Directorate for Engineering Advisory Committee Meeting

National Science Foundation
Arlington, Virginia
October 17–18, 2012
Room 1235

ENG AdCom Members Present:

Dr. Ilesanmi Adesida (Chair)
Dr. Linda Abriola
Dr. Peter Cummings
Dr. Patrick Farrell
Dr. Alison Flatau
Dr. Mary Jane Hagenson
Dr. Pramod Khargonekar
Dr. L. Gary Leal
Dr. Bruce Logan
Dr. Ann Savoca
Dr. Michael Silevitch
Dr. David Spencer

ENG Senior Staff Present:

Dr. Thomas Peterson (Assistant Director)
Ms. Cheryl Albus
Mr. Darren Dutterer
Ms. Cecile Gonzalez
Dr. Theresa Maldonado
Dr. Steven McKnight
Dr. Alexandra Medina-Borja
Dr. Kesh Narayanan
Dr. Sohi Rastegar
Dr. Mihail Roco
Dr. Richard Smith
Dr. Robert Trew
Dr. Grace Wang
Dr. Rose Wesson

ENG AdCom Members Absent:

Dr. Lance Collins
Dr. Enrique Lavernia
Dr. Lueny Morrell
Dr. Mehmet Toner

ENG Senior Staff Absent:

Ms. Deborah Young

Wednesday, October 17, 2012

The meeting convened at 8:10 a.m.

CALL TO ORDER

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

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

Dr. Steven McKnight, Division Director for the ENG Division of Civil, Mechanical, and Manufacturing Innovation (CMMI), began his overview of the division by highlighting areas within the four clusters that are in transition, such as earthquake engineering, and gaining external attention, such as engineering systems design. He described internal programmatic initiatives, such as the creation of three programs that cut across the division clusters, and participation in cross-NSF and interagency initiatives, for example, in the areas of advanced manufacturing and robotics. He shared data on proposals, grants, and award distribution, and he introduced new data visualization tools for management and evaluation.

CMMI COMMITTEE OF VISITORS REPORT

Dr. Julie Chen, co-chair of the CMMI Committee of Visitors (COV), explained that the COV was responsible for reviewing the process for proposal review and the portfolio of CMMI awards during the period of June 30, 2008, through June 30, 2011. They examined a random selection of proposals and awards from each of the four CMMI clusters. The COV found no operational procedures or processes that would have a substantive negative impact on the efficiency and integrity of the proposal review process, despite stressful conditions. They praised CMMI program directors for creating panels with appropriate representation and “teaching” the community how to improve proposals. The COV advised the division to embrace a leadership role in interdisciplinary, interagency, and international activities. They underscored the importance of in-person meetings for panels and program oversight, and they recommended careful pilot activities to explore the use of virtual meeting participation.

Discussion

AdCom members asked Dr. Chen how the COV came to its conclusions about virtual meetings, and she explained that the recommendation was based on interviews with people who participated in virtual meetings and on the examination of review summaries. Blended review panels, with a limit of five virtual participants, seem to be effective as long as the topic isn’t too broad.

In response to a question about CAREER proposals and awards, Dr. Chen stated that the CAREER projects integrated research and education quite well. Reviewers interpret broader impacts in different ways, and the panel summaries do a much better job on it. The National Science Board is examining broader impacts criteria for merit review.

AdCom members were interested in understanding long-term outcomes of awards, and ENG staff described the growing emphasis on evaluation and assessment that will help identify them.

The group was pleased that CMMI is addressing emerging areas like systems engineering head on, and connecting them with education. Program directors must keep aware of and guide new research directions through travel and workshops.

INTRODUCTION TO ENG STRATEGIC ACTIVITIES

Dr. Peterson introduced the topics of the meeting's three panel discussions—Advanced Manufacturing, Education, and Neuroscience and Engineering—as areas in which NSF has significant interest, investment, and opportunities for collaboration, both within NSF and with others.

PANEL ON ADVANCED MANUFACTURING

Dr. McKnight introduced the topic of advanced manufacturing, which has a high profile these days. Many studies offer recommendations on how to improve the posture of U.S. manufacturing, which is responsible for two-thirds of all industrial R&D and 85 percent of patents, and has a strong need for high-tech workers. While manufacturing is now much cleaner and a valued part of communities, people continue to hold misperceptions about what it is. ENG seeks to address both near-term and long-term needs in manufacturing research and education to strengthen innovation. The panelists will help NSF understand what role and opportunities are best to pursue.

