Directorate for Engineering Advisory Committee Meeting

National Science Foundation
Arlington, Virginia
October 19-20, 2016
Room 375

ENG AdCom Members Present:
Dr. Louis Martin-Vega (Chair)
Dr. Tilak Agerwala
Dr. Gilda Barabino
Dr. Susan Butts
Dr. Reginald DesRoches
Dr. Hossein Haj-Hariri
Dr. Kenneth Lutchen
Dr. Darryll Pines (day 1)
Dr. Sarah Rajala
Dr. Thomas Skalak

ENG Senior Staff Present:
Dr. Grace Wang (Acting Assistant Director)
Dr. Filbert Bartoli
Dr. Deborah Goodings
Dr. Barry Johnson
Dr. JoAnn Lighty
Dr. Don Millard
Ms. Graciela Narcho
Dr. Sohi Rastegar
Dr. Mihail Roco

ENG AdCom Members Absent:
Dr. Pedro Alvarez
Dr. Curtis Carlson
Dr. Debasish Dutta
Dr. S. Shankar Sastry

Wednesday, October 19, 2016

The meeting convened at 12:00 p.m.

CALL TO ORDER

Dr. Louis Martin-Vega, chair of the NSF Directorate for Engineering (ENG) Advisory Committee (AdCom), welcomed everyone to the meeting. AdCom members and ENG senior staff introduced themselves. The members approved the minutes of the April 2016 meeting.

DIRECTORATE FOR ENGINEERING REPORT

Dr. Grace Wang, Acting Assistant Director for Engineering, gave a warm welcome to new committee members. She introduced new ENG staff and leadership changes. She described the current budget and operational improvements to streamline the Directorate's work.

Dr. Wang then highlighted emerging opportunities within ENG research and education investments. These areas include cyber- and biomanufacturing; the nexus of food, energy and water systems; resilient, interdependent infrastructure systems and smart systems; multi-hazard engineering research;

and designs and devices for high-performance computing and for wireless and quantum communication.

She then provided a brief update on REvolutionizing Engineering and Computer Science Departments (RED) and NSF Inclusion across the Nation of Communities of Learners that have been Underrepresented for Diversity in Engineering and Science (NSF INCLUDES). She described results and the expansion of the Innovation Corps program for experiential entrepreneurship education.

Next, in the context of global challenges, Dr. Wang discussed how today's fundamental engineering research has the potential to address critical societal needs in the future. Great opportunities are emerging where the digital world meets manufacturing, where engineering intersects with the biological sciences, and where humans harness machine intelligence. Convergence is enabling profound transformations that can help address future challenges.

NSF and the community must be prepared to enable future students, create a diverse and inclusive workforce, and stimulate the innovation ecosystem. To help position itself, the Directorate continuously seeks ideas from the research community and others. Dr. Wang asked Advisory Committee members to help the Directorate obtain essential input from the engineering community.

INTRODUCTION TO NSF BIG IDEAS

Dr. Wang introduced the NSF Big Ideas with particular relevance to ENG: Harnessing Data for 21st Century Science and Engineering, Shaping the New Human–Technology Frontier, Understanding the Rules of Life, The Quantum Leap, Navigating the New Arctic, and Growing Convergent Research, as well as NSF INCLUDES.

Discussion

Advisory Committee members pointed out that the concepts behind NSF INCLUDES and Growing Convergent Research could infuse all of the NSF Big Ideas. Diversity and inclusion help drive innovation.

To help the Big Ideas resonate with lay audiences, Advisory Committee members suggested that NSF avoid technical language, describe the profound opportunities for each, and present the Big Ideas in connection with transformative impacts on our lives. (For example, research for Understanding the Rules of Life could be a game-changer for cancer or Alzheimer's treatments.) In the end, scientific advances in the Big Ideas must be translated into technologies in order to benefit society.

Some members expressed interest in helping to develop Big Idea research context, such as knowledge gaps, roadmaps, expected outcomes, and timelines. At DARPA and other mission agencies, these help achieve real progress, if not the goal.

AdCom members discussed the scope of some of the Big Ideas, based on the public, initial 1-page descriptions of each. Some Ideas may be too limited; for example, the Rules of Life go beyond phenotypes to ecosystems/complex systems, and New Arctic issues such as climate change and the oceans are also global. Some concepts may be missing, such as the emergence of benevolent regionalism, creating cities and workplaces that are in harmony with nature, next-generation computing, and clean energy.

Advancing the Big Ideas will require interagency and international collaboration — bringing the right people together to solve problems. NSF could use a strong plan for collaboration and partnerships with respect to the Big Ideas.

Academic culture must begin supporting collaborative and convergence research more. Engineering programs must also evolve to prepare students to take on such research by, for example, training undergraduate students to work with big data.

Advisory Committee members asked about the relationship between NSF Big Ideas and future investments. Dr. Wang explained that the Big Ideas are not exclusive but will help define agency priorities.

PERSPECTIVES FROM THE OFFICE OF THE DIRECTOR

Dr. France Córdova, NSF Director, and **Dr. Richard Buckius**, NSF Chief Operating Officer, joined the meeting, and the Advisory Committee members introduced themselves. Dr. Córdova welcomed the AdCom members and the insights they may contribute, and she expressed appreciation to Dr. Wang and the Directorate.

Dr. Córdova described the genesis of the Big Ideas at a spring 2016 retreat with NSF leadership, who supported ideas that have roots within the agency, involve several areas of science, and excite the public. Since that time, NSF leaders have been developing the Big Ideas more fully in white papers. Support for basic research has been relatively flat, and NSF is taking this opportunity (during a period when no budget request is due) to think strategically and long-term.

Dr. Martin-Vega thanked Dr. Córdova for the context and invited Committee members to ask questions.

Advisory Committee members applauded the vision of the NSF Big Ideas as a strategy and a statement of priorities, as well as the prominence of NSF INCLUDES, which infuses the other Big Ideas and all areas of science, engineering, and innovation. Dr. Córdova responded that INCLUDES is important for achieving all of the NSF Big Ideas, because investing in talent makes other things fall into place.

AdCom members encouraged consistent, inspiring language and graphics that portray the Big Ideas as exciting, important areas of frontier research that may lead to significant innovations and impacts on our quality of life. Some Big Ideas, such as INCLUDES and Convergence, are pervasive concepts. Within each of the Big Ideas are truly profound questions at the forefront of human knowledge that can't be answered with existing science. New knowledge creates new value for society.

Members also mentioned areas that seem too narrow or missing. For example, the Rules of Life is broader than phenotypes and is really about massive gene flows between species and across ecosystems. NSF also should consider problems related to regionalism, and not exclusively ones of increasing urbanization; cities rely on rural areas and must respect regional heritage and human culture.

Dr. Córdova said that the Big Ideas white papers now underway will have more developed details and will be completed in the next few months.

Advisory Committee members commented that the Big Ideas are very big, and given a flat budget, success may depend on collaboration outside of academia, with other agencies, and/or with other

countries. Dr. Córdova explained that NSF has a key role in many interagency groups, from brain science to arctic science, and often coordinates funding opportunities with others. NSF hopes to build the Big Ideas into its FY 2018 and FY 2019 budget requests. NSF plans to create a budget exercise in which the NSF budget doubles; a budget increase would bolster the core programs and support powerful concepts including the Big Ideas.

AdCom members said that convergence is a huge cultural change for team science. What's the NSF strategy for enabling team science, and how will NSF help catalyze breakthroughs in areas of convergence? Dr. Córdova's letter to university presidents about NSF INCLUDES was very effective. Dr. Córdova explained that NSF is developing a new approach after INSPIRE (Integrated NSF Support Promoting Interdisciplinary Research and Education), which was hindered by bureaucracy. NSF will help build shared language between fields and conduct pilot programs and modeling to catalyze thinking.

Advisory Committee members asked how the way of doing research (for example, through teams) may change due to the Big Ideas. Dr. Buckius said there are implications for the NSF proposal system, FastLane, which currently requires investigators to designate a program upon submission of a proposal, and there may be implications for the review process. NSF always will fund research by individuals (who also are capable of convergence research) and needs to develop the structure to fund the highest quality team research. Universities now accept team activities for promotion.

AdCom members commented that it's a challenge to continuously explore when in a large organization, and asked how they can help with the NSF 2050 foundational fund, one of the Big Ideas for processes. Dr. Córdova compared it to the National Institutes of Health common fund, which has allowed NIH to move outside of institutional stovepipes and invest in the Human Genome Project and precision medicine, for example. NSF wants a mechanism to welcome ideas that are big, different, high-risk, and longer term, and which may not be easy to support through the directorates.

Dr. Córdova thanked the committee for the exciting discussion.

FUTURE OF CENTER-SCALE MULTIDISCIPLINARY ENGINEERING RESEARCH

Dr. Maxine Savitz, co-chair of the National Academies committee, introduced the study's timeline and committee members, which include members of the ENG Advisory Committee as well as National Academy of Engineering members, university deans, and venture capitalists. She described the committee's statement of task and key questions for the study, such as: What will an engineering research center look like 20-30 years from today? What will its value proposition be? What research model will be appropriate? What kind of education and innovation infrastructures will it enable?

The committee received input from many places in the ecosystem; they held a public symposium and commissioned papers on trends in industry–university relationships and on international approaches to center-based multidisciplinary engineering research. There are few multidisciplinary engineering research centers around the world; however others tend to have more funding. Many countries are grappling with the same questions. Everyone wants impacts but struggles with measuring them. Deep collaboration is difficult to achieve and may be an area where the U.S. can take leadership. We have a good opportunity to reimagine and redefine centers.

Discussion
Advisory Committee members inquired about the source for higher-level funding overseas, and Dr. Savitz said funding comes mainly from government sources, for example, at the Fraunhofer Institutes in Germany.

Concerning research at the centers, members asked what is inhibiting deep collaboration. Real teams are possible, and NSF may have a role in helping them form and develop. Dr. Savitz suggested that the preproposal process and workshops could help. NSF may offer seed money to help form the teams, and funding may provide incentives for cultural change.

Members asked whether the results of center-type versus individual research were examined. Dr. Savitz explained that the study committee interviewed center directors and looked at metrics to determine the research products, which often came down to human capital and students who were better trained. It's hard to produce products and companies in the 10-year timeframe of center funding, and today retrospective metrics are not available.

Advisory Committee members asked about technology translation and collaboration with industry. In industry–university relationships, the two often perceive the value of intellectual property (IP) differently. Dr. Savitz said IP issues must be resolved, and experimentation is underway at some institutions. The committee has been in communication with the University–Industry Demonstration Partnership (UIDP). The committee looked closely at manufacturing institutes, although the National Network for Manufacturing Innovation institutes are a bit young to evaluate. They discussed the continuum of the research enterprise.

DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC) OVERVIEW

Dr. Don Millard introduced the EEC team, budget and programs. Starting with the Centers and Networks cluster, Dr. Millard summarized the Engineering Research Centers program, its distinguishing features, and some of its results for students and society. He then described the Network for Computational Nanotechnology and its user community. Activities in the engineering education cluster, including REvolutionizing Engineering and Computer Science Departments (RED), focus research on the professional formation of engineers. The Broadening Participation cluster leads ENG participation in NSF INCLUDES and is home to the directorate-wide Broadening Participation in Engineering program. The Workforce Development cluster leads the directorate Research Experiences for Undergraduates Sites and Research Experiences for Teachers Sites programs, as well as activities to explore Advanced Placement course in engineering and provide teacher resources.

EEC COMMITTEE OF VISITORS PRESENTATION

Dr. Galip Ulsoy, co-chair of the ECC Committee of Visitors (COV), reported on the Committee's findings in their study of the period 2013-2015. He introduced the members and process of the COV. The committee examined the quality and effectiveness of merit review, reviewer selection, program management, the award portfolio, and other topics. The COV suggested more geographic diversity and industry experience on review panels, more documentation of reviewer selection, and greater use of goals and metrics in programs. The programs are well-managed, timely, and relevant, and the portfolio is balanced and aligned with national priorities. The Division responded appropriately to previous COV reports.

Discussion
Advisory Committee members discussed how to assess quality in the merit review process. The charge is concerned with the process and effectiveness, and quality of the results is implied. Dr. Ulsoy noted that COV members were not trying to re-review proposals but to determine if the process was careful, thoughtful, efficient and fair. The answer to all of these questions for EEC was yes.

The Advisory Committee discussed the relative attention paid to the Intellectual Merit and Broader Impacts merit review criteria. Individual panelist reviews gave Intellectual Merit more attention, but the panel summaries were more balanced. Do the panelists develop appreciation for Broader Impacts during the panel with guidance from program directors? Can panelists begin their review with a more balanced perspective? Dr. Ulsoy agreed with this interpretation, that panelists pay greater attention to Broader Impacts once the group gets together. Providing more structured guidance and/or templates to reviewers may help. NSF staff added that this issue is found across Engineering, and the Directorate is working on a Directorate-wide solution. Panels are an opportunity to educate panelists about Broader Impacts and, through the panelists, to inform the broader community.

Advisory Committee members asked if the Committee of Visitors determined the reasons for the relatively low level of geographic diversity among panelists. Dr. Ulsoy responded that the Committee had some hypotheses but lacked data.

Dr. Wang thanked the COV members and the NSF staff who facilitated the COV. She then explained that COVs are subcommittees of the Engineering Advisory Committee, and the Advisory Committee reviews the COV reports and votes on accepting them. Sometimes the Directorate cannot adopt certain recommendations due to privacy, legal, and other implications. The Engineering Assistant Director provides a yearly response to the COV report that is available to future COVs. She added that NSF has one strategic plan, and program goals are to align with that.

The committee unanimously voted in favor of accepting the EEC COV report.

BREAKOUT SESSIONS: HOW TO SYSTEMATICALLY SEEK INPUT FROM ENGINEERING COMMUNITIES?

The Committee members and ENG leadership divided into three breakout groups and discussed the current approach to seeking input from engineering communities, what might be missing, and how the Advisory Committee can contribute.

The meeting adjourned at 6:20 pm.

Thursday, October 20, 2016

The meeting resumed at 8:33 a.m.

BREAKOUT SESSION REPORTS: HOW TO SYSTEMATICALLY SEEK INPUT FROM ENGINEERING COMMUNITIES?

Group 1. Dr. Reginald DesRoches reported on the variety of people who could provide feedback or identify engineering challenges in workshops (related to Big Ideas, for example). The Directorate could involve thought leaders, engineering societies (particularly Fellows or deans), and/or junior faculty (such

as recent CAREER grantees). After receiving input, ENG should offer the group another opportunity for feedback. During their meetings, AdCom members can provide feedback on challenges or solicitations.

Group 2. Dr. Hossein Haj-Hariri reported on several mechanisms. The Computing Community Consortium (CCC) involves partners and workshops and doesn't rely on the perspective of a single program officer. By networking, silos can be spanned.

The community includes research-active engineering faculty, undergraduate institutions, National Labs, the broader public, and partner organizations (for example, those who participate in INCLUDES). The Directorate could quickly pose ideas to experts by using new technologies, such as curated chat rooms. Scalable tools have the power to expand the community by orders of magnitude and avoid implicit bias. Engaging K-12 students would help ensure young people understand what engineering is. To understand societal needs requires hearing from a broad swath of society.

Blue-sky ideas, which could be focused the way DARPA's are, could be discussed at conferences or workshops, and the Directorate could actively broaden participation in these by providing travel subsidies and by engaging undergraduate institutions and non-engineers.

Group 3. Dr. Tilak Agerwala reported that ENG wants an understanding of the complete landscape to identify future bleeding edge research work, and hopefully avoid missing a significant frontier activity.

Their high-level recommendation was to first establish the landscape using a dynamic process. CCC is a good model because it is agile and high-output. Industry research expertise would be important. Also, leveraging social media might help to hear all voices; preferred tools for input may be different for different people and generations. These would help identify areas for deep dives.

The Directorate should recognize that sifting and synthesizing across areas of engineering is a valuable function. AdCom can play a more proactive and significant role in vetting ideas, shaping NSF workshops, and advising on strategy.

Dr. Wang thanked the Committee for a valuable discussion. ENG will synthesize input and get back to AdCom.

SBIR SUBCOMMITTEE REPORT

Dr. Martin-Vega and **Dr. Barry Johnson** introduced the Small Business Innovation Research program (SBIR) subcommittee of the Engineering Advisory Committee, on which Dr. Susan Butts serves.

Dr. Butts introduced the charge and members of the subcommittee, which meets twice per year (including one meeting at the SBIR Phase II grantee workshop). The subcommittee currently has four working groups taking closer looks at assessment, broadening participation, deal flow, and entrepreneurial education. She reviewed the recommendations from the subcommittee's last meeting.

Discussion
Advisory Committee members discussed situations where the initial SBIR product doesn't succeed, but the person succeeds in later business endeavors. Dr. Butts asserted that the hardest things about starting a business are the first infusion of capital and gaining exposure to business tools, and the NSF

SBIR program provides both. For new high-tech start-ups, funding comes from angel investors and NSF. NSF wants to trace success, including non-monetary success, back to NSF grants where possible.

Members observed that making the SBIR tools for success available on the web would help people learn that NSF offers not only money, but support. Dr. Butts responded that training materials are on the website. The deal flow working group is advising on design changes to improve web resources, and also makes themselves available to program directors and grantees at conferences.

Dr. Johnson added that the NSF SBIR Phