Directorate for Engineering Advisory Committee Meeting

National Science Foundation
Arlington, Virginia
April 11–12, 2012
Room 1235

ENG AdCom Members Present:

Dr. Ilesanmi Adesida (Chair)

Dr. Lance Collins

Dr. Peter Cummings

Dr. Patrick Farrell

Dr. Alison Flatau

Dr. Mary Jane Hagenson

Dr. Pramod Khargonekar

Dr. Bruce Logan

Dr. Michael Silevitch

Dr. Bruce Logan

Dr. Michael Silevitch

Dr. David Spencer

ENG AdCom Members Absent:

Dr. Linda Abriola

Dr. Enrique Lavernia

Dr. L. Gary Leal

Dr. Lueny Morrell

Dr. Mehmet Toner

ENG Senior Staff Present:

Dr. Thomas Peterson (Assistant Director)

Mr. Darren Dutterer

Dr. Omnia El-Hakim

Ms. Cecile Gonzalez

Ms. Susan Kemnitzer

Dr. Theresa Maldonado

Dr. John McGrath

Dr. Steven McKnight

Dr. Kesh Narayanan

Dr. Sohi Rastegar

Dr. Mihail Roco

Dr. Donald Senich

Dr. Robert Trew

Ms. Deborah Young

ENG Senior Staff Absent:

Dr. Robert Trew

Wednesday, April 11, 2012

The meeting convened at 11:55.

CALL TO ORDER

Dr. Ilesanmi Adesida, the chair of the NSF Directorate for Engineering (ENG) Advisory Committee (AdCom) welcomed everyone to the spring meeting of the ENG Advisory Committee (AdCom) and reviewed the materials and agenda. AdCom members and ENG senior staff, including Dr. Thomas Peterson, NSF Assistant Director for ENG, introduced themselves.

DIRECTORATE FOR ENGINEERING UPDATE

Dr. Peterson reviewed the meeting agenda and proposed dates for future meetings (October 17–18 in 2012, and two possibilities each in April and October of 2013). He informed the members about recent National Science Board (NSB) activities and NSF organizational activities, introduced new staff, reviewed the ENG budget request for fiscal year (FY) 2013, reviewed activities for the Office of Emerging Frontiers of Research and Innovation (EFRI), highlighted recent outreach to a range of communities and partners, and described recent ENG strategic activities.

Discussion

Committee members focused on issues in engineering education. They emphasized how paths from community colleges into engineering programs can increase the number of students in those programs and enhance the diversity of the engineering profession. Retention rates within engineering programs were another concern. ENG staff agreed that community colleges are important links, and they are a part of several new ENG supplement and partnership opportunities.

DISCUSSION WITH THE NSF DIRECTOR AND DEPUTY DIRECTOR

NSF Director Dr. Subra Suresh welcomed the committee and thanked them for their participation. He described the NSF FY 2012 budget request and appropriation, and he described the FY 2013 budget request and response by Congress. The FY 2013 budget was framed within the concept of OneNSF, which has been well-received so far.

With the support of Secretary Arne Duncan, NSF has been strengthening its relationship with the Department of Education in order to leverage resources in the area of STEM (science, technology, engineering, and math) education. NSF grantees have created many successful, innovative models for education that are ready to scale up through collaboration. With the number of U.S. engineering graduates shrinking, serious attention to engineering education is needed, including at the K–12 level. Dr. Suresh invited AdCom to share their advice and ideas.

He noted that NSF will have three Assistant Director (AD) positions to fill in the next year, as the current ADs for Geosciences (GEO), Mathematics and Physical Sciences (MPS), and ENG finish their terms. AdCom member suggestions for potential candidates may be sent to Dr. Adesida, who is part of the search committee.

Deputy Director Dr. Cora Marrett added that NSF invites AdCom to consider strategic collaborations between ENG and other parts of NSF, as well as with other organizations.

Discussion

AdCom members asked Dr. Suresh to describe the OneNSF philosophy, and he explained that OneNSF aims to integrate NSF's intellectual and operational activities while preserving unique aspects of NSF.

The group also discussed issues related to the number and preparation of engineering students. Many students do not have exposure to engineering classes or even what engineers do until after high school. If K–12 teachers in the U.S. received the respect and the salary that teachers do in other countries (such as Singapore), more people with deep knowledge of science and engineering would consider it as a career. NSF does not directly affect K–12 teaching or curricula, but NSF can partner with the Department of Education and others to spread effective models for education to state and local levels.

Too many engineering undergraduates change majors before they have a chance to engage in creative engineering design, do research, or make connections between what they are learning and ways to make a difference in the world. Having an engineering degree is useful in many professions, and we should recognize that sometimes engineering serves as a path to other careers, and even support that path. Inspiring teachers are critical. Many STEM faculty have not been taught how to be effective teachers, and they learn primarily through trial and error once they reach the classroom. Fortunately, good undergraduate teaching has increased in importance in professional evaluations, such as those for promotion and tenure.

DEVELOPING NEXT-GENERATION ENGINEERS

Dr. Theresa Maldonado offered some context for engineering education. She described ENG strategic activities for education and outlined a number of recent reports. Personalized learning was one of the 14 Grand Challenges for Engineering identified by the National Academy of Engineering. She then shared data that showed differences by state in poverty and mental health, and reminded AdCom that our current economic situation and unemployment has both cyclical and structural components that are relevant for engineering. She posited that engineering education is a large, complex system that engineers can model and influence.

Dr. Maldonado introduced the guests for this portion of the meeting: Drs. Barbara Olds, James Lightbourne, Don Millard, and Muriel Posten, all from the NSF Directorate for Education and Human Resources (EHR); and Dr. Norman Fortenberry, from the American Society for Engineering Education.

Small Group Discussion

Facilitator Roger Burton organized the committee and ENG leadership into small, mixed groups. He instructed them to review what they have heard about the present state of engineering education and to identify the underlying assumptions that go with it.

When the groups reconvened, they discussed the context for education in the upcoming decades. One major consideration is the rapid demographic shift among young people in the U.S. Another is the world's political and economic landscape, which appears to be in the process of disruptive change. Younger engineers are generally more attuned to these shifting currents.

Like researchers who adapt to new discoveries and methods, educators can adapt to new social and economic conditions. Educational strategies will be more effective if developed and evaluated with future needs in mind. For example, with society's growing reliance on technology, an engineering

degree may increasingly serve as a springboard to a wide variety of careers instead of as a direct path to an engineering career. To serve these different students well will likely require a different sort of engineering curriculum.

With clear ideas on what to change and what to preserve, NSF may affect the culture and practice of engineering education. For example, NSF could emphasize the importance of effective teaching through the broader impacts review criterion, through award and reporting requirements, and through community engagement. Educational challenges may be met by combining the philosophical principles (or *core*) of engineering with the concreteness offered by rapid iteration and robust feedback on educational models.

The meeting adjourned for the day at 6:00 p.m.

Thursday, April 12, 2012

The meeting reconvened at 8:00 a.m.

BUILDING A SYSTEM FOR EVALUATION AND ASSESSMENT

Dr. Kesh Narayanan explained how evaluation and assessment (E&A) became critical components of the ENG strategic plan. Dr. Steven McKnight, who led the E&A working group, described the four main recommendations in the ENG strategy for E&A:

- Dedicate resources (personnel and funding) for E&A

- Establish a framework to organically incorporate E&A into ENG processes

- Benchmark and take advantage of the latest methods, systems, tools, and data for E&A

- Integrate the Committee of Visitors (COV) process and the E&A process

Dr. Alexandra Medina-Borja, ENG Program Director for E&A, described how the public and Congress have strong interest in the performance of NSF activities. E&A can help NSF be responsive to that interest and the research communities. However, E&A does not occur in a vacuum, and so ENG efforts must take into account how E&A affects other activities. Several ENG programs, such as the Engineering Research Center (ERC) and Small Business Innovation Research (SBIR) programs, have been engaged in E&A for a long time, and now the focus is turning as well to the disciplinary programs. She then introduced the plan for the morning.

THE ROLE OF THE LATTES PLATFORM IN THE BRAZILIAN INNOVATION SYSTEM

Dr. Roberto Pacheco of the Federal University of Santa Catarina, Brazil, described the Lattes platform in Brazil and its origins. Lattes serves as a national platform for strategic, operational data on individual researchers, groups, projects, and institutions. The system has become a new international standard.

When designing Lattes, the National Council for Scientific and Technological Development of Brazil (CNPq) involved the Brazilian Department of Education and more than 400 researchers in choosing data

and formats. The foremost technical goals were data quality and capabilities for cross-sectional views. Currently, Lattes pulls together data that is commonly shared on the Web, such as researcher CVs, and allows individuals to have control and authorship of the information about themselves. Lattes integrates with other platforms, such as governance and innovation. It can answer questions about scientific developments and collaboration, government funding, and industry trends.

The Lattes platform requires certain information about individuals, such as gender and nationality, and assigns each person a unique identifier. An updated CV, for example, is required in order to submit any grant proposal to the Brazilian government. Even students who are not seeking funding will submit CVs, because Lattes has become an accepted part of university culture. Because the system is used by the research and education communities, industry, and government, there are significant professional expectations on researchers to participate in the system and maintain accurate information. In one semester, 80 percent of CVs are updated, giving confidence to the recency of the data.

STAR METRICS AND DEMONSTRATION OF THE PORTFOLIO EXPLORER MODULE

Dr. Julia Lane, formerly the director of the NSF Science of Science and Innovation Policy Program, described the U.S. STAR METRICS project. The impetus for STAR METRICS was the American Recovery and Reinvestment Act of 2009 (ARRA), which funded scientific research in order to generate jobs. So STAR METRICS aimed to answer three main questions:

- How do we describe the investments we have made?

- What do we know about the workforce?

- What are the products of the workforce?

With the Lattes system as a model, STAR METRICS was designed around people and needed to align data from the portals serving the 17 U.S. agencies that administer research grants. In 2012, six federal agencies are participating in the STAR METRICS pilot: OSTP, DOE, EPA, NIH, USDA, and NSF. STAR METRICS captures information automatically, with no new effort required on the part of contributing research scientists. The system uses tools such as natural-language processing, topic modeling, algorithms for key words and topics, and automatic cross-referencing among databases in order to classify research and expenditures.

Dr. McKnight introduced the Portfolio Explorer Module of STAR METRICS, which was developed in response to ENG strategy by two AAAS Fellows in ENG, Dr. Jessica Foley and Dr. Rebecca Rosen. The Module will be used by upcoming ENG Committees of Visitors (COVs) in their studies of division activities. Dr. Rosen demonstrated how the Module can answer questions about panelist backgrounds and panel composition and appropriateness.

Discussion on National Systems for Evaluation and Assessment

AdCom members appreciated how STAR METRICS minimizes new reporting by researchers. They also suggested some ways to enhance the system, for example, by considering other economic indicators besides patents. Existing data may not capture the whole impact of research investments.

AdCom members discussed whether the system can answer the most important questions. The data at hand should not be driving our questions. Different audiences will ask different questions. To make the

system more robust will require collaboration with other federal agencies, universities, and many others.

NSF-WIDE EVALUATION AND ASSESSMENT STRATEGY

Dr. Pamela O'Neil of the NSF Office of Integrative Activities described the Foundation's long-term, high-level activities for E&A. These are underway at a number of levels: proposals, projects, programs, the whole Foundation, and science writ-large. To begin, a baseline analysis and a strong articulation of goals are necessary. We then rely on a systematic collection of information about the activities, characteristics, and outcomes of a program, for example, in order to make judgments about it, improve its effectiveness, and inform decisions. Logic models allow us to align inputs and activities with expected outputs while still in the planning stages. NSF has begun implementing new, internal requirements for E&A, such as requiring roadmaps for large, cross-cutting programs. However, goal-setting, planning, and creating logic models remain critical needs across the Foundation. In the future, NSF's two main challenges will be sufficient resources and in-house expertise to create and critique E&A designs.

STRATEGY FOR EVALUATION AND ASSESSMENT IN ENGINEERING

Dr. Medina-Borja described how the directorate is developing logic models to answer its own questions for E&A. With a conceptual logic model, E&A can be used to conduct program evaluation, portfolio analysis, and analytics for decision support. She described NSF current systems for data collection, data retrieval, and data visualization and their most pressing issues. ENG is working to address these issues in order to build the infrastructure needed for different forms of evaluation.

Discussion on NSF and Engineering Systems and Strategy for Evaluation and Assessment

AdCom members suggested that E&A practices include interaction directly with the individuals involved in a project or program, which at present happens primarily through site reviews for large projects. Virtual reviews are becoming more common, although they have some drawbacks, such as the loss of student perspectives that are offered informally during a visit.

At present, NSF is building a consistent, engaged approach to E&A across the Foundation, and is developing ways to handle special circumstances, such as jointly-funded projects. AdCom members expressed concern about how high-risk and/or potentially transformational activities with unanticipated or unknown results would fare in E&A. However, NSF is designing the logic model template with space for unforeseen outcomes and will examine investments as a portfolio. E&A must also accommodate NSF's desire to nurture potential and innovation, not just to identify who or what is already successful.

ADCOM RECOMMENDATIONS, DECISIONS, AND WRAP-UP

AdCom members expressed continued support for ENG strategic activities and leadership in evaluation and assessment. In the area of education, follow-up discussion was requested because the topic is complex. However, AdCom members offered several specific ideas, such as: recognizing master teachers of engineering, enlisting resources besides those currently in academia, and understanding how to replicate successful education models.

Dr. Adesida and Dr. Peterson thanked AdCom members and NSF staff for their contributions, and they recognized ENG staff Dr. John McGrath and Dr. Omnia El-Hakim, whose terms at NSF will end before the next AdCom meeting. The meeting adjourned at 12:15 p.m.