional structure and leadership to affect change. She also recommended shifting toward collaboration rather than competition when it comes to recruitment and retainment of students and to focus on fixing systems and structures rather than treating individuals as the problem.

The committee inquired as to whether there is any evidence of change or action in response to the report. Dr. Barabino answered that there has been engagement and interest around the report, although not yet necessarily change. She mentioned that the report talks about the importance of leadership and that leaders have been showing the report to groups that may not have otherwise known about these issues.

The committee discussed the increase in broadening participation efforts in STEM in recent years and whether these efforts have led to any measurable improvements. Dr. Barabino does not think that we have yet adequately assessed and demonstrated the impact of the broadening participation work that has been done, and that the return on investment is not consistent. She emphasized a need to shift from recruitment efforts to retainment efforts; focusing more on supporting pathways instead of getting more people into the pipeline; and that retainment of faculty of color leads to increased recruitment of people of color.

The committee discussed the possibility of providing guidance to institutions for metrics and goals to assess their progress and Dr. Barabino said that new methods and tools for assessment will need to be developed.

The committee also asked about how the report will be used by the ENG Directorate and Dr. Susan Margulies said that NSF can use the report to promote diversity in the NSF workforce and NSF leadership; they can create opportunities for success in funding research and education; and they can create new funding opportunities to support ideas around broadening participation in STEM that come from the community.

## **CHIPS AND SCIENCE SEMICONDUCTOR ACTIVITIES UPDATE**

**Dr. Eric Lin**, Interim Director of the CHIPS Research and Development Office, NIST, talked about the overall goal of the CHIPS and Science Act R&D program and how it is important to develop ecosystems and create connections between different pieces of the semiconductor industry that already exist, rather than starting from scratch.

He gave an overview of a paper that NIST released today (April 25<sup>th</sup>, 2023) for a vision and strategy for a National Semiconductor Technology Center (NSTC), a key component of the research and development program established by the CHIPS and Science Act. The paper laid out three primary goals:

1. Maintain US leadership in semiconductor technology and promoting the development of foundational technologies within the US.
2. Reduce time and costs for ideas to reach commercial scale.
3. Build and sustain a semiconductor workforce development ecosystem.

He also spoke about three interrelated CHIPS R&D programs:

1. National Advanced Packaging Program
2. NIST Manufacturing USA Institution
3. CHIPS Metrology Research Program

**Dr. Tsu-Jae King Liu**, Dean and the Roy W. Carlson Professor of Engineering, University of California, Berkeley, spoke about the talent shortage in the US semiconductor workforce, the lack of alignment between industry needs and the goals of higher education, and the fact that training is difficult due to the high costs of equipment and the aging population of instructors.

She spoke about the American Semiconductor Academy (ASA) Initiative, a national network open to all interested faculty members to participate, collaborate, and partner with industry to attract and increase talent in the semiconductor industry.

To meet workforce development needs, she recommended that new federal funding be allocated to establish a nationwide network for microelectronics education, to raise awareness of the industry, modernize curricula, foster DEI, and modernize equipment.

**Dr. Ann Kelleher**, Executive Vice President and General Manager, Technology Development, Intel, spoke about how Intel has a track record of working with US semiconductor training programs and funding higher education programs. Intel works with NSF to put together programs in terms of semiconductor research to accelerate innovation. She would like to see the current collaborations with NSF continue and stated that NSF needs to have a key role within NSTC going forward to support non-duplicational research.

**Dr. Barry Johnson**, Division Director, Division of Translational Impacts, NSF Directorate for Technology, Innovation and Partnerships, talked about semiconductor activities that are ongoing at NSF including the creation of a steering group made up of members from ENG, CISE, EDU, and MPS. The goal of this group was to identify a short list of R&D activities that NSF currently has ongoing that could be immediately leveraged into CHIPS activities. They identified several relevant activities in R&D, including Future of Manufacturing, Semiconductor Prototyping, and Designing Materials for the future; and several in workforce development, including ExLENT, the Advanced Technological Education (ATE) Program, and the INTERN program.

The steering group has also been engaged with the Department of Commerce on workforce development issues and collaborates with other federal agencies. Their next goal is to look at the NSF-funded facilities and infrastructure in support of CHIPS.