Dr. David Spencer explained that his perspective is that of a business person in the recycling sector. He asked why the role of engineers in manufacturing and business isn't valued more, both socially and monetarily, because that is an important part of attracting students to engineering.

Mr. Neil Orringer described how, for the Department of Defense, manufacturing is uniquely important. They plan, design, buy, and maintain manufactured products, typically ones that are highly specialized and built in low volumes. So innovation can mean technological performance or the speed and cost of manufacturing. NSF is focused on the "invent" part of innovation but has a novel way of understanding and seeing the entire lifecycle. The National Network for Manufacturing Innovation (NNMI) is a great example of how NSF can accelerate new products to the market, develop future tools and workers, and collaborate with industry, academia, and other agencies.

Dr. Bruce Kramer explained that NSF seeks a balance between giving freedom and direction to the research community. One example of research helping industry was the use of algorithms to create schedules, which was common practice in factories at a time when airlines were still creating schedules manually. Other successes were enabling CAD files to be translated automatically into machine directions, open-access controls for machine tools, and several rapid prototyping methods.

NSF's nanomanufacturing program has resulted in many new components through methods that are more like fabrication (small-scale production) than like manufacturing; in the last few years, the scalable manufacturing program is investing in research to grow incipient ideas.

Dr. Thomas Rieker of the Directorate for Mathematical and Physical Sciences (MPS) joined the panel in place of Dr. Ian Robertson. He manages and coordinates centers, facilities, instrumentation, and partnerships for research and education materials in MPS. Dr. Rieker explained that MPS and ENG complement each other and collaborate frequently, especially the MPS Division of Materials Research in the areas of materials synthesis, modeling, characterization, and others. These collaborations occur between core programs and across the agency, for example with the Materials Genome Initiative (MGI) and Designing Materials to Revolutionize and Engineer our Future (DMREF). NSF has an opportunity to drive and coordinate education in materials science and engineering across disciplines. While it is increasingly challenging for NSF to provide experimental and computational infrastructure due to sophistication and expense, MPS supports a network model with thematic hubs and nodes and is seeking community input on future directions.

Dr. Erwin Gianchandani of the Directorate for Computer and Information Science and Engineering (CISE) joined the panel in place of Dr. Keith Marzullo. Dr. Gianchandani described NSF activities in the area of cyber–physical systems (CPS), which seek to understand how to design, build, and verify tightly coupled systems that are reliable. Cyber–physical systems would provide manufacturing with greater agility and higher control. CPS educational activities are aim to build a new ecosystem of researchers and workers.

Dr. Celeste Carter described the Advanced Technological Education (ATE) program, which prepares students, particularly those in two-year colleges, to become technicians in high-tech fields. The hands-on coursework provide high-demand skills and knowledge for technology workers. The program relies on active partnerships between academia, industry, and economic development agencies, and this model has worked for about 18 years. Recruiting students is sometimes a problem due to misperceptions about manufacturing, but other students, especially in a slow economy, seek out ATE programs to gain skills sought by high-tech employers.

Discussion

AdCom members point out that sharing on the National Nanotechnology Infrastructure Network (NNIN) is limited due to compatibility and format issues. NSF responded that data management and global architecture are important, and NSF is in contact with the community about current and future needs.

The group discussed the lack of inspiring message for the public, especially parents, about technology careers and salaries and about the flexibility that two-year degrees offer. Engineering technology degrees are sometimes perceived as lesser degrees, and some four-year schools are closing engineering technology programs. Workforces skilled in the use of technology and in the innovation of products are often distinct, but they could benefit by exposure to each other, as is done in the University of California – Irvine engineering school and in teaching hospitals.

AdCom members also discussed levers for education and for technology pull and push. These differ among government agencies but there are many opportunities for collaboration if cultural differences can be bridged. Cross-disciplinary study is needed to understand changes in the last decade, impacts on communities and supply chains, and how to leverage existing resources and systems and plug them into a new manufacturing ecosystem. The goals for U.S. manufacturing must be future-oriented and promote U.S. competitiveness. Research and manufacturing knowledge quickly spread around the world, so the U.S. must be at the forefront of the next big thing. The last big thing was computers, and the next one might be Internet-based manufacturing infrastructure, with software tools just about anyone can develop and use. Another trend is the blurring of the division between manufacturing and the service sector. Big ideas should be able to find a home in ENG programs.

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

Dr. Sohi Rastegar, acting Division Director for the ENG Division of Chemical, Bioengineering, and Environmental Transport (CBET), gave an overview of the division, beginning with its mission, vision, and main areas of focus. CBET is an interdisciplinary division, and it leads and participates in many cross-disciplinary activities with NSF and other agencies. To manage its growing proposal pressure, CBET instituted a single proposal window per program, which slightly decreased the number of proposal submissions. Nonetheless, funding rates for CBET remain lower than elsewhere in NSF. Dr. Rastegar shared award and investigator characteristics and distributions, and ended by highlighting CBET projects to improve health and sustainability.

CBET COMMITTEE OF VISITORS REPORT

Dr. Bruce Logan, chair of the CBET Committee of Visitors (COV), explained the scope and timeframe for their report. The research topics funded by CBET, while quite broad, by and large were appropriate and supported only by NSF. The performance and productivity of CBET staff were excellent, especially considering the increasing number of proposals to CBET. They found that the success rate was too low, and the award size was too small. The COV recommended that the change to using one proposal window, designed to mitigate this issue, be reviewed every few years to avoid unintended consequences. Of particular concern were potential impacts on early-career faculty. Dr. Logan finished with recommendations on conducting the COV itself.

Discussion

The committee discussed support for early-career researchers in general. While core programs may have one proposal window in CBET, there are windows in other parts of NSF that are open at different times of year, as well as windows for NSF solicitations. CBET has maintained significant funding for CAREER (at 14-16 percent of the budget). The annual funding amount for CBET awards is lower than in most other parts of NSF, and universities often must step in to help early-career faculty succeed.

AdCom members also suggested approaches to reduce proposal pressure in CBET, such as ways to handle resubmittals and to help faculty prepare better proposals. The division may attract more proposals in part because so many of its topics are interdisciplinary, and therefore of interest to more communities. The committee discussed the pros and cons of proposal review processes used at academic journals and other funding agencies. NSF has pilots underway to help evaluate different review processes.

PANEL ON NEXT-GENERATION ENGINEERS

Dr. Theresa Maldonado began with an update from the spring AdCom meeting, outlining the transition for the ENG Engineering Education Research Program and some high-profile activities. ENG has become involved in the President's Council on Jobs and Competitiveness, which aims to graduate an additional 10,000 engineers per year. NSF will contribute to this effort, for example, through the STEM Talent

Expansion Program (STEP). While undergraduate enrollment has increased by the millions, the number enrolled in engineering has been pretty flat—capacity is an issue. She introduced the panelists.

Dr. Michael Silevitch raised questions about the engineering curriculum and how well it prepares students for the work they will actually do as engineers. He stressed the importance of disciplinary and interdisciplinary strength, experience in industry and global settings, and the process of innovation and continual learning over a career.

Dr. Alan Cheville began by pointing out how little the challenges facing engineering education have changed over the last 15 years ago. At the spring AdCom meeting, the group foresaw a disruptive future for higher education and the country. To achieve an impact on such a large problem will require a systems approach. The focus of engineering education investments may range from who we teach (people—a focus with more certainty, small scale, and less research challenge) to where learning occurs (the education systems— a focus with less certainty, large scale, and great research challenge). If engineering education is treated as a large, complex, distributed system, research on that system could elucidate strategic changes that will enable the system to better meet our goals.

Dr. Eduardo Misawa described the main idea of the 5XME workshop on transformation changes for mechanical engineering education, held in 2007. If considered a commodity, engineering education in the U.S. costs five times the amount that it does in other countries. So U.S. engineers want to provide five times the value, through breadth, innovation capacity, and leadership. This requires change in all five stages of engineering education. Based on these ideas, ASME (the American Society of Mechanical Engineers) has proposed change to the ABET criteria for engineering programs to allow more flexibility.

Dr. Don Millard described several elements of good engineering education. Contemporary curricula must take into account dramatic changes in engineering tool-sets, so students know the principles behind how they work. The need for tinkering and projects are important not just for seniors, so students learn to ask themselves questions and learn. Course content should connect with other content, so students will understand integration and multidisciplinary infrastructure. The NSF Directorate for Education and Human Resources (EHR) supports undergraduate education through several prams:

- STEM Talent Expansion Program (STEP) to increase the quantity and retention of students
- Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) to enhance educational quality and curricula
- Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) to enhance scaling of educational improvements

ENG and EHR are working together to create a shared vision of change in engineering and to leverage their investments.

