Directorate for Engineering Advisory Committee Meeting

National Science Foundation
Arlington, Virginia
October 22-23, 2014
Room 1235

ENG AdCom Members Present:
Dr. Patrick Farrell (Chair)
Dr. Karen Butler-Purry
Dr. Curtis Carlson
Dr. Andres Clarens
Dr. Mary Jane Hagenson
Dr. Enrique Lavernia
Dr. Louis Martin-Vega
Dr. S. Shankar Sastry*
Dr. Ann Savoca
Dr. David Spencer

ENG Senior Staff Members Present:
Dr. Pramod Khargonekar (Assistant Director)
Ms. Cheryl Albus
Dr. Samir El-Ghazaly
Dr. JoAnn Lighty
Dr. George Hazelrigg
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
Dr. L. Gary Leal

ENG Senior Staff Members Absent:
Dr. Rathindra DasGupta
Dr. Theresa Maldonado

* denotes members that were present for day one only
** denotes members that were present for day two only

Wednesday, October 22, 2014

The meeting convened at 12:20 pm.

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 and introduced the first speaker.

THE FEDERAL ADVANCED MANUFACTURING LANDSCAPE

Michael Molnar, director of the NIST Advanced Manufacturing Program Office and of the Advanced Manufacturing National Program Office, explained that the National Network for Manufacturing Innovation (NNMI) is a partnership between industry, academia, and government. NNMI was launched in 2012 to address the significant losses in the nation's manufacturing workforce and to help ensure that products invented in the U.S. are also made in the U.S.

In its 2011 report, the President's Council of Advisors on Science and Technology (PCAST) made the case for a strong national innovation policy. The report noted that manufacturing, design and innovation are all closely linked and that service plays a growing role in U.S. manufacturing, as it shifts from making things to making value. In its 2012 report, PCAST called for coordinated government action to must bridge the gap between basic science and commercialization. The Obama Administration soon launched NNMI with a pilot institute focused on scaling up additive manufacturing techniques, such as 3-D printing.

The agencies designed an institute framework that promotes collaboration between industry and academia. The institutes focus on applied research and demonstration, on contributing to the system of innovation, and on education and workforce development. The vision is to establish 45 institutes within ten years. So far, 6 institutes have been initiated, and solicitations for 2 more are expected this year. Congress may authorize additional institutes and activities to network them through the Revitalize American Manufacturing and Innovation Act of 2014. A new report from the Advanced Manufacturing Partnership 2.0 (AMP 2.0) will be released October 27, 2014.

If NNMI unfolds as envisioned, it could have as great an impact on the country as the creation of NSF, by spurring employment and economic impacts for today and in the future through research and education.

Discussion
AdCom members noted the importance of sustainability for the institutes to meet their goals. Mr. Molnar explained that, by design, the institutes have government funding for the first seven years but then rely on industry support in return for the value of the institute research. To ensure that institute research is of broad value, each institute has a technology advisory committee that will create, own, and keep evergreen their technology roadmap, which balances risk and short- and long-term results.

Dr. Louis Martin-Vega remarked that the institutes build upon many existing relationships between academia and industry, as was the case for North Carolina State University, where the NSF FREEDM Systems Engineering Research Center led to the Next Generation Power Electronics National Manufacturing Innovation Institute.

AdCom members asked if being industry-led means the institutes may miss opportunities in industries that haven't been established yet or where the sector is small but full of potential. Mr. Molnar explained that the technology roadmaps will help them meet grand challenges of the future state of industry.

If the institutes are successful, they will create industry sectors that don't exist and that will need workers with new skills. Education and outreach for K-12 students are part of every institute.

PANEL ON THE FUTURE OF ADVANCED MANUFACTURING

Dr. Bruce Kramer of the NSF Division of Civil, Mechanical, and Manufacturing Innovation (CMMI) highlighted historic advances in manufacturing that had NSF funding, from the first unambiguous solid geometry modeling system for CAD to additive manufacturing methods such as 3-D printing.

Dr. Kershed Cooper of CMMI described nanomanufacturing, which aims to make and control things at the nanoscale and to take advantage of special effects and features. For example, researchers are creating carbon nanotubes (CNTs) for electronic applications. The CNTs may perform better than silicon

if the researchers can overcome issues with purity and uniformity. Scaling nanomanufacturing techniques, whether roll-to-roll, self-assembly, or another method, is critical, and NSF just published a solicitation for the fifth year of targeted research in this area. Nanomanufacturing research is a component of other ENG investments, such Two-Dimensional Atomic-layer Research and Engineering and the Engineering Research Centers (ERCs).

Dr. David Corman of the NSF Directorate for Computer and Information Science and Engineering (CISE) introduced NSF's investment in cyber–physical systems, which integrate computing, networking, sensing, and real work in real time. Medical devices, the smart grid, and the Internet of Things are all examples, and advanced manufacturing is ripe for innovation. Researchers are designing cyber-enabled manufacturing systems for the small-scale and for new digital capabilities, like machining, while optimizing for accuracy, time, and cost. We are now bringing security to cyber–physical systems so as to prevent and detect malware in manufacturing systems.

Dr. Alexis Lewis of CMMI described the national Materials Genome Initiative (MGI), begun three years ago, which aims to double the speed of materials development and manufacturing, as well as to train the next-generation workforce. NSF participates in MGI through Designing Materials to Revolutionize and Engineer our Future, which integrates experimental and computational design of materials. For example, magnesium alloys have excellent mechanical properties and light weight but are difficult to form at room temperature; researchers are finding that magnesium alloy microstructure affects formability and can be altered. CMMI funds other materials research as well, particularly additive manufacturing materials for structures, where the integration of computational tools now available and the sharing of accessible data are creating many opportunities.

Dr. Keith Roper of the Division of Engineering Education and Centers (EEC) described sustainable advanced biomanufacturing, from biomolecules to biosystems. Biomolecules can be reprogrammed to perform particular functions and produce things we want, such as bio-detergents. Biomanufacturing with cells via active cell assembly can support the development of therapeutics, e.g., for prostate cancer. New biomanufacturing methods—from scaffolds to ink-jet printing to bio-plotting—are enabling researchers to grow multicellular tissues and organs such as skin and cardiac patches. Finally, biosystems are possible with wearable, wireless sensing devices like those being created at the Nanosystems ERC for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST).

Dr. Rajesh Mehta of the Division of Industrial Innovation and Partnerships (IIP) described what some companies in the NSF Small Business Innovation Research Program (SBIR) are doing in advanced manufacturing. One company found a way to reprogram bacteria to produce spider silk and use microfluidics as spinnerets, succeeding after large corporations gave up. Another company has reprogrammed tobacco to make pure proteins, avoiding the typical, expensive purification process because the protein is secreted on plants. A small business in Boston has a new electrochemical method to produce magnesium as an alternative to aluminum, something that wasn't feasible economically or environmentally before. NSF funded the first company to achieve commercial production of graphene for printable electronics market, which could significantly reduce the cost of RFIDs. An Industry/University Cooperative Research Center spin-out has created a fleet-based control algorithm that looks at the signatures of all machines operating at same time to understand how they are running, avoiding costs of breakdowns and unnecessary maintenance for wind farms or auto plants. In the future, Dr. Mehta sees the trend of personalized manufacturing growing more important.

Discussion
Several AdCom members expressed concern about keeping NSF and the country at the very frontier of advanced manufacturing, when every country in the global innovation economy is trying to do the same thing. We need an approach to quickly bring pieces together and follow up on emerging ideas, even before they have buy-in from industry. NSF staff explained that the Foundation collaborates with other agencies on the manufacturing institute topics. However, the institutes are one vehicle, and NSF has other vehicles available to fulfill its role is research and education. The educational component is very valuable and perhaps underappreciated.

AdCom members had several questions about how NSF activities target education and workforce development. Are NSF programs providing opportunities to workers at different educational levels? Can advanced manufacturing help broaden participation in the workforce? NSF staff said that students in centers and institutes work side-by-side with industry. Also, the Advanced Technology Education program targets a very broad segment of the population through its ~70 centers based at community colleges, which provide technician training in new areas of manufacturing. Outreach to K-12 students may tie in to design and making, which hold great appeal to them. Accurately conveying the nature of manufacturing jobs of the present and future is very important to attract students.

PERSPECTIVE FROM THE WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY (OSTP)
Mr. Thomas Kalil, Deputy Director for Policy, OSTP, presented four areas where the White House has been working with ENG and engineering community. First, federal research investments across agencies have built momentum in national priorities such as robotics, neuroengineering, and cyber–physical systems. Second, collaborations in STEM education are advancing engineering pedagogy and retention, pursuing the creation of an Advanced Placement engineering course, and scaling up the Grand Challenges Scholars activity. Third, interest in innovation, moving ideas from lab to market, is growing, and NSF's Innovation Corps is model is spreading to other agencies. Fourth, the Maker Movement presents opportunities for the three previous areas, and the White House and NSF are working to build university engagement. He concluded by asking AdCom members what the ideal resources and programs would be for NSF's role in innovation, and how the engineering community can lower barriers to innovation.

Discussion
AdCom members stated that most places in America do not have a true innovation ecosystem, and that building one would require significant and sustained investment. NSF may serve as a leader and model for other agencies, as with Innovation Corps. Beyond supporting small teams, NSF may help convene institutions and industry sectors that are willing to cooperate on standards. Young faculty and students are demanding access to innovation culture and may present new opportunities.

DIRECTORATE FOR ENGINEERING REPORT
Dr. Khargonekar and ENG leadership introduced new Engineering staff. Dr. Khargonekar described Directorate priorities for FY 2014 and plans for FY 2015, particularly in advanced manufacturing, brain-related research, communications and systems, and infrastructure resilience. He also described ENG investments in workforce development and broadening participation, and ENG innovation activities in programs such as Innovation Corps. He stressed the Directorate's commitment to catalyzing transformative research, educating a diverse engineering workforce, and innovating for societal benefit.

Discussion
AdCom members discussed NSF's interest in the reproducibility of research results and how important results in engineering research are quickly tested by the research community and industry in order to improve upon it. Verification may be more difficult if special equipment or simulations are needed or if reported data does not convey the whole picture. Good data management plans are critical.

AdCom members encouraged Engineering to continue nurturing the innovation process.

ADVANCED MANUFACTURING BREAK-OUT SESSIONS

Factory of the Future and Cybermanufacturing
Led by Dr. Shankar Sastry, the session included Dr. Curtis Carlson, Dr. Andres Clarens, Dr. Patrick Farrell, and Dr. Ann Savoca. The AdCom members expressed whole-hearted support for ENG carving out portions of advanced manufacturing to support, especially for sectors where the Directorate may create value propositions. Centers should have executable value propositions (not just a vision), plans for achieving it, and white space around research. ENG can make important contributions to workforce development and domain-specific design tools. NSF may support technology translation and incubation to extract more value from centers

Broadening Participation in Manufacturing
Led by Dr. Louis Martin-Vega, the session included Dr. Karen Butler-Purry, Dr. Mary Jane Hagenson, Dr. Enrique Lavernia, and Dr. David Spencer. To broaden participation in manufacturing, the AdCom members expressed the need to systematically approach the problem of broadening participation, including the needs for leadership to "walk the talk" and for accountability. Changing the brand must begin with changes in engineers and engineering leaders, who must act with respect for others and express excitement to inspire others.

TOPICS FOR DISCUSSION WITH NSF LEADERSHIP

AdCom members decided to share their ideas about broadening participation, technology incubation, choosing a role for NSF in national needs, and engineering education.

The meeting adjourned for the day at 6:10 p.m.

Thursday, October 23, 2014

The meeting reconvened at 8:33 a.m.

PERSPECTIVE FROM THE OFFICE OF THE DIRECTOR

Dr. Richard Buckius, the NSF Chief Operating Officer, told the AdCom members that NSF Director Cordova 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 NSF stakeholders, including the public.

Discussion
Dr. Martin-Vega described the group's ideas for broadening participation with Dr. Buckius, who encouraged the members to write them down and share them.

Dr. Buckius invited the group to weigh in on the relative importance of broader impacts in merit review, and members responded that the community may lack clarity with what it is and how it's used in proposal evaluation, and they may feel that their disconnected, individual efforts in broadening participation may have a limited impact.

Dr. Carlson stated that transitioning ideas into marketplace requires training and mentoring to avoid the "valley of death," and Dr. Buckius agreed that success takes more than the right science and engineering.

The group discussed how NSF balances its responsibility to the research community and to opportunities for new initiatives. NSF responds to community input, recommendations from the Directorates, and national priorities.

AdCom members said that NSF core programs and broader impacts from NSF grants can make the connection between research and societal benefits. Dr. Buckius encouraged faculty to communicate what they do to neighbors, friends, and others in a way that is meaningful for their audience.

PLANNING FOR ENG ADCOM SUBCOMMITTEE WORK

The Advisory Committee members discussed a number of ways that the committee could pursue ideas for broadening participation. They expressed interest in the work of the Committees of Visitors and of the NSF Committee on Equal Opportunities in Science and Engineering (CEOSE). They see opportunities through partnerships with education.

Dr. Khargonekar invited the group to take a systems approach, identify points of leverage, and take advantage of the engineering community's strengths.

Drs. Butler-Purry, Hagenson, Lavernia, Martin-Vega, Savoca, and Spencer offered to work on broadening participation together before the next meeting. The Advisory Committee members agreed to share information with NSF.

Longer term, the Advisory Committee may also pursue the ideas for technology translation described by Dr. Carlson.

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

Dr. JoAnn Lighty presented an overview of CBET, whose large research community spans many fields of engineering. CBET leads in national priorities and emerging research areas, such as biomanufacturing and brain-related research. The Division values partnerships within NSF and with other Federal Agencies, in areas such as energy research. CBET emphasizes support for early-career investigators, investing more than 13 percent of its research budget in NSF CAREER grants. CBET leadership is keeping programs focused on priorities through portfolio analysis.

Discussion
Advisory Committee members asked how collaborations with other agencies work, and Dr. Khargonekar explained that they frequently involve collaboration on ideas and proposal review rather than a transfer of funds.

Members expressed interest in the portfolio analysis tools and in finding measureable outcomes, which would be useful for communication with the public too. NSF is in the early stages of developing and using tools to understand and analyze its portfolio.

Advisory Committee members asked to know impacts of the Division's transition to one proposal window once that information is available.

ROUNDTABLE ON ENG STRATEGIC ACTIVITIES AND RECOMMENDATIONS

Dr. Farrell reminded the group that NSF is seeking input on the reproducibility of research results. Members remarked that data management will become more important as "big data" becomes more prevalent, and that graduate students must be well-trained in the preservation of data.

AdCom members also expressed interest in learning about funding trends and portfolio analysis tools at a future meeting.

CLOSING REMARKS AND WRAP UP

Dr. Farrell reminded the committee of their future meeting dates and of his plans to follow up on the current meeting with Dr. Khargonekar and the Advisory Committee members in the next couple of weeks.

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

The meeting adjourned at 12:25pm