Directorate for Engineering Advisory Committee Meeting

National Science Foundation
Arlington, Virginia
April 17-18, 2013
Room 1235

ENG AdCom Members Present:

Dr. Patrick Farrell (Chair)

Dr. Linda Abriola

Dr. Lance Collins

Dr. Peter Cummings

Dr. Alison Flatau

Dr. Mary Jane Hagenson

Dr. Enrique Lavernia

Dr. Bruce Logan

Dr. Ann Savoca

Dr. Michael Silevitch

Dr. David Spencer

ENG Senior Staff Present:

Dr. Pramod Khargonekar (Assistant Director)

Ms. Cheryl Albus (on day 2)

Ms. Susan Kemnitzer

Dr. Theresa Maldonado

Dr. Steven McKnight

Dr. Alexandra Medina-Borja

Dr. Kesh Narayanan

Dr. Sohi Rastegar

Dr. Mihail Roco

Dr. Robert Trew

Dr. Grace Wang

Dr. Rose Wesson

ENG AdCom Members Absent:

Dr. L. Gary Leal

Dr. Mehmet Toner

Wednesday, April 17, 2013

The meeting convened at 12:00 p.m.

CALL TO ORDER

Dr. Patrick Farrell, the chair of the NSF Directorate for Engineering (ENG) Advisory Committee (AdCom) welcomed everyone to the spring meeting of the ENG AdCom and reviewed the materials and agenda. AdCom members and ENG senior staff introduced themselves. Dr. Kesh Narayanan, NSF Deputy Assistant Director for Engineering, highlighted recent budget activities and explained that Dr. Khargonekar was on Capitol Hill for testimony to the House Science Committee. The Committee asked to have time to prepare for the session with Dr. Cora Marrett, and Dr. Farrell agreed to set aside time during the afternoon discussion period.

UPDATE ON ADVANCED MANUFACTURING

Dr. Steven McKnight, Division Director for the ENG Division of Civil, Mechanical, and Manufacturing Innovation (CMMI), described the President's Advanced Manufacturing agenda and how ENG programs and NSF solicitations support it. One highlight is the National Additive Manufacturing Innovation Institute, launched in August 2012 as a collaboration between NSF, the Department of Energy, the Department of Defense, and others. During the President's 2013 State of the Union Address, he announced a plan for three more Institutes to build a national network for innovations in advanced manufacturing, and NSF will participate in these too.

Discussion

AdCom members noted that manufacturing ventures encounter challenges when scaling up, and Dr. McKnight noted that the Institutes are designed to address this issue. The current Institute has a 50-50 cost sharing arrangement and expects to be self-sustaining within five years; it is already gaining industry members. The new Institutes will be structured in a similar way; however, Institute elements and industry interest will vary depending on the manufacturing topic and its community. Supply chain security has been a concern for some time, and there's growing interest in cybersecurity research with respect to manufacturing.

UPDATE ON ENGINEERING EDUCATION

Dr. Theresa Maldonado, Division Director for the ENG Division of Engineering Education and Centers (EEC), described NSF's recent workshop and strategy development in engineering education. The community faces the question: What characteristics will distinguish U.S. engineers in the future?

Dr. Donna Riley, ENG Program Director for Engineering Education Research, began with a summary of NSF support for engineering education over the past several decades. The focus of support shifted from reform of laboratory and curriculum elements, to supporting education coalitions to meet workforce needs and broaden participation, to the conduct of rigorous education research and formation of departments of engineering education. These projects met with local success and widespread adoption of new first-year curricula; however industry saw smaller gains.

She described a vision for the program that involves an agile systems approach with the right structures; connect with cognitive and learning sciences; and access equality and affordability (connects to structures). She summarized strengths, weaknesses, opportunities, and threats with respect to preparing future engineers, and new developments, such as MOOCs (Massive Open Online Courses), that may provide new opportunities.

Discussion

AdCom members pointed out that the program's $10-million budget will make it difficult to create an impact without goals and expectations that are in line with NSF resources. They suggested focusing on two or three strategic areas where NSF has particular strengths, such as the ability to influence and coordinate. Success may be found in serving as an agent of change.