Dr. Daniel Hastings spoke about MOOCs (massive online open courses), having experience with edX, a MOOC platform begun by MIT and Harvard. He explained that MIT chose this path in order to redefine what a residential research university is/means. New capabilities include video on demand, connectivity, automated feedback (different from open courseware, which offers no capacity for feedback), social media, semi-synchronous delivery, crowd-sourcing, acknowledgement of certification, and others. So, disruption is here, and MIT is trying to get ahead of it. The ability to collect data on each student presents an opportunity for personalized learning, which involves more interaction. If lectures are not needed, because they are on the Web, class time might be used to present concepts in different contexts and to increase time spent on things students don't understand. Personalized interaction will lead to better thinkers, making commodified education relatively less valuable. While this approach works better for some content (for example, computer science or electrical engineering), it's not really a choice – it's forced upon us by the convergence of technology.

Discussion

AdCom members discussed what MOOCs mean for universities. MOOCS may help universities make space for additional students coming from different pathways. They may also free up time for more personal, hands-on learning, an area where industry can contribute real-world problems and mentoring. Education is often thought of as formal structures, like schools, and that constrains our thinking. Connecting learning experiences and offering credit for them could open up new educational pathways.

However, completely self-guided learning would make misperceptions hard to correct. Students learn when put in unfamiliar/uncomfortable situations that they need to figure out, and faculty can guide exploration and provide challenges. Faculty will require some education of their own in order to serve students well in this new environment. Low faculty-student ratios will be required for this new model of residential universities, but this model doesn't scale well.

Universities are still trying to figure out how to use MOOCs and make money from them. They may be helpful as a path to universities (for rural or high school students) or in university systems that don't have enough classroom space or teachers. For engineering, though, the hands-on component will remain necessary.

FUTURE OPPORTUNITIES AND CHALLENGES

Dr. Peterson began by recognizing the departing AdCom members, particularly Chairman Ilesanmi Adesida, thanking the incoming chair, Pat Farrell, and thanking panel chairs and ENG staff. He then described major ENG investments, including Innovation Corps growth, Emerging Frontiers in Research and Innovation awards, optics and photonics, centers and facilities, and new research networks. He gave examples of international engagements, such as a bilateral Joint Commission Meeting with Brazil and a collaboration with the G8 Heads of Research Councils. He outlined changes in the structure of the NSF Director's Office and the activities of NSF working groups (for a new strategic plan, the process of merit review, and the use of virtual panels). He highlighted ENG efforts in evaluation and assessment, in broadening participation, and in outreach. He invited the group to consider whether ENG investments are focused on the right areas, and how to make investments in research and education more seamless.

Discussion

The brief discussion centered on whether game theory could be used in a pilot of the merit review process. NSF is willing to consider out-of-the-box ideas, and this approach has been used, for example, to allocate telescope time.

The meeting adjourned at 5:30 p.m.

Thursday, October 18

The meeting reconvened at 8:00 a.m.

FUTURE OPPORTUNITIES AND CHALLENGES (continued)

The group discussed possible ideas for sharing with the Director and decided to ask about: the education of future engineers; the merit review process; the demand for basic research support, based on COV findings; and structural changes in NSF and their effect on ENG and partnership opportunities.

WELCOME FROM DIRECTOR AND ASSISTANT DIRECTOR

Dr. Subra Suresh expressed appreciation to the group and opened the floor to questions. Dr. Silevitch asked how NSF can meaningfully impact the education of future engineers and excite students to pursue engineering. Dr. Suresh invited AdCom members to share their ideas and described some recent activities, such as the work of the National Science and Technology Council (NSTC) Committee on Science, Technology, Engineering, and Math Education, and the special track of STEP that NSF established with industry support. Dr. Cora Marrett added that university programs, including the Engineering Research Centers, may be able to address the specific requirements for engineering.

Dr. Bruce Logan stated that while the NSF system for merit review is well-respected, it's coming under pressure. He asked when new approaches for conducting merit review and their outcomes will be available. He also suggested that the community be informed about processes that work.

