

**Directorate for Engineering Advisory Committee Meeting**

National Science Foundation  
Arlington, Virginia  
April 15-16, 2015  
Room 1235

**ENG AdCom Members Present:**

Dr. Patrick Farrell (Chair)  
Dr. Karen Butler-Purry  
Dr. Curtis Carlson  
Dr. Debasish Dutta  
Dr. Mary Jane Hagenson (by phone, day one only)  
Dr. Enrique Lavernia  
Dr. L. Gary Leal  
Dr. Louis Martin-Vega  
Dr. S. Shankar Sastry  
Dr. Ann Savoca  
Dr. David Spencer

**ENG Senior Staff Present:**

Dr. Pramod Khargonekar (Assistant Director)  
Dr. Samir El-Ghazaly  
Dr. Deborah Goodings  
Ms. Judy Hayden  
Dr. George Hazelrigg  
Dr. Barry Johnson  
Dr. JoAnn Lighty  
Dr. Alexandra Medina-Borja  
Dr. Don Millard  
Dr. Sohi Rastegar  
Dr. Mihail Roco  
Dr. Grace Wang

**ENG AdCom Members Absent:**

Dr. Robert Chau  
Dr. Peter Cummings

*Wednesday, April 15, 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 members.

**DIRECTORATE FOR ENGINEERING REPORT**

Dr. Khargonekar started by reviewing the agenda, introducing new leadership and staff, and recognizing recent retirements. He then described the recent fiscal year 2016 budget request for NSF's Directorate for Engineering. He highlighted the leadership role for Engineering research in several new cross-directorate initiatives: Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS), Risk and Resilience, Understanding the Brain (UtB), Inclusion across the Nation of Communities of Learners that have been Underrepresented for Diversity in Engineering and Science (INCLUDES), and Urban Science/Smart Cities. He then described emerging areas within ongoing ENG priority areas, such as bio- and cyber-manufacturing, optics and photonics, engineering education, and Innovation Corps. New awards are anticipated in summer 2015 for Natural Hazards Engineering Research Infrastructure (NHERI) and National Nanotechnology Coordinated Infrastructure (NNCI). He concluded with an invitation to

AdCom members for their ideas on education, broadening participation, and emerging research questions.

### **Discussion**

AdCom members expressed concern that NSF's efforts to increase participation in engineering by women and minorities, which focus on post-secondary students, come far after the critical time for influencing students, which research shows to be from 3<sup>rd</sup> through 8<sup>th</sup> grades. Requiring mentoring plans for graduate students might be a simple improvement. ENG expects to collaborate across NSF and with external partners to leverage and scale successful broadening participation activities via INCLUDES.

AdCom members asked whether NSF-funded researchers are able to work with the best people in the world. Principal investigators forge the majority of international relationships based on their own preferences. In international projects, NSF can fund only the component for U.S. researchers. NSF and foreign agencies also must agree on topic areas and a process for merit review when forming a partnership. Funding for travel also can affect the ability of investigators and NSF program directors to forge and maintain partnerships.

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

Dr. Samir El-Ghazaly presented the ECCS mission and described its programs for the fundamental research underlying devices, components, and systems and network engineering for applications in energy and power, controls, networks, communications, computation, and sensing. The division also supports education of a diverse workforce in electrical and computer engineering. ECCS contributes to several NSF priorities, including Cyber-Physical Systems (CPS), Enhancing Access to the Radio Spectrum (EARS), the BRAIN Initiative, and the National Robotics Initiative. ECCS will also support and manage the National Nanotechnology Coordinated Infrastructure (NNCI). At the same time, the division's support for core research remains steady and support for CAREER awards has increased. ECCS anticipates growing its investment in several emerging, and potentially disruptive, technology areas, such as smart cities, low-power computing, and photonics.

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

Dr. Karen Butler-Purry, AdCom member and COV co-chair, presented a summary of the ECCS COV report, which the group found to be performing well overall. The Committee made several recommendations for the division. First, ECCS should carefully monitor the effects of having only one unsolicited proposal window, particularly any effects on junior faculty, who may miss the proposal window as they settle into new positions in the fall. Second, ECCS uses a mixture of on-site, virtual, and hybrid panel reviews, and should continue to study which form works best in different situations. Third, principal investigators continue to experience confusion about broader impacts and may not give this portion of their work the attention it deserves; reviewers are confused about how to weigh broader impacts when evaluating a proposal. Can ECCS (or NSF) clarify broader impacts and/or allow them to be included in proposals when they arise naturally? Fourth, the Committee underlined the importance of core programs and didn't want investment in initiatives to weaken core investments. Last, the Committee of Visitors suggested that the process for EAGER proposal submission and review become more transparent.

### **Discussion**

AdCom members remarked on the growing percentage of investigators who opt out of answering demographic questions on their proposal and how helpful that information would be.

AdCom members asked Dr. Butler-Purry to elaborate on the COV discussion concerning broader impacts. She observed that the goal of broader impacts is an effective activity, not simply checking a box or stating an intention to reach out to historically black colleges and universities, for example.