**Dr. James L. Moore III**, Assistant Director for STEM Education, NSF, spoke about the need to create opportunities everywhere to reach and inspire the “Missing Millions.” He talked about NSF investments in scholarships for STEM degrees and investments in community colleges. He discussed the importance of technical training for jobs that may not require a college education. He talked about how REUs are a good way for young people to get hands on experiences that will inspire them. He also spoke about the

ExLENT experiential learning program as an opportunity for people with varying levels of education to pivot and transition into industry.

### **Discussion**

The committee discussed specific opportunities for improvement in the semiconductor industry, in energy usage in fabrication, advanced packaging, and process technologies. They discussed ways to develop the semiconductor workforce, such as increasing the fluidity between individuals in industry, academia, and community colleges; developing certification programs as pathways to enter the field; providing equitable access to education; promoting engineering education in K-12; and providing funding to address achievement gaps caused by the pandemic. They talked about areas that ENG could support, such as upgrading facilities, providing educational infrastructure, and finding ways to incentivize collaboration between faculty.

They talked about proprietary issues that come up with collaboration; the areas where collaboration is possible, such as in the pre-competitive space and in developing grand challenges and roadmaps; and efforts to collaborate with other countries, such as the Interuniversity Microelectronics Centre (IMEC).

### **TEACHENGINEERING UPDATE**

**Michael Soltys**, Teaching Associate Professor for the Integrated Design Engineering program, University of Colorado, Boulder, gave an overview of TeachEngineering, how they are creating opportunities for K-12 student in engineering, and the benefits of engineering literacy for the general population. He spoke about barriers to the introduction of engineering education in K-12, such as the teacher shortage, that teachers feel they need special training, and that engineering is associated with expensive materials.

He talked about the three main components of TeachEngineering:

1. Digital library – over 1800 resources free for educators
2. Professional development
3. Strategic collaborations with partners across the country

He spoke about data they collected on TeachEngineering audience attitudes and usage and how they identified barriers to usage, such as low market awareness and a need for K-12 resource providers to better coordinate.

**Jessica Noffsinger**, Teacher, talked about how every child should have access to engineering education, how there can be flexibility in the length of project to suit each teacher's needs, how there have been achievement gaps after COVID, and how TeachEngineering makes engineering education more accessible.

**Kayla Sutcliffe**, TeachEngineering Teacher Ambassador, spoke about her experience with TeachEngineering, how she started in the RET program developing curriculum, and is now in a STEM Ed PhD program.

**Cynthia Walker**, Teacher, Air Force base, Title Schools, spoke about how engineering education can be used as a motivator for students to come to school, how she is able to use TeachEngineering resources to find materials in a certain price range, and how it enables her to build community partnerships.

### **Discussion**

The committee discussed how NSF can accelerate the impact of TeachEngineering, by supporting teachers with training and increasing the awareness of resources. They spoke about how programs like RETs are helpful because they give credits or stipends to teachers who may not otherwise be able to do training, however, more RETs should be focused on K-8 education because recruitment of students into engineering/STEM careers needs to start early. They spoke about partnerships and collaborations with NSF PIs, the National Academies of Engineering, and the undergrad engineering population, as tools for increasing awareness and participation in the program. They discussed the potential of adding curriculum development components into other NSF grants, such as the CAREER award. They spoke about how engineering needs to do a better job in communicating about the field to the public. They also discussed the challenges of the teacher shortage and the non-uniformity of teaching standards nationwide, which make it hard to implement policy changes.

### **STRATEGIC RECOMMENDATIONS FOR ENG**

**Dr. Jamieson** invited the committee members to share recommendations.

The committee made several recommendations around engineering education, such as finding ways to recruit K-8 students into engineering careers, putting more funding toward initiatives that involve elementary schools, increasing the collaboration between K-12 and institutions of higher education, connecting and amplifying K-12 engineering education activities that exist, better tracking outcomes of K-12 programs, building the TeachEngineering infrastructure into CAREER awards, and collaborating with industry for K-12 outreach.

They had recommendations around workforce development, such as increasing public awareness of engineering, broadening the scope of problems that engineers work on, developing regional solutions for workforce development, and incentivizing institutions of higher education to provide opportunities for reskilling and upskilling the existing workforce.

