

## **Directorate for Engineering Advisory Committee Meeting**

National Science Foundation  
Arlington, Virginia  
October 26–27, 2011  
Room 1235

### **ENG AdCom Members Present:**

Dr. Ilesanmi Adesida (Chair)  
Dr. Linda Abriola  
Dr. Lance Collins  
Dr. Patrick Farrell  
Dr. Alison Flatau  
Dr. Pramod Khargonekar  
Dr. Bruce Logan  
Dr. Michael Silevitch  
Dr. David Spencer  
Dr. Mehmet Toner

### **ENG AdCom Members Absent:**

Dr. Lueny Morrell

### **ENG Senior Staff Present:**

Dr. Thomas Peterson (Assistant Director)  
Mr. Darren Dutterer  
Dr. Omnia El-Hakim  
Ms. Cecile Gonzalez  
Dr. Theresa Maldonado  
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. John McGrath

*Wednesday, October 26, 2011*

The meeting convened at 12:35.

### **CALL TO ORDER**

Dr. Thomas Peterson, NSF Assistant Director (AD) for the Directorate for Engineering (ENG), welcomed everyone to the fall meeting of the ENG Advisory Committee (AdCom) and reviewed the materials and agenda. He noted that the agenda would be slightly rearranged to accommodate a change in Dr. Cora Marrett's schedule. AdCom members and ENG senior staff introduced themselves.

### **DISCUSSION WITH THE NSF DEPUTY DIRECTOR**

After a welcome from Dr. Peterson, the NSF Deputy Director Dr. Cora Marrett provided introductory remarks to the committee, thanked them for their participation and welcomed their ideas. She

commended AdCom for examining the NSF and ENG strategic goals and activities, which have been a focus of previous AdCom meetings and the primary topic of this meeting. She pointed out that NSF looks to ENG for leadership in making connections between intellectually-driven and issue-driven research. A commitment to innovation and talent preparation is critical to the future. She encouraged AdCom to continue their work in providing important feedback to the ENG directorate regarding the directorate's future strategic directions.

### **Discussion**

NSF must work with others to make our priorities clear and to ensure the health of U.S. research and discovery. Carrying out strategic plans and priorities is critical when resources are limited and creative ideas are plentiful. NSF will remain committed to certain things regardless of budget, such as the investment in development of talent and enhancing discovery.

NSF will need to continue balancing the program portfolio that supports research at different scales. Advancing science and engineering requires investment in infrastructure so that new cutting-edge work can be performed, and investment in larger, more collaborative programs that capitalize on public private partnerships (such as IUCRC, ERC, I-Corps, etc.). However, NSF will not abandon support for individual researchers, who are the core of our program. The Foundation focus remains on basic research.

NSF is examining new mechanisms for conducting the merit review process which will preserve the review integrity while hopefully cutting down on cost and travel related to those reviews. NSF is seeking external input on changes to the merit review process and will provide feedback on the new ideas.

### **DIRECTORATE FOR ENGINEERING UPDATE**

Dr. Peterson reviewed the meeting agenda and proposed dates for future meetings (April 11–12 and October 17–18, 2012). He handed out an NSF communications survey and a description of potential new NSF merit review processes. He and ENG division leaders introduced new ENG staff and listed open positions. Dr. Peterson went on to describe ENG investments in basic research, innovation, next-generation engineers, and outreach. He described the ENG budget and trends. He provided an update on strategic planning activities and asked AdCom for feedback on ENG alignment with strategic goals during the meeting.

### **Discussion**

The group discussed the number of people from under-represented groups in engineering degree programs and careers. While some improvements have been made with respect to women, no major shifts have occurred in recent years despite efforts by virtually every engineering program in the country. Many of the sciences have seen greater improvements, with respect to both gender and ethnic diversity.

AdCom members asked how ENG will manage new initiatives if the budget decreases. Dr. Peterson explained that, in many cases, NSF and ENG are changing or sharpening the focus of existing activities, and that we must plan for new activities and priority areas in case the funding does become available.

In response to a question about the reception for advanced manufacturing activities, Dr. Peterson described encountering widespread support for research in advanced manufacturing, robotics, and computing, but also occasionally a misperception that basic research is not needed in these areas.