Dr. Khargonekar explained that the broader impacts merit review criterion has roots in The America COMPETES Act of 2007 and is not the same thing as broadening participation (although broadening participation could be a broader impact). Specifying activities to serve as broader impacts would eliminate flexibility for investigators. What may better serve investigators and broader impacts is institutional participation.

Committee members discussed the difficulty of evaluating broader impacts in proposals.

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

### **PANEL ON NEW DIRECTIONS FOR BROADENING PARTICIPATION WITH NSF INCLUDES**

Dr. Patrick Farrell introduced panel members Dr. Joan Ferrini-Mundy, Assistant Director for the NSF Directorate of Education and Human Resources, and Dr. Wanda Ward, Head of the NSF Office of International and Integrative Activities.

Dr. Ward emphasized both the importance and trailblazing nature of the broadening participation challenge. Building on the past success of increasing STEM participation, INCLUDES will focus on measurable outcomes and approaches that are scalable to achieve documented impacts on broadening participation.

Dr. Ferrini-Mundy underscored the importance of the beginning stages of a new initiative. This will be a campaign to catalyze the scientific community, with a thematic focus beyond NSF. Broadening participation is an asset and a solution that will bring better science. Some kind of infrastructure connecting communities could address systemic sources of talent at the K-12 level. Talking to communities to find agreement on goals and then aligning our actions will be critical for a collective impact.

Dr. Khargonekar introduced Dr. Roger Wakimoto, Assistant Director for the NSF Directorate for Geosciences. Dr. Wakimoto stressed the solidarity among NSF assistant directors on this initiative and the brave nature of elevating broadening participation as an NSF-wide initiative. To get the best science the country needs broader participation.

### **Discussion**

In order to reach K-12 students and nurture their interest in STEM, NSF and the Department of Education can partner in advocating and disseminating a shared vision. However, new efforts are more likely to gain traction if tied to something that people are already familiar with. A national perspective with local implementation implies that the former is telling the latter what to do in an unwelcome way. Rather, NSF can tap into, align, and amplify local activities.

Addressing academic readiness at the K-12 level will not eliminate the prevalence of under-prepared undergraduate students or students who leave engineering during undergraduate years for reasons other than preparedness. The question becomes: are some problems too big to achieve measurable success against? What transformative concepts will address the lack of access to education for a big subset of young people, similar to bookmobiles helping address the lack of access to libraries?

Dr. Khargonekar introduced Dr. James Kurose, Assistant Director for the NSF Directorate for Computer and Information Science and Engineering. Dr. Kurose compared the current discussion to the CISE AdCom discussion about education and systemic problems. Identifying a problem that is too big can lead to a solution that does not solve anything real. Systemic solutions embed themselves into the system and persist there, similar to the creation of a computer science Advanced Placement course.

Students want meaningful course content and teaching style. Disruptive innovation would mean changing the framework and moving away from a sole focus on curriculum. STEM as a four-year educational program could give way to STEM as a talent to be developed and matched to how people want to impact the world. Curriculum would flow easily from such a framework. Gains need to be institutionalized to survive leadership changes.

#### **INCLUDES BREAK-OUT SESSIONS**

##### Scaling Local Success

The group discussed approaches that successfully engage women and minorities, such as project-based learning, mentoring, and forming personal connections between families and teachers/principals. One solution will not fit all situations, and results may be incremental within such a complex system. NSF's role may be small within this scenario.

##### Catalytic Innovations

The group suggested that NSF pursue simple ideas that divisions can pilot easily. They favored using a pot-of-gold approach rather than penalties for non-compliance. NSF might institute a prize or an institutional scorecard for diversity in STEM (and possibly publish the results). Other ideas involved reaching young students in remote areas with new technologies, such as virtual labs, and broadening use of more established methods, such as project-based learning.

##### Collective Impact Strategy

The group reported that a variety of pilot projects with the common themes of innovation and entrepreneurship should tap into and build excitement. Each university might be given money to think of solutions, with social scientists involved in the process to make success scalable. Any efforts to broaden participation should be firmly linked with advancing science and engineering.

The meeting adjourned for the day at 6:20 p.m.

*Thursday, April 16, 2015*

The meeting reconvened at 8:31 a.m.

#### **PERSPECTIVE FROM THE OFFICE OF THE DIRECTOR**

Dr. Richard Buckius, NSF Chief Operating Officer, told the AdCom members that NSF Director Córdoba listens closely to their perspectives and recommendations. She is very interested in broadening participation in science and engineering, partnerships to leverage our capabilities, and serving the research community, the public, and other NSF stakeholders.

### **Discussion**

AdCom members described their ideas from the INCLUDES break-out sessions. They recognized India's innovation week as a great example of collective impact strategy. NSF can serve as the backbone for such an initiative; however other organizations will have to step up where NSF is limited. Silicon Valley is facing the same challenges to workplace diversity, and some of those CEOs could join NSF's initiative for broadening participation.

Dr. Buckius responded that, like the I-Corps program, a small financial investment can grow with the investment of many people. INCLUDES is starting the same way, with the potential to scale after identifying early priorities.

The discussion then shifted to options for alleviating the workload on Principal Investigators when resources are limited and the current success rate hovering around 17 percent. Most options involve tradeoffs. For example, NSF could award more grants if they are smaller or shorter in duration, but then some institutions and students would be marginalized.

Dr. Buckius pointed out that NSF looks beyond success rates and funds the very best ideas for research and education. Directorates are trying things to reduce the workload on Principal Investigators, such as shortening proposals or using pre-proposals. NSF would welcome suggestions from the Advisory Committee to improve the success rate.

The discussion moved to the relationship between NSF and research universities. In the shifting funding environment, universities have stepped up to fill gaps in funding; where is this trend heading in the next ten years?

Dr. Buckius stated that, while on average 22 percent of every dollar funded comes from universities, self-reported contributions among the top 100 schools vary widely. NSF currently funds 1,900 institutions and will continue to value and need many, diverse institutions to conduct research and prepare the STEM workforce. Everyone involved will feel financial pressure, including students. Corporations and economic demands will bolster university support for STEM education and research.

AdCom members remarked that, in the past, NSF has not been subject to much controversy within Congress. Recently NSF's merit review process has been under scrutiny.

Dr. Buckius noted that there is concern over what the criticism does to young scholars, particularly those whose research is singled out, and to the engineering community as a whole. Exposing members of Congress to researchers with passion for science and engineering and to the fruits of their research is crucial.

AdCom members asked how NSF handles convergent research, and Dr. Buckius responded that ideally scholars could submit proposals to NSF and not need to designate a program within NSF. However, they

are handled within programs and directorates, or by the Office of Integrated Activities. It is a situation that NSF studies.

### **EMERGING FRONTIERS IN RESEARCH AND INNOVATION (EFRI) OVERVIEW**

Dr. Rastegar presented an overview of the EFRI program, beginning with its mandate and its criteria and process for choosing research topics. He described some of EFRI's recent outcomes, including (1) the creation of a center and new community of researchers, (2) the creation of a new interdisciplinary program within ENG, and (3) the creation of promising new technologies. He also described EFRI's work in the area of broadening participation. While EFRI's Research Experiences and Mentoring (REM) supplement activities are showing promising early results, the participation of women and underrepresented minorities as investigators remains a challenge.

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

Dr. Gilda Barabino, COV co-chair, presented a summary of the EFRI COV report. The COV praised the leadership and operation of the EFRI program. The Committee expressed concerns about the additional workload placed upon program directors responsible for managing EFRI topics. While they agreed that the EFRI program should involve participants from industry, Committee members had differing perspectives on the optimal extent of that involvement, for example, during topic selection and/or proposal review. The Committee lauded the REM activity and encouraged ENG to make more targeted outreach efforts to increase diversity among EFRI investigators.

#### **Discussion**

AdCom members inquired about most recent topic selection process. EFRI experimented with a blind review of topics where researchers and institutions were not revealed until the end of discussions with the engineering directorate senior leadership. Blind review of proposals is not currently feasible because the expertise of investigators is taken into consideration.

AdCom members also discussed what incentives exist or could be adopted to encourage principal investigators to seek REM supplements and expand engagement with students.

The motion is put forth to vote on acceptance of the EFRI COV Report with additional thanks to the COV members; the AdCom voted to accept the EFRI COV report.

### **ROUNDTABLE ON ENG STRATEGIC ACTIVITIES AND RECOMMENDATIONS**

Dr. Pramod Khargonekar opened a discussion about how NSF initiatives work and the importance of communication with the community about how initiatives are developed at NSF. NSF-wide initiatives, such as Innovation at the Nexus of Food, Energy, and Water System (INFEWS), are constructed primarily based on the feedback and input from the research community, the NSF program directors and emerging research trends within core programs.

AdCom members suggested that this may be a perception problem rather than a substantive problem for the research community, who are concerned about future funding opportunities and where research directives come from. Dr. Khargonekar explained that research areas in initiatives originate with the community and are absorbed by NSF program directors through conversations, proposals, publications,

and workshops. NSF leadership connects community research priorities with national priorities to form coherent initiatives and make significant advancements in scientific knowledge and innovation.

Committee members commended the Directorate for leading initiatives, and the Directorate does a good job of transitioning new initiatives to core programs and maintaining, and even growing, funding for the engineering research community in a time of dynamic budgets.

AdCom support and insights for INCLUDES will be important, as initial activities in FY 2016 grow over the course of five years. INCLUDES has the potential to influence existing investments as a social movement. Broadening participation activities must be aligned, integrated, and leveraged. The concept of inclusion may be ideal but is more difficult to measure than participation.

AdCom members plan to continue the discussion about broader impacts and ways to help the community by clarifying what it means and how to implement it.

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

Dr. Farrell reminded the committee of their future meeting dates on October 21 and 22, 2015. Dr. Khargonekar announced the 2015 Waterman Award winner as Dr. Andrea Alù, a recipient of ECCS funding.

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

The meeting adjourned at 11:56 a.m.