The committee had several recommendations in the area of diversity, equity, and inclusion, such as moving to translate recommendations into actions in order to broaden participation in engineering and reach the “Missing Millions;” enhancing communication about outcomes and impacts of broadening participation activities; holding universities and PIs accountable for making progress in broadening participation; shifting from broadening participation and diversity to promoting institutional transformation and modifying review criteria to advocate for this transformation; and disseminating recommendations from the “NASEM Report on Advancing Antiracism and DEI in STEMM Organizations” through NSF newsletters. They also recommended that NSF provide more guidance on grant writing to encourage applications from a broader group.

They recommended that NSF take on a leadership role in in the climate change crisis, both in the US and internationally, suggesting that NSF collaborate with other federal agencies, like DOE, to accelerate climate change research. They recommended leveraging existing members of industry and consortiums to accelerate semiconductor research, increased investment in lowering the computational costs associated with AI, and promoting math education. They recommended enhancing collaborations with NIH in developing technologies necessary for human biomedical devices and in the area of climate change and its effect on human health.

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

The committee decided to focus the discussion on the opportunity for engineering to be a leader in addressing climate change adaptation and mitigation, the low funding rates of the ENG Directorate and how this impacts early career researchers, and that multiple pathways are critical for engineering workforce development.

The meeting adjourned for the day at 5:15 p.m.

*Wednesday, April 26, 2023*

The meeting reconvened at 8:00 a.m.

#### **NSF BUDGET UPDATE**

**Ms. Caitlyn Fife**, Division Director, NSF Budget Division, described NSF's budget activities in the context of the U.S. federal budget process. NSF's FY 2023 appropriation is its highest ever, indicating that NSF enjoys the support of Congress and that they see the opportunity NSF offers. She described NSF's FY 2024 strategic pillars and crosscutting themes. The President's budget request for FY 2024 would further increase NSF's funding level.

#### **Discussion**

The committee discussed how ENG is involved in each of the NSF FY24 pillars and themes, which is recognized in the FY24 budget request. They discussed how opportunities available to ENG go beyond just the ENG budget, because of the strong collaboration between ENG and TIP, and that members from the engineering community can benefit from TIP programs. They discussed the need to increase graduate student stipends and the possibility of providing supplements to existing grants.

#### **REPORTS FROM ADVISORY COMMITTEE LIAISONS – ENVIRONMENTAL RESEARCH AND EDUCATION**

**Dr. Kimberly Jones**, Advisory Committee on Environmental Research and Education (AC-ERE) chair and ENG liaison, discussed the initiatives that the AC-ERE are focusing on, including broadening participation, improving interdisciplinary collaborations, centering environmental equity in research activities, water availability and security, and minimizing the environmental impact of research.

She spoke further on one initiative called "the Sustainability of Science," which asks whether the scientific community (and NSF, in particular) is doing its part to provide a forward-thinking approach to

sustainability practices and to limit its own environmental impact. NSF currently considers environmental impact by requiring impact statements for projects that are subject to NEPA compliance, however the AC-ERE recommends that all of NSF researchers start thinking about how their research affects the environment, not just those that meet a narrow set of criteria. She spoke about how there are areas where PIs can influence the environmental impacts of their work and other areas that are out of their control. She solicited feedback from the ENG Advisory Committee on how to increase visibility of this issue without increasing burdens on PIs in the proposal process. She also discussed the inequitable impact additional proposal requirements would place on PIs from less-resourced institutions.

### **Discussion**

The committee discussed the need for guidance for PIs on how to consider their environmental impact, and the possibility that NSF could post guidance and best practices on their website. The committee suggested providing funding for people to do research on better understanding environmental impact and being able to calculate in an auditable way. The committee suggested including environmental impacts as part of the broader impacts section of proposals or alternatively under the data management plan as to not take away from the research proposal itself, which has page limits.

### **ENGINEERING RESEARCH VISIONING ALLIANCE (ERVA) UPDATE**

**Anthony Boccanfuso**, ERVA Co-Principal Investigator (Co-PI), and UIDP President and CEO, **Pramod Khargonekar**, ERVA Co-PI, and Vice Chancellor for Research, University of California, Irvine, and **Edl Schamiloglu**, ERVA Co-PI, and Associate Dean for Research and Innovation, School of Engineering, University of New Mexico, gave an update on the activities of ERVA, a 5-year NSF cooperative agreement that started two years ago.