Dr. Suresh explained that a group of program directors is examining ideas and organizing pilots, with different approaches for different parts of NSF. Advances in virtual panels and data systems might enable new options that are robust and secure. Changes may not affect all parts of a community in the same way, and it is essential for communities to be on board and realistic in their expectations.

Dr. Farrell remarked that the CBET and CMMI COV reports spotlighted low success rates and funding amounts, and the Committee is concerned that ENG award size makes it difficult to cover the costs of research and graduate student support. The engineering community is particularly affected because of the loss of industrial research labs over past 20 years, and its reliance on graduate students for the transfer of knowledge and technology.

Dr. Suresh agreed and pointed out the connection to community expectations and what they are willing to do for a higher success rate. He mentioned that, with respect to graduate students, in 2010 NSF doubled the number of Graduate Research Fellowships. Since then NSF has maintained this new level of support, while also increasing the cost of living allowance and tuition subsidy. NSF will continue to prioritize opportunities for early-career researchers.

Dr. Peter Cummings, who is also a member of Advisory Committee on Cyberinfrastructure, asked Dr. Suresh to share his thought on cyberinfrastructure.

Dr. Suresh stated that cyberinfrastructure will only become more important to research community, as its uses and users grow. Moving the NSF Office of Cyberinfrastructure from the Office of the Director to the Directorate for Computer and Information Science and Engineering (CISE) is a reflection of the interdisciplinary role of cyberinfrastructure and its ability to serve all.

Dr. Adesida and Dr. Suresh thanked Dr. Peterson for his service as Assistant Director for Engineering.

PANEL ON NEUROSCIENCE AND ENGINEERING

Dr. Sohi Rastegar, acting Division Director for Chemical, Bioengineering, Environmental, and Transport Systems (CBET), introduced the members of the panel.

Dr. Mark Humayun described the work of the NSF Engineering Research Center (ERC) for Biomimetic Microelectronic Systems for neural applications. Because neurons transfer large amounts of data, a device like a pacemaker, with five to six electrodes, won't work. The ERC is creating direct, high-density interfaces to restore lost neural function. Because the whole body relies on complex electrical impulses, reliable, implantable systems will increase understanding of the body and therapeutic approaches.

The ERC has goals for retinal, cortical, and cellular testbeds. Millions are blind from photoreceptor loss, but the rest of the eye is fine. Their approach for the retinal system is to bypass the damage with an electrode array and send information inductively through wireless electronics. They are pursuing advances on compatibility, resolution, the intraocular camera, packaging, and the chip. Presently, the retinal prosthesis, which allows most subjects to read, is being developed by Second Sight Medical Products. The Food and Drug Administration just voted to approve the device in the U.S., and it is already commercially available in Europe.

The cortical prosthesis is designed to overcome damage/pathology to hippocampus. It works by recording information upstream, processing it, and sending it downstream. The cellular testbed is investigating alternatives to electrodes for reliable, high-density interfaces, which don't work at the cellular scale. Instead they are working with photo-activated cellular switches to impart light sensitivity to neurons. In summary, the ERC is investigating how engineering can control and affect neural systems.

Dr. Yann LeCun described his investigations into machine learning for speech recognition and computer vision. A set of methods called deep learning employs large data sets and learning algorithms to train artificial perception systems end to end. Using a series of trainable modules enables a hierarchical representation similar to that of the mammalian visual cortex. These deep learning methods are developing incredibly quickly, going from blue-sky academic research to commercial applications in five years. Their use is growing in speech recognition, computer vision, natural language processing, applied mathematics, and other areas.

The artificial neural networks used by LeCun have a convolutional network architecture, which perform well with many types of signals and require little pre-processing of signals. State-of-the-art performance was demonstrated in competitions on traffic sign recognition and house number recognition, and now Google is using essentially this system. LeCun's method for computer vision has reached a new record, working 100 times faster than the second best method. Now they are working on more challenging datasets and making significant progress. These methods could be used for driver assistance, visual prosthetics, surveillance, automation, robotics, and many other applications.

In the ImageNet 2012 Large Scale Visual Recognition Challenge, more than 100 million images in 1000 categories (species of plants, dogs, etc.) were used to train the systems. The competition was won by SuperVision from the University of Toronto using deep convolutional neural networks. The whole system was trained at once with back-propagation algorithms, a 20-year old approach, but using high-power computer platforms and large data sets. On the classification task, SuperVision had 15 to 16 percent error, and the other groups were far behind. None of winners were from the U.S.