### **OVERVIEW OF ACCELERATING INNOVATION RESEARCH (AIR) AWARDS**

Dr. Karlene Hoo described the inception and purpose of the Accelerating Innovation Research (AIR) program and the initial AIR awards.

#### **Discussion**

AIR projects are led by universities and involve industry partners; how to handle proprietary information is worked out between the parties prior to applying for a grant from NSF.

The AIR program complements other NSF programs and supports innovations at the pre-venture capital stage. Support for this activity is particularly beneficial at academic institutions that are not well-connected to the innovation ecosystem.

University culture will need to change in order to foster innovation more broadly. The tenure process can reward innovation by faculty, curricula can promote innovation by students, and intellectual property practices at each institution significantly impacts the willingness of both faculty and students to engage in this enterprise.

### **PANEL DISCUSSION ON THE NSF INNOVATION CORPS (I-CORPS) PROGRAM AND AWARDS**

Dr. Peterson introduced the NSF Innovation Corps panelists—Dr. Farnam Jahanian, Dr. Dedric Carter, Dr. Babu DasGupta, and Dr. Errol Arkilic—and three AdCom panelists with connections to innovation.

Dr. Jahanian described how ENG and CISE (the Directorate for Computer and Information Sciences and Engineering) developed the I-Corps concept to link discovery, innovation, and national needs. (I-Corps is one of many ENG-CISE joint activities.) ENG and CISE then brought in other directorates. I-Corps aims to leverage NSF investments from across the science enterprise for societal benefit, and it will help educate the next generation of scientists of engineers in innovation.

Dr. Carter explained that the Office of the Director became interested because every directorate signed up to participate, and we found great candidate proposals from across the Foundation. NSF found a compelling angle on innovation that would attract the support of others; the Deshpande Foundation and the Kauffman Foundation are current partners. In addition to any commercial successes, the program will be training future scientists and engineers for entrepreneurship.

Dr. Arkilic presented an overview of the I-Corps program process and awards, which builds on a lineage of NSF-supported basic research. The \$50K awards support small teams as they engage in intense work over a six-month period to determine the commercialization potential of a technology concept.

Dr. Khargonekar described recent changes related to innovation in the region around the University of Florida. The state is geographically isolated from industry, so it's building an innovation hub and funding local companies through a high-tech corridor program. On campus, the Engineering Leadership Innovation Institute is changing the culture of the college to emphasize innovation, research for real-world problems, and student education in innovation. An interdisciplinary student design course requires an assessment of intellectual property and commercialization potential as part of the projects; so far at least five startups have resulted. There is also a graduate-level, cross-disciplinary curriculum in innovation, which is giving many students an idea of how to take basic research to market.

Dr. Silevitch described the innovation atmosphere at Northeastern University and the need to nurture innovation in both students and faculty. Despite the small award size, the opportunities that could come from an I-Corps award—opening doors and acquiring new knowledge—convinced him to assemble a project and team. The I-Corps project has revitalized their basic research and the people are demonstrating new skills and energy.

Dr. Adesida said that the two I-Corps winners on his campus received their awards in very short order. The students involved are receiving great education and are very excited by the experience. Students say that they were not aware of the business process before, but now they are learning and trying to figure out what comes next.

### **Discussion**

AdCom members discussed how the institutions of I-Corps grantees contribute to the projects. While no co-funding from the university is required by NSF, some may provide additional support to the project. During NSF's vetting process, many universities were so enthusiastic about the concept that they offered to partner financially. However, the perspectives from different positions within a university (e.g., faculty and leadership) are likely to differ. Funding for this type of work may bring the same concerns to a university whether it comes from NSF or venture capitalists.

AdCom expressed interest in tracking results and outcomes from I-Corps and in developing meaningful metrics. I-Corps grantees could license their concepts, or start a spin-off or a partnership to develop them further; new small businesses could attract SBIR funding or venture capital.

Economic development has become part of the mission for many universities, from preparing their students for innovation to supporting the state economy.