The landscape is more complicated than simply producing more engineers; some engineering schools are full to capacity. Community colleges have an important role, yet there are challenges at each transition point along paths to an engineering degree. Maybe NSF should try to generate a spectrum of interests, backgrounds, skills, etc., among U.S. engineers, because they are not commodities.

INPUT TO ENG/NSF PLAN FOR PUBLIC ACCESS TO RESEARCH RESULTS

Ms. Sue Kemnitzer, Deputy Division Director for the ENG Division of Electrical, Communications, and Cyber Systems (ECCS), introduced the request from the White House Office of Science and Technology Policy (OSTP) for NSF to create a plan for providing public access to NSF-funded research results and data. NSF must share its plan with OSTP in August 2013. Currently NSF and ENG are seeking input on NSF's initial approach, which is to tackle providing access to research publications first and then data. She asked for AdCom input particularly in the areas of assuring compliance and access.

Discussion

AdCom members encouraged NSF to seek a simple solution for sharing research results. They suggested exploring partnership with Google Scholar, which would involve negotiations with publishers, or with the National Institutes of Health, which already requires its grantees to make publications available and has agreements with publishers in place. The question of who will pay remains.

They expressed more concern about sharing research data. They questioned what business model would support this effort. They discussed what data would be reasonable or useful to share, what would be considered "data" (for example, would code be part of the data?), and how the massive quantity of data generated by some research (for example, raw data from high-energy physics) could be handled.

Another concern was how this effort might affect U.S. competitiveness and security, if compliance with ITAR (International Traffic in Arms Regulations) were to be threatened.

In support of research openness, AdCom members suggested that NSF define useful data and non-useful data and offer a way to provide what's useful. Different scales of research effort/funding might merit different levels of response.

NSF STRATEGIC PLAN

Dr. Alan Blatecky of the Directorate for Computer and Information Science and Engineering (CISE) introduced a high-level draft of the NSF strategic plan, how and why it is being developed, and how the goals shape operations and performance assessment.

Discussion

NSF must be recognizable from its strategic plan, and the NSF vision must be evident throughout the objectives. AdCom members encouraged the Foundation to think carefully about its objectives and ask why the chosen ones are the right ones for NSF.

NSF CAREER

Dr. Theresa Maldonado introduced herself and CAREER co-chair Dr. Anita LaSalle from CISE. She described a timeline of recent activities undertaken to provide oversight and advice on the NSF CAREER program, which has been in its current form since 1995. Dr. Farrell convened a cross-disciplinary CAREER Advisory Committee in fall 2012 to determine how well CAREER meets the needs of today's junior faculty. The Committee members were asked to envision how the program could develop leaders for 20 years from now. While the group's recommendations were modest, NSF has an opportunity to do something very different.

Discussion

AdCom members discussed ways that receiving a CAREER grant affects grantees —professionally, psychologically, and socially. Some members expressed concern that new limits on submission windows may disproportionately impact early-career faculty and unintentionally increase the importance of winning a CAREER grant. Early-career faculty members do not begin with a level playing field, in terms of start-up packages and university support.

They circled back to the original mission of CAREER, which was to identify and support future teacher-scholars. Integration of research and education is required across NSF but what this means differs significantly over time and among directorates.

The AdCom expressed a desire to provide more early-career faculty with opportunities for CAREER grants, whether through mentoring, expanded eligibility, shortened award duration, or other means. They also supported providing options for customization of the awards by including components besides academic fundamental research, for example through collaboration with industry or other non-academic partners.

The NSF CAREER Coordinating Committee favors offering more flexibility. It supports the removal of rules pertaining to funding levels, duration, and eligibility, and aims to offer options for award types and to emphasize leadership among all CAREER grantees.

PANEL ON LEVERAGING FUNDING FROM INDUSTRY

Dr. Grace Wang, Division Director for the ENG Division of Industrial Innovation and Partnerships, introduced the concept of leveraging —putting resources together towards a common goal to maximize return on investment. These resources may include funding, knowledge, and networks; however, this discussion will focus on NSF leveraging funding from industry. In order to increase the impacts of our investments, NSF encourages leveraging by providing incentives, such as third-party matching funds, research capacity, and commercialization assistance. A number of ENG programs leverage industry funds, totaling approximately $145 million in FY 2012. Dr. Wang invited the group to describe leveraging opportunities for now and the future.

Dr. Claire Gmachl, director of the Mid-InfraRed Technologies for Health and the Environment (MIRTHE) Engineering Research Center (ERC), discussed the ERC's academia–industry partnerships. The Center

started with a small group of very committed partners and now has about 50 industry members. Actively recruiting members was essential, and members suggested companies to recruit and networked on our behalf. Partnership pays off handsomely for them because of pre-competitive research — one start-up now has more than 100 employees, and one large company's idea has turned into products. A partner's relationship with one faculty member connects them to the whole ERC.

The pay-off for academics is research funding (from NSF and membership fees, dispersed with IAB advice) and related problems from industry that turn into sponsored research projects. A second benefit is the research that's inspired; hearing about industry needs does inspire future fundamental research. A third benefit is that our students are well-trained to work in industry settings.

Dr. Olivier Cadet of Air Liquide, a member of the Industrial Advisory Board for the Center for Excellence in Logistics and Distribution (CELDi), described why his company joined the NSF Industry/University Cooperative Research Center (I/UCRC). The decision was part of a bigger company program to improve competitiveness and efficiency, and it had strong leadership support. The company also was seeking external expertise to help with a complex optimization problem. After evaluating several centers of excellence, Air Liquide chose CELDi because of the quality and depth of expertise. Another benefit was how the knowledge and experience of other universities and companies could be leveraged through the Center. The company also gained access to student talent at several universities.

Dr. Terri Lomax, Vice Chancellor for Research, Innovation and Economic Development at North Carolina State University, discussed a recent agreement with Eastman Chemical. In contrast to Air Liquide, Eastman wanted to have a tighter/broader/deeper relationship with fewer universities. The agreement involves a guaranteed $10 million over 6 years for faculty research projects (selected by a joint team) and an Eastman Center of Innovation on campus, where eventually about 25 Eastman staff will nurture university innovation. The agreement addresses intellectual property in way that provides more certainty for both parties in the long term.

Dr. J. Christopher Ramming, Director of Intel Labs' University Collaboration Office, asserted that industry has an equal interest in leveraging, as evidenced by Intel's recent set-aside of $100 million for academic research. Intel, where 4 out of 5 employees have technical roles, invests in academic research through traditional means but also, because of its "float all boats" perspective, invests through small grants, center-scale grants, curriculum initiatives, etc. Intel wants to be both an inventor *and* an innovator, and universities offer a way to do that.

Dr. Cadet described some challenges in collaboration, which include: how to increase collaboration between industry members (e.g., to share best practices); how to ensure that knowledge is accessible to future members; how to capture and disseminate success stories; and how to invest in students. The I/UCRC structure makes it cost-effective for a company to join (whether it's big or small), but centers need help to attract smaller companies and start-ups.

Dr. Lomax suggested that, to motivate faculty to partner with industry, ENG should continue what it's doing by requiring industry partners and initiating dialogue. At the department level, shared revenue from projects serves as an incentive to work with industry. For individual faculty, however, one difficulty

is that they are often advised not to work with industry until after tenure, but it's up to universities to address this problem. Some universities have changed tenure requirements and now give faculty credit for patents and inventions.

Dr. Gmachl stated that students benefit from working with industry, whether through internships or by participating in faculty-industry research collaborations. Students like working on something they know will be used, they gain exposure to different professional environments, and they learn that quantitative specifications, timelines, etc. are important. They often become more motivated working at a company, and may be inspired by small businesses to start their own company. Some hurdles for students working with industry are funding (for example, who will pay for a summer internship at a small company?) and continuity of stipends/benefits (for example, how to justify for a grant the basic research performed in collaboration with industry?). NSF could set up something similar to the Research Experiences for Undergraduates (REU) program for industrial collaborations and could add language to more solicitations that encourages industry collaboration.

Dr. Ramming explained that Intel performs applied research, which is not well-suited for a university setting, and funds use-inspired basic research (Pasteur's quadrant) at universities. It would be difficult to find an Intel research funder who would support funding in pure basic research (Bohr's quadrant). In the U.S., government provides the funding for basic research (industry sponsors about 6 percent of basic research), and it is primarily performed in academia.

Discussion

AdCom members noted that many industries invest in use-inspired basic research at universities. They find value in ERCs, for example, getting access to students, research results and trends, and other companies' ideas. Industry also may advise university researchers on potential basic research questions to investigate. However, in the near future US industry is unlikely to invest in pure basic research in academia because the near-term value is not clear.