Dr. Greg Farber explained that several of the National Institutes of Health (NIH) support the study of neuroengineering. NIH seeks to coordinate research with NSF (and ENG in particular) in complementary areas. Currently, their portfolio has about 250 awards on neuroscience and engineering, which are typically about $450K/year for three to four years. Approximately one third of these go to individual investigators, and approximately one third go to graduate students and early-career investigators. NIH is interested in brain imaging, computational models and mouse models of disease, devices and imaging for disease, and bioengineering tools and techniques. For example, researchers want tools to probe thousands of human neurons simultaneously. They also want imaging techniques that are powerful enough to help us understand and delimit neurological disease and mental illness. Computational and engineering approaches could make valuable contributions in all of these areas.

Dr. Jack Judy described how DARPA has invested in a range of applied and some fundamental research for systems to help the warfighter, for example, to prevent or repair injury. DARPA convenes large teams to build systems and then sometimes finds that things don't work as well as expected. Reliability is really important and is not always a consideration when in pursuit of fundamental insights. This presents an opportunity for NSF, studying interactions at interfaces with tissues, performing quantitative analyses, creating tools to make breakthroughs and gain insight. DARPA's investments are sizable but very targeted, and NSF can enable fundamental breakthroughs that push whole fields.

Dr. Amber Story, co-chair of working group, explained that, while neuroscience and engineering have a large role in the NSF Directorate for Social, Behavioral, and Economic Sciences (SBE), few SBE programs focus on it. Coordination with ENG would make sense, particularly for studies on systems dynamics and controls and on biomimetics, prosthetics and robots (as with the ENG Emerging Frontiers in Research and Innovation topic "Mind, Machines, and Motor Control").

Dr. Diane Witt described her background in cognitive science and explained that the NSF Directorate for Biological Sciences (BIO) focuses on basic neurobiology, not disease or pathological conditions. Now that BIO focuses on research themes, proposals have become much more integrative. Engineering is becoming a dominant theme in neuroscience, with investigations of how the brain is organized, activated, and modulated. They are interested not just in the human organism, but in all organisms, to understand how are they adapting in current environments. Some opportunities include the design of nanoprobes and nanosensors to understand morphology and differentiation, how pressure waves (for example, from blasts or wind turbines) reorganize brains, and brain activity maps and epigenetics.

Dr. Ken Whang described his background in computational neuroscience. He explained that challenges like DARPA's reveal where real problems are that may have been overlooked or set aside. Education is inherently multidisciplinary — people approach questions from different trajectories, and multiple trajectories will bring about comprehensive knowledge. The range of questions is expanding into social aspects and other areas.

Discussion

AdCom members and the panelist discussed some of the research challenges in neuroscience and engineering. For neural control, the difficulty is not just in stimulating neural activity, but in recording it and interfacing with it. Interest is growing in how biological systems like the brain process signals, and in discovering the nature of signals the brain can receive. Understanding how the neurological system interacts with other parts of the body is just beginning. For example, the pheromonal, endocrine, and immune systems all affect brain function.

Once engineers understand the signals, the signals can be recorded and interpreted. Researchers now face limits in the measurement and level of analysis possible with the brain. What's happening at the nanoscale may provide clues. Unlike a computer, the brain develops and responds to context. Questions about the mind and brain require transdisciplinary thinking, in part because different communities define them differently.

ROUNDTABLE ON ENG STRATEGIC ACTIVITIES AND RECOMMENDATIONS

The AdCom members summarized the meeting's ideas and next steps. The committee agreed to send feedback to Dr. Peterson about the merit review process and to connect with the NSF Advisory Committee on Merit Review Process. They wanted to continue studying proposal pressure and success rates and perhaps find an intrinsic measure that would useful across NSF. They also were interested in future directions for CAREER and support for junior faculty and in giving feedback to the NSF Advisory Committee on CAREER. The AdCom was eager to remain engaged in the creation of a new vision and strategy for engineering education.

RECOGNITION, CLOSING REMARKS, AND WRAP UP

Dr. Peterson expressed deep appreciation for the discussion. The panels represent a microcosm of stages we're involved in: advanced manufacturing has well-defined connections inside and outside NSF; engineering education is making progress; and neuroengineering is an exciting, new area ready for exploration.

The meeting adjourned at 12:30.