### **BREAK-OUT SESSIONS ON ENG FLAGSHIP AND BEACON ACTIVITIES**

In these breakout sessions, Dr. Peterson asked AdCom members to discuss how well ENG is actually carrying out its strategic goals. Specific actions have been recommended with respect to each of the

primary elements in the strategic plan, and the AdCom was asked to evaluate how well ENG is doing in carrying out those actions.

### **ENG Flagship Presentations and Discussion**

Dr. Peterson introduced the four overarching goals and provided more detail on the frontier research goal—a flagship activity for ENG.

Dr. Rastegar described activities of the Office of Emerging Frontiers in Research and Innovation (EFRI), how EFRI topics related to National Academy of Engineering Grand Challenges, which topics garnered co-funding from other agencies, and recent achievements of EFRI grantees. AdCom members discussed how risky EFRI projects actually are, which seems to vary by topic and community.

Dr. Bruce Hamilton of ENG introduced SEES (Science, Engineering and Education for Sustainability) and how sustainability has become more visible since the activity began three years ago. While universities are slow to change, SEES is building awareness of the social/human side of science and engineering, and it is providing a sense of opportunity through collaboration. AdCom members discussed changes in education due to SEES and agreed that NSF/ENG is definitely the leader in this area.

Dr. McKnight described the Advanced Manufacturing Partnership (AMP) and the ENG investment in advanced manufacturing and related areas, which is carried out through the ENG core programs. The idea is to enhance U.S. competitiveness in the long term through basic research.

Dr. Trew talked about research in robotics and cyber–physical systems, which eventually will build intelligence into hardware for a wide variety of applications. Such research also helps interest children and the general public in engineering.

The discussion about ENG frontier research broadened from particular research areas to foreign collaborations. These are usually ground-up and ad-hoc activities, except for the third-generation Engineering Research Centers and the new initiative Science Across Virtual Institutes (SAVI). Some international collaborations are more successful than others; bilateral agreements work best when both parties are equally interested. ENG should focus on the “mutually beneficial international collaborations” that are most strategic.

AdCom members stressed the importance of supporting creative ideas, whether through EAGER grants or elsewhere, and helping those ideas develop.

### **ENG Beacon Presentations and Discussion**

The session began with two brief presentations about the ENG goal to prepare the “Engineer of the Future.” Dr. Omnia El-Hakim gave an update on activities related to broadening participation, including workshops, outreach, and grants. She also described recent NSF efforts to enhance career-life balance. Workshops are collaboratively funded between the ENG Office of the Assistant Director and divisions; sometimes other parts of NSF contribute also.

Dr. Theresa Maldonado described an important change in education strategy that begins with understanding the real needs of the stakeholders. Engineering educators must look ahead at what jobs will be available and what skills will be in demand. ENG staff are examining broadening participation strategies holistically and the entire framework for engineering education research. Engineering centers will be using best practices more systematically. Improvements must be implemented across engineering programs, not just at the top schools, in order to affect the entire engineering workforce of the future.

Regarding the ENG goal to cultivate an innovation ecosystem, AdCom members discussed what the proper role is for NSF in the innovation space, for example, whether teaching innovation (through programs like I-Corps) or researching how innovation occurs should be part of the NSF portfolio. Some were unclear about what NSF means by “innovation ecosystem,” and some stressed the importance of strengthening innovation at the regional level.

While the goals are worthy, ENG should focus on what they do uniquely and well, and where they can have an impact. NSF can model innovation and enable others to do it, and NSF can foster an environment that is conducive to research and innovation.

Measuring results and outcomes is important. While NSF’s primary goal must remain basic research, there is a need for translating some of the fruits of basic research into commercial products and processes. . Newer faculty members are embracing the twin roles of research and innovation.

Regarding the ENG goal to develop next-generation engineers, with billions spent on engineering education across the country, how can NSF’s relatively small contribution have the greatest impact? NSF can devote effort to leading and sharing its best ideas.

Although the diversity of engineering students and the workforce has barely changed over the last decade, the conversation about broader impacts has changed. NSF can look for ways to connect with people at the ground level and replicate activities that make a difference.

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

*Thursday, October 27, 2011*

The meeting began at 8:20 a.m.

#### **DIVISION OF ELECTRICAL, COMMUNICATIONS AND CYBER SYSTEMS (ECCS) OVERVIEW**

Dr. Robert Trew, ECCS division director, gave an overview of the division, explaining how frontier research areas have changed in recent times and how the division is adapting. Funding rates are fairly steady and average award size is increasing in order to accommodate real project needs. The Division’s future areas of emphasis include: Science and Engineering beyond Moore’s Law; flexible electronics; energy and power; cyber–physical systems; Enhanced Access to the Radio Spectrum; and robotics.

#### **Discussion**

Dr. Trew explained the complexity involved in deciding on future directions for the Division, which is influenced in part by the Program Directors (PDs), recommendations from numerous workshops, and input from other agencies. ECCS is working with education groups and engineering departments in order to support the development of new engineering faculty and researchers.

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

Dr. Margaret Murnane presented an overview of the recent ECCS COV report. The findings overall were positive—they described active and strategic management, strong organization, and teamwork at ECCS. The COV found that the review process is thorough, inclusive, and effective. They were concerned with proposal pressure and agreed the Division should consider restricting the number of proposals per PI (principal investigator) while working to better understand the underlying causes of the pressure. There is confusion about the meaning of the broader impacts criterion, and the COV suggested efforts to educate PDs and PIs on the subject. Other recommendations included bringing on an ECCS Deputy Director and strategic collaborations with other agencies to leverage resources.

#### **Discussion**

The committee discussed options for decreasing proposal pressure by, for example, limiting PIs to one proposal per program. There was concern that the broader participation requirements lack teeth and may result in gaming in the short-term, at least until there is a change in the local culture of universities. In that regard, NSF's role beyond funding was discussed, and Dr. Peterson explained that ENG supports collaborations with other agencies and industry as well.

### **REPORTS AND DISCUSSION FROM BREAK-OUT GROUPS**

#### **Flagship Group** (Drs. Logan and Spencer reporting)

ENG activities in three of the four areas supporting Goal 1 (Frontier Research) were A-plus. They expressed concerns about the quality of international collaborations yet were unsure how strategically important such collaborations should be. The Directorate should consider cutting back on the importance placed on international activities.

#### **Beacon Group** (Dr. Abriola reporting)

Regarding Goal 2 (Innovation Ecosystem), the discussion focused more on new efforts and less on existing programs. They requested further information to put these programs into context with one another and the broader goals. What is the unique role for NSF in this space and how can we focus and measure success? There was discussion on whether the role of NSF should be in understanding the mechanisms of innovation or in active participation in the laboratory to market transition.

Regarding Goal 3 (Education), there was discussion on the value of NSF investments in broadening participation. NSF should identify what precisely is its role and what value it contributes. ENG can help NSF as a whole to prepare students to innovate, which might be the most significant broader impact of programs such as I-Corps.

### **RE-EXAMINING THE MERIT REVIEW PROCESS**

Dr. Farrell is the representative from an NSF-wide advisory committee for the merit review process, which includes a member from each AdCom. The committee is looking for ways to enhance the current system in light of increased proposal pressure and technological advances. Dr. Candace Major and Dr.

Stephen Meacham, co-chairs of the NSF Merit Review Working Group, presented six options being studied and piloted to understand their advantages and disadvantages in different situations.

### **Discussion**

Overall reaction to all six options for modification of the merit review process was lukewarm. AdCom members suggested alternative options for consideration, for example, a mentoring system to enhance the quality of PI proposals, proposal-writing workshops, and routing resubmissions back to their original review panels.

### **ADCOM RECOMMENDATIONS, DECISIONS, AND WRAP-UP**

The AdCom expressed appreciation for the chance to discuss progress on ENG strategic activities. Several members suggested that ENG build in mid-course evaluations for its longer-term strategies. ENG was asked to think about ways to support mid-career faculty who have a track record of excellent work. Another issue is the coming changes in higher education—not just in teaching and students, but in operations and credentialing. There was additional discussion of broadening participation and getting more young students into the engineering pipeline, perhaps through mentoring programs, Research Experiences for Undergraduates programs, and interdisciplinary versions of capstone programs.

Dr. Adesida and Dr. Peterson thanked AdCom members and NSF staff for their contributions, and the meeting adjourned at 12:00 p.m.