Directorate for Engineering Advisory Committee Meeting

National Science Foundation
Arlington, Virginia
October 21-22, 2015
Room 1235

ENG AdCom Members Present:
Dr. Patrick Farrell (Chair)
Dr. Gilda Barabino
Dr. Karen Butler-Purry
Dr. Susan Butts
Dr. Andres Clarens
Dr. Peter Cummings
Dr. Reginald DesRoches (day one only)
Dr. Debasish Dutta
Dr. Henry Foley
Dr. Mary Jane Hagenson
Dr. Louis Martin-Vega

ENG Senior Staff Present:
Dr. Pramod Khargonekar (Assistant Director)
Dr. Samir El-Ghazaly
Dr. Deborah Goodings
Dr. Barry Johnson
Dr. JoAnn Lighty
Dr. Alexandra Medina-Borja
Dr. Sohi Rastegar
Dr. Mihail Roco
Dr. Mario Rotea
Dr. Grace Wang

ENG AdCom Members Absent:
Dr. Curtis Carlson
Dr. Robert Chau
Dr. S. Shankar Sastry

Wednesday, October 21, 2015

The meeting convened at 12:10 p.m.

CALL TO ORDER

Dr. Patrick Farrell, chair of NSF Directorate for Engineering (ENG) Advisory Committee (AdCom), welcomed everyone to the meeting. AdCom members and ENG senior staff introduced themselves. Dr. Pramod Khargonekar, Assistant Director for Engineering, welcomed new committee members.

DIRECTORATE FOR ENGINEERING REPORT

Dr. Khargonekar started by introducing Dr. Mario Rotea as the new division director for Engineering Education and Centers (EEC), and then each division director introduced new staff members from their respective divisions. Dr. Khargonekar encouraged AdCom members to help find excellent people for open positions within the Directorate.

Reviewing the fiscal year (FY) 2015 investments and planned FY 2016 investments for ENG, he highlighted the two broad goals — to enable breakthrough research and to support national priorities — and specific investments supporting them. He described new emphases in ongoing NSF initiatives, such as advanced biomanufacturing with NSF's Advanced Manufacturing portfolio.

Dr. Khargonekar outlined ENG investments in new NSF initiatives and activities where the Directorate plays a major role, including Innovations at the Nexus of Food, Energy and Water Systems (INFEWS), Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP), and Smart and Connected Communities. He also described emerging areas in core programs, for example, Engineering Biology, and the new topics for Emerging Frontiers in Research and Innovation in FY 2016: Advancing Communication Quantum Information Research in Engineering (ACQUIRE) and New Light and Acoustic Wave Propagation: Breaking Reciprocity and Time-Reversal Symmetry (NewLAW).

Dr. Khargonekar then provided updates on INCLUDES (Inclusion across the Nation of Communities of Learners that have been Underrepresented for Diversity in Engineering and Science) and engineering education, innovation activities, and research infrastructure. He highlighted NSF and ENG efforts to improve operations, to facilitate and streamline the preparation and processing of proposals, and to communicate clearly and openly with the research community and the public.

During his remarks, Dr. Khargonekar made special requests for AdCom member input in four areas: graduate education, broader impacts, reproducibility/reliability of research, and public access to data.

Discussion
In response to a question on the implementation of programs to foster science, technology, engineering and mathematics (STEM) education, Dr. Khargonekar noted that INCLUDES is not a fundamental research study, but rather it focuses on creating new approaches to scale up the impacts of successful and inclusive STEM education. He also noted that NSF's evaluation and assessment group is examining broader impacts this year.

REVOLUTIONIZING ENGINEERING AND COMPUTER SCIENCE DEPARTMENTS (RED) OVERVIEW

Dr. Elliot Douglas presented the RED program, beginning with its NSF context and historical roots. The goals for RED are to support students in attaining professional formation as engineers, to broaden participation in engineering through cultures of inclusion, and to disseminate successful change processes nationally. The program focuses on the middle two years of the traditional four-year undergraduate engineering curriculum, and it enlists and leverages the power of engineering department heads, department culture, faculty development, as well as student internships and co-ops to achieve its goals. NSF has designed activities to create a collaborative cohort of RED institutions to share and spread successful outcomes.

Discussion
AdCom members discussed RED's use of the department chair as the fulcrum of change. They noted that teaching assistants often provide a student's primary interaction with faculty, and that some faculty may be resistant to change. Dr. Khargonekar observed that working through the department chair and supporting their visions promotes a consistent effort from all faculty members.

AdCom members recognized that institutions are better served with a continuously implemented strategy. NSF, as one player among many larger ones in education, relies on partnerships to implement and spread effective new educational approaches and activities. AdCom members also noted that the community has to be prepared to handle RED projects that do not produce the desired results.

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

Dr. Deborah Goodings presented the CMMI mission and described its investments in fundamental research for advanced manufacturing; mechanics and engineering materials; operations, design and dynamical systems; and resilient and sustainable infrastructures. The Division contributes to several NSF priorities, including Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP), Scalable Nanomanufacturing, Designing Materials to Revolutionize and Engineer our Future (DMREF), and the National Robotics Initiative (NRI). CMMI's guiding principle are to broaden participation through formal and informal avenues, and to inspire and position researchers for high-impact fundamental research. Future directions include citizen engineering, cybermanufacturing, and urban engineering.

CMMI COMMITTEE OF VISITORS (COV) REPORT

Dr. Louis Martin-Vega, AdCom member and COV co-chair, presented a summary of the CMMI COV report. The group found CMMI performing well based on analysis of the research portfolio and program management. Beyond these main performance areas, the COV made several recommendations and observations. First, panelists remain confused about how to interpret and weigh the broader impacts as the merit review criterion. Second, CMMI should continue to develop and share benchmarks and best practices for programs. Finally, the community misses the opportunity to share research results and develop professionally that was provided by the CMMI grantee conference, and the COV recommends its return. ENG program directors have a limited ability to travel, which makes interacting with the research community more challenging.

Dr. Farrell motioned for a vote on acceptance of the CMMI COV Report, and all AdCom members voted to accept it.

Discussion
AdCom members asked how CMMI determines the line between fundamental and applied research, and ENG staff explained that program directors define the line and that NSF funding helps connect fundamental and applied research but doesn't venture into applied research territory.

AdCom members compared European investment models with NSF's, which seeks advances that may not be commercialized for many years.

AdCom members observed that panelists conducting merit review are more focused on intellectual merit than on broader impacts, which may result from the lack of a measure for broader impacts. One possible solution may be procedural changes to improve understanding. Exemplars could also guide both panelists and prospective principal investigators. Institutional support and alignment of their faculty's broader impacts efforts would also help, but institutions must be motivated.

REPORT ON ENVIRONMENTAL RESEARCH AND EDUCATION (ERE) ADVISORY COMMITTEE ACTIVITIES

Dr. Andres Clarens, ENG AdCom member and ERE AdCom liaison, presented a summary of the ERE AdCom activities. Past reports of the ERE AdCom described cutting-edge research areas and recommendations that in time have become integral parts of environmental research and education. The committee is now finishing a new report with recommendations for NSF environmental research and education support, especially in interdisciplinary areas, at a time of significant environmental challenges. The report aims to help shape and secure the future of environmental research and education, and change environmental forecasts for the world.

Dr. Clarens sought ENG AdCom input about communicating and connecting with stakeholder communities and framing environmental challenges.

Discussion
AdCom members suggested that providing ready-to-implement recommendations and focusing on what technology breakthroughs can enable would help catalyze action with a high return on investment. Economic incentives are often overlooked in environmental engineering design; regional economic organizations bring the stakeholder community together with industry in a way that promotes action. Industry is a critical partner in addressing our environmental challenges.

REPORT ON COMMITTEE ON EQUAL OPPORTUNITIES IN SCIENCE AND ENGINEERING (CEOSE) ADVISORY COMMITTEE ACTIVITIES

Dr. Louis Martin-Vega, ENG AdCom member and CEOSE AdCom liaison, presented an account of the CEOSE AdCom activities. The CEOSE AdCom was congressionally mandated to advise NSF on implementation of the Science and Engineering Equal Opportunities Act, as well as other policies and activities designed to encourage full participation of women, minorities, and people with disabilities in STEM.

Prior CEOSE reports recommended NSF pursue a bold new initiative for broadening participation and identified essential components for successful implementation. The latest report focuses on accountability and metrics, what has worked, and how to scale those activities. The NSF Broadening Participation Working Group examined an array of activities in terms of boldness and potential impact, and their effort led to the creation of the NSF INCLUDES initiative in FY 2016. INCLUDES will begin with two new models — the network pilot and the youth empowerment pilot — and external evaluations.

Discussion
The group noted that the collective impact approach, which brings groups with shared objectives together, aligned well with the CEOSE AdCom goals. Launching a pilot idea like INCLUDES to seed several efforts, the next step after demonstrated success will be tying into a larger network to scale that success. The timeframe for accountability will be two years before the next report.

TOPICS FOR DISCUSSION WITH NSF LEADERSHIP

AdCom members discussed their ideas and concerns about broader impacts, mentoring, preparing doctoral graduates for diverse careers, and potential strains caused by uncertain NSF appropriations, and they decided to share these topics with the Office of the Director at the next morning.

The meeting adjourned for the day at 5:23 p.m.

Thursday, October 22, 2015

The meeting reconvened at 8:30 a.m.

PERSPECTIVE FROM THE OFFICE OF THE DIRECTOR

Dr. Richard Buckius, NSF Chief Operating Officer, told the AdCom members that NSF Director France Córdova listens closely to their perspectives and recommendations. She is very interested in preparing operationally in case a lapse in funding occurs, reducing administrative burdens on NSF staff, reducing the already low rate of proposals returned without review, and serving the research community, the public, and other NSF stakeholders.

Discussion

AdCom members brought up the inconsistent interpretation of broader impacts by investigators, reviewers, and NSF program officers. Dr. Buckius shared the concern and echoed the need for NSF to ensure that panelists know what to evaluate for both criteria, intellectual merit and broader impacts. Dr. Córdova is also delving into this discussion with NSF senior leadership.

AdCom members raised the possibility of professionalizing broader impacts at the universities to bring more knowledge and creativity to the work, and sharing these resources regionally. Dr. Buckius added that such an approach has parallels to INCLUDES.

Discussion then shifted to the potential effects of budget uncertainty on NSF operations and staff. Dr. Buckius stated that NSF can manage with a continuing resolution, however a potential shut-down in December would mean a halt in proposal processing and travel that would disrupt a critical period in the NSF award cycle. Facilities would also be negatively affected by a lapse in appropriations.

AdCom members asked about the difficulties that come from recruitment of IPAs (Intergovernmental Personnel Act employees) and other program directors from the research community. Dr. Buckius noted that temporary employees make up 40 percent of NSF staff, and Congress questions why some IPAs are paid more than government employees. NSF needs both staff continuity and staff flexibility to move with the research environment and attract new ideas. Competitive pay enables NSF to attract talented people and manage the flow of employees. NSF is also working to shorten the recruitment process.

AdCom members followed up with questions about minority representation among IPAs, including potential barriers for inclusion. Dr. Buckius remarked that NSF does well with representation of women among IPA positions, but lags behind in Hispanic/Latino and African American appointments.

The group discussed NSF support for graduate education and the role of mentoring. Because most support for graduate education comes through grants, some believe that mentorship only focuses on producing lab researchers, although this is less of a concern in engineering. Creating roles beyond the lab could help attract underrepresented minorities.

All parties agreed that good individual mentorship creates an experience that leads to success. Mentorship by teams could help minimize deficiencies in individual mentors and enable more students to have mentors who they relate to. NSF can examine language surrounding graduate student mentorship, traineeship, and research positions to ensure it sends the intended signals.

Dr. Buckius expressed appreciation for the discussion and input, and the AdCom reciprocated the sentiment.

THE FUTURE OF CENTER-SCALE MULTIDISCIPLINARY ENGINEERING RESEARCH

Dr. David Walt explained that he and Dr. Maxine Savitz are co-chairs of a committee studying the future of center-based, multidisciplinary engineering research. The ENG-funded study, organized by the National Academy of Engineering and the National Research Council, sets the stage for the next thirty years of engineering research centers and will lay out a high-level vision and opportunities for the future.

The study committee, whose membership is nearly confirmed, will have less than 18 months between its first meeting on December 14-15, 2015, and completion of the report. A community gathering, scheduled for January 25, 2016, will provide an opportunity for broader input.

Discussion
AdCom members asked about the process for developing the report and recommendations. Dr. Walt stated that based on experience with ten National Research Council committees, the process for the committee will be to gather information, discuss, and deliberate. Later committee meetings will include guests to fill topical gaps identified at the January symposium. Then, they will outline opportunities and challenges by shaping constructs, recommendations, and messages for the report. Refinement will take place over the following months as ideas are challenged and sharpened. The draft report is peer-reviewed.

AdCom members observed that from the institutional viewpoint, center-scale activities generate new knowledge and scholars for the next generation, and they provide a great opportunity to train undergraduate students, graduate students, and post-doctorate researchers. Student training and research priorities must be properly balanced. Dr. Walt explained the focus will be on a future-oriented vision and structure.

The audience for this report will be NSF, universities, industry and innovators, but also policy-makers. For this last group, the idea of a vision that expresses potential value to society is crucial.

Dr. Walt offered his thanks and welcomed continued input from the AdCom.

RECOGNITION OF DEPARTING ADVISORY COMMITTEE MEMBERS

Dr. Khargonekar expressed deep gratitude to three members of the Committee whose terms ended at this meeting: Dr. Peter Cummings, Dr. Mary Jane Hagenson, and Dr. Patrick Farrell.

Dr. Louis Martin-Vega will chair the ENG Advisory Committee for the next several years.

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

Dr. JoAnn Lighty presented an overview of CBET, beginning with the vision and goals of the Division. She then described CBET investments in strategic areas within NSF priorities such as INFEWS and Advanced Manufacturing, and in emerging areas such as research related to shale gas extraction. The Division

partners with other parts of NSF and agencies across the federal landscape, which increases funding for the CBET research community. CBET continues to support early-career investigators through CAREER awards, which comprised about 17% of the CBET budget in FY 2015. To ensure flexible investing in emerging, high-risk areas, CBET keeps programs focused with the help of portfolio analysis driven program evolution.

CBET COMMITTEE OF VISITORS (COV) REPORT

Dr. Mary Jane Hagenson presented a summary of the CBET COV report; co-chair Dr. Linda Abriola joined by phone. The Committee praised CBET for its conduct of merit review, panelist selection, and program management. CBET's portfolio is forward-looking, strategic, and balanced. Considering the Division's large number of proposals and portfolio scope, the COV encouraged CBET to consider new ways to conduct merit review and support researchers, and to make more use of statistical analysis and metrics related to award results for strategic planning. They also advised CBET to look at opportunities to improve business continuity.

The ENG AdCom voted to accept the report.

Discussion
AdCom members asked if funds from external partnerships support projects that NSF would have funded. Dr. Lighty replied that NSF and partner agencies fund the projects that are most important to them; coordinating the investment allows the funding to go further and serve the needs of all.

AdCom members asked how CBET ensures it funds fundamental research, and Dr. Lighty explained that CBET program directors carefully craft CBET program descriptions to seek fundamental research proposals, and they consider panelists' perspectives and what other agencies support when making funding decisions.

AdCom members asked how panels are composed for broad topics. Dr. Lighty explained that proposals are binned into smaller areas for review by relevant experts, and where there are only a few proposals NSF might use virtual panels. The group suggested that using hybrid panels would avoid the tendency to over- or under-use virtual panels, as there are trade-offs to virtual participation. Personal preference, effective technology for virtual participation, and the value of face to face interactions are key considerations in choosing what type of panel to use.

ENG staff added that they are currently developing ways to improve the hiring process and succession planning across the Directorate.

ROUNDTABLE ON ENG STRATEGIC ACTIVITIES AND RECOMMENDATIONS

Dr. Patrick Farrell opened the discussion by asking if the Committee had other subjects to pursue in the future besides graduate education and broader impacts. AdCom members mentioned that workshop reports merit a broader audience, an issue connected to public access to research results and data.

Reproducibility remains a problem of unknown scope in engineering research and may most likely be tied to interpretation of data. Comparatively speaking, reproducibility is less problematic in engineering research due to rapid research progress and a competitive landscape where any claimed breakthroughs will be immediately tested by many others in the field.

Committee members requested an update on NSF pilot activities to manage proposal load and the merit review process, such as the use of one submission window, in order to inform discussion at a future AdCom meeting.

CLOSING REMARKS AND WRAP-UP

Dr. Farrell reminded the Committee of their next meeting on April 27-28, 2016.

Dr. Farrell and Dr. Khargonekar offered their thanks to the committee members and NSF staff.

The meeting adjourned at 12:27 p.m.