They presented on the mission of ERVA to identify and develop societally impactful bold new engineering research directions that catalyze the engineering research community's pursuit of innovative high-impact research. They discussed how visioning events obtain and integrate input from engineering stakeholders into one coordinated voice; communicate opportunities and priorities in engineering; and strengthen connectivity across diverse stakeholders. They discussed ERVA outcomes, such as identifying lines of research ripe for engineering community pursuit; providing actionable recommendations for academia, industry, and government; and raising awareness of the role of engineering to advance the nation's pursuit of high-value, high-return research. They discussed their engagement strategy, the evolution of the ERVA team and structure, and how they have continued to adapt and optimize operations. They gave an overview of published reports and plans for future reports.

### **Discussion**

The committee discussed how ERVA is playing a role with the CHIPS & Science Act and how this could be an opportunity to support ideation to generate and harvest ideas in the semiconductor space, but also the need to not replicate what others are already working on. They discussed opportunities for engineering in biology and health and how ERVA plans to have more visioning events around health and medicine. They discussed ERVA collaborations with industry and how ERVA has established connections there.



The committee suggested that ERVA could play a role in establishing communities around their visioning themes, rather than publishing static reports, and the possibility for follow on events, social media, and periodic updates on the report themes. They discussed the benefits and pitfalls of in-person and virtual events and the ERVA team mentioned that visioning themes do include online discussion prior to events as well as dissemination and feedback gathering after events, to include a broad range of people.

The committee discussed how to increase the awareness of ERVA activities and their reports, such as including ERVA reports in the FY24 budget language and meeting with congressional staffers to get feedback and inform future visioning events.

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

**Robin Coger**, ENG Advisory Committee Co-Chair, reminded the committee of the teams that will be speaking to the Director's Office around three themes:

1. The opportunity for engineering to be a leader in addressing climate change adaptation and mitigation.
2. The low funding rates of the ENG Directorate and how this impacts early career researchers.
3. Multiple pathways are critical for engineering workforce development.

The committee chose to use this time to discuss the topic of engineering leadership in climate change adaptation and mitigation and developed the talking points they wanted to bring to the attention of the Director's office. They chose to emphasize that a systems approach is critical and that this is something engineers excel at; that the ENG Directorate should take a strong leadership role in this space, because as a nation, we are not on track with emissions trajectories; and that climate change is impacting human health, that this is understudied, and ENG needs to help with new technologies; and that engineering education and workforce development will be essential to achieve these goals.

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

**Dr. Margulies** welcomed Chief Operating Officer Karen Marrongelle and Chief of Staff Brian Stone. Everyone introduced themselves.

**Dr. Marrongelle** thanked the committee members for their service and welcomed any advice.

**Dr. Jamieson** informed Dr. Marrongelle and Mr. Stone of the three topics that the committee would like to discuss and presented on the topic of supporting multiple pathways to develop the engineering workforce and engaging the "Missing Millions." She spoke about supporting widespread access to engineering for even the youngest students to meet the workforce needs necessary for the CHIPS Act and beyond. She brought up the need to explore new tools to make assessments of current approaches and investments in broadening participation and workforce development. She mentioned the importance of NSF ENG playing a role in supporting AI and Data Science research.

**Dr. Marrongelle** agreed that engineering should have a role in reaching the "Missing Millions" and that NSF should empower teachers to renew their curriculum through programs like TeachEngineering. She

applauded the committee for thinking about making progress in broadening participation and knows that institutional transformation is necessary. She mentioned that the National Science Board is reviewing merit review criteria and encouraged the committee to further think about broadening participation in the context of merit review, focusing on institutions in particular.

**Dr. Stone** agreed that engineering workforce development is an important issue, and that NSF should think about supporting activities at the K-12 and community college levels.

**Dr. Jones** spoke on the low funding rates of ENG and the concern for how this affects early career researchers. She recommended that funding in engineering should be increased to meet increasing proposal demand.

**Dr. Bott** spoke about how the increases in the ENG budget in recent years are commendable, however the funding level for ENG should be commensurate with how important engineering is to our society.

**Dr. Marrongelle** encouraged ENG to focus on telling engineering impact stories, or stories about loss of impact that we will feel if we are not able to advocate for and fund the best ideas. **Dr. Margulies** can use these stories in working to set up partnerships to make sure all the great ideas have some way to get off the ground.

**Dr. Furse** emphasized that for climate change adaptation and mitigation, a systems approach is critical; that the ENG Directorate should take a strong leadership role in this space; that climate change is impacting human health, and ENG needs to help with developing new technologies; and that engineering education and workforce development will be essential to achieve these goals.

**Dr. Marrongelle** agreed that ENG should be involved in climate change adaptation and mitigation, and she encouraged the committee to loop back to this topic in future meetings to provide advice about the role of ENG in this space.

**Dr. Stone** mentioned that NSF has leadership that promotes partnerships with other agencies and that they are well set to interface with other agencies on this issue.

**Dr. Marrongelle** appreciated the committee's thoughts, encouraged them to loop back on the topics of climate change and broadening participation to clearly define their recommendations, and thanked the committee for their time and attention.

## **REPORTS FROM ADVISORY COMMITTEE LIAISONS**

**Dr. Amy Walton**, Deputy Assistant Director, NSF Office of Advanced Cyberinfrastructure (OAC), Advisory Committee on Cyberinfrastructure (ACCI), gave an overview of the ACCI structure and membership, and announced the departure of OAC Office Director Manish Parashar, saying this is time of transition and change. She gave updates on the last ACCI meeting, where they had updates from CISE and OAC; worked on the OAC response to the COV report; and made recommendations in the areas of broader

impacts, broadening participation, and establishing data metrics needed to assess success. Their next course of action is to define high priority areas for dealing with rapidly growing quantities of data.

**Dr. James Martin**, Committee on Equal Opportunities in Science and Engineering (CEOSE), gave a presentation around the themes of broadening participation; innovation and partnerships; and geography of innovation, intersectionality and data. He announced the completion of a new CEOSE Biennial Report draft titled, “Making Visible the Invisible – Bold Leadership Actions,” which will be submitted to the Director’s Office in May and released in June. He gave an overview of the committee’s efforts to assemble this report, which focuses on recent NSF strategies for broadening participation and advocates for a shift from diversity toward equity and institutional transformation.

He encouraged the committee to read the recent reports, “Envisioning the Future of NSF EPSCoR,” released in August 2022; and the NCSSES report on “Diversity and STEM: Women, Minorities and Persons with Disabilities,” released in January 2023.

## **STRATEGIC RECOMMENDATIONS FOR ENG**

**Dr. Jamieson** invited the committee members to share recommendations.

The committee made several recommendations around broadening participation in engineering and diversity, equity, and inclusion, such as making a shift from broadening participation to equity; examining merit review criteria; moving to action to affect change in the present moment; closing achievement gaps in early education; and thinking about ways to hold institutions accountable for transforming systems to foster inclusion.

The committee emphasized support for systems-based engineering solutions to address the climate crisis, funding to develop cross-sectional teams to tackle this issue, and providing support at the state and local levels to ramp up solutions. The committee emphasized that engineering is essential to the current state of human health and biology, and that engineering can contribute very tangibly to a health care system that needs fixing. The committee discussed lessons that can be learned from the pandemic, and that we need to establish data collection practices now that can help us understand the long-term effects that we may not see until 5-10 years from now. The committee voiced concern about graduate student stipends rising and recommends keeping that prominent in budget discussions.

## **CLOSING REMARKS**

**Dr. Margulies** thanked the committee members and the NSF team for their engaging comments, and for supporting the mission of NSF and ENG to move the needle in our nation in our quality of living and our future. She thanked **Dr. Jamieson** and **Dr. Thompson** for their service to the committee.

**Dr. Jamieson** added her thanks to the committee and for the opportunity to serve as Chair.

**Dr. Margulies** announced that **Dr. Coger** will step into the role of Chair and **Dr. Pérez** will take the role of Co-Chair.

The meeting adjourned at 12:15 p.m.