In the past, companies such as GM and Bell Labs permitted basic research with no clear use. Now, companies such as Google permit employees some time to pursue these kinds of projects, but this is not a reliable mechanism for investing in pure basic research. Many companies leave that responsibility up to the government. Governments in other countries are also investing heavily in basic research.

For many industries, intellectual property (IP) remains a significant hurdle to research collaborations with academia, and it must be streamlined in order for collaborations to be effective. Faculty and universities may have misunderstandings about IP and its value. Involving students in industry-sponsored research may require other protections, depending on the goal of the research.

Convincing industry leaders that these investments are worthwhile may take powerful stories about the unforeseen economic outcomes of pure basic research, even if the research encounters setbacks along the way and takes 20 years to materialize into a technology. Stressing the unique value added by collaborations with universities and other companies may also be persuasive. That value may be found in workforce development, special instrumentation, the relationships themselves, or other things.

In order to collaborate, companies must put resources into research intelligence. The right person in a company, who understands their technology needs and basic research questions and who can make a decision, must be matched with the right university research group, which has discerned impending breakthroughs on which industry can start to build. They must look at data and trends and make use of knowledge management tools.

PREPARATION FOR DISCUSSION WITH DR. MARRETT

The AdCom briefly discussed potential issues to raise with Dr. Marrett the next day and tasked members with preparing questions.

The meeting adjourned for the day at 5:30 p.m.

Thursday, April 18

The meeting reconvened at 8:00 a.m.

WELCOME FROM DIRECTOR

Dr. Cora Marrett, acting NSF Director, welcomed the Advisory Committee and opened the floor to questions.

Discussion

Dr. Farrell asked Dr. Marrett about the selection of a new director for NSF and how NSF continuity will be affected. She explained that the President chooses a nominee, who must then be vetted and confirmed by the Senate. The NSF budget will not change with the leadership transition. The agency is resilient and is working hard to ensure continuity.

Dr. Bruce Logan expressed a concern that increased leveraging of industry support might lead NSF into more applied areas of research. Dr. Marrett assured the committee that NSF remains committed to fundamental research yet is aware of ways it can bring about societal benefits. There is a lot of interplay between basic and applied research —innovations do not follow a straight path, and applied research may highlight fundamental question to investigate. ENG has a unique perspective here and can serve as a leader for the Foundation.

Dr. Alison Flateau expressed AdCom interest and concern about CAREER and encouraged greater flexibility and options within CAREER grants. Dr. Marrett responded that CAREER must foster the leadership qualities needed in the future and have a structure that serves the needs of all science and engineering fields. ENG supports more CAREER awards than many other directorates, and its recommendations will be considered carefully.

Dr. Peter Cummings inquired about the future of the Office of Cyberinfrastructure, and Dr. Marrett explained that it is returning to CISE, where it originated and has many intellectual connections.

Dr. Enrique Lavernia posited that NSF's future depends on its ability to tell its story. Dr. Marrett responded that thinking of success in terms of an increasing budget is not realistic for the immediate future. NSF needs to tap into different types of audiences and capture their imagination. It's easier to talk about where investments have been made, as opposed to predicting future outcomes. NSF is seeking advice and help from external communities to do this.

Dr. Michael Silevitch asked how to make alliances between NSF and sister agencies more sustainable. Dr. Marrett said the key is to differentiate between what is opportunistic and what is strategic. Hard-pressed program officers may have difficulty thinking about long-term strategy, and other agencies may have different strategic or time considerations, but having a unifying vision can help.

Dr. David Spencer asked Dr. Marrett if there were opportunities to increase or leverage the travel budget for NSF. She noted that NSF actually has a fund through which people may contribute to NSF outside of the appropriated funds. She also explained that NSF negotiated with the Office of Management and Budget to reduce the size of the travel decrease, explaining that the funding was necessary to properly conduct merit review and award oversight.

DIRECTORATE FOR ENGINEERING UPDATE

Dr. Pramod Khargonekar, Assistant Director for Engineering, acknowledged the contributions of former NSF Director Dr. Subra Suresh, and highlighted the background of acting NSF Director Dr. Cora Marrett. He mentioned current searches for ENG Division Directors and introduced new ENG staff. He described the NSF/ENG budget request for FY 2014, which includes major investments in national initiatives such as Advanced Manufacturing and Robotics, and NSF priorities such as Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMS) and Science, Engineering, and Education for Sustainability (SEES). He announced the FY 2014 topic for Emerging Frontiers in Research and Innovation (EFRI) projects: 2D Materials Beyond Graphene. Regarding operations, Dr. Khargonekar shared data from two ENG divisions that showed a correlation between the institution of a single proposal window and a reduction in proposal submissions. He also shared information about the growing use of virtual and hybrid panels. He ended by sharing the opportunities and challenges he sees, and posed questions to the group about strategy in the future.

Discussion

Several AdCom members asked about the ENG investment in engineering education, which is concentrated in undergraduate and graduate education, and whether there was a role for ENG in the creation of K-12 engineering education standards and curricula. Dr. Khargonekar responded that NSF does that through collaboration with the Department for Education. Dr. Maldonado added that the NSF Research Experiences for Teachers (RET) program serves high school and middle school teachers.

STATISTICAL SCIENCE

AdCom member Dr. Alison Flateau has begun serving on a new group that is exploring the NSF strategy for statistical science, which is an important part of many emerging research areas. They are

determining research themes and issues to be addressed and how best to support them (for example, through an initiative, program, or supplements). They are also debating what to call research in this new area, for example, "data science" or "science of data." She asked AdCom members to provide her with feedback, ideally by early May.

ADCOM MEMBER TOPICS

Dr. Farrell invited AdCom members to discuss what the group brings to the table in order to ensure that AdCom meetings are productive, important, and strategic, and are being conducted in an optimal way. The group may reinforce topics it thinks is important or introduce new topics.

Regarding the conduct of the meetings, AdCom members responded that they have reviewed data to understand practices and trends. When information is shared far enough in advance, members can contribute more thoughtfully to the discussion. A focus on small details or day-to-day management issues should be avoided, unless a subset of the group has a particular passion for that area. More frequent interaction might encourage deeper dives and follow through. Interactive discussion and brain-storming around a critical question (similar to the April 2012 meeting) really engages the group, and could lead to a white paper or report.

Regarding meeting topics, AdCom members suggested that they could articulate grand challenges to help prepare the community for future initiatives and to help capture the public's imagination. Grand challenges are supported by deep and broad expertise and are achieved on different timescales that typical research projects. For new initiatives, the committee could help define the ENG role.

ROUNDTABLE ON ENG STRATEGIC ACTIVITIES AND RECOMMENDATIONS

AdCom members stressed the importance of broadening participation activities and engaging more people, particularly during difficult funding climates. NSF's reexamination of the CARREER program comes at a good time. ENG should reach out to community colleges, which are a huge untapped resource, for information, collaboration, and pathways into undergraduate degrees in engineering. The topic of MOOCs should be revisited at a future meeting.

Regarding leveraging, AdCom members found appeal in NSF being a broker between academia and industry. They noted that opportunities will vary by discipline. Dr. Khargonekar posed the idea of an ENG workshop on leveraging that would feature success stories and lessons learned from different industries. Such stories could express the value of NSF-funded research to many audiences, and they would carry more weight when told by someone outside of NSF.

As the discussion wound down, Dr. Khargonekar mentioned that ENG will be recruiting new AdCom members over the next few months. The Directorate doesn't want to lose the wisdom that comes from experience; however, NSF decisions affect students and junior faculty too. Could the committee include junior faculty and students, and how would the committee work with these kinds of members?

AdCom members expressed interest in including assistant professors, formally or informally, and discussed what credentials to look for and how participation might affect their future careers. Students

might need additional preparation for meetings since they are less familiar with NSF outside of particular topics. ENG staff mentioned potential models for student inclusion, such as TAMU's student regent and the Engineering Research Center student leadership councils. In either case, a small cohort might function better than a solitary assistant professor or student. No matter what, to be worthwhile the other AdCom members and ENG staff will need to be open to their ideas and concerns.

CLOSING REMARKS AND WRAP UP

Dr. Farrell thanked committee members for their participation, and Dr. Khargonekar thanked NSF staff for arranging the meeting.

The meeting adjourned at 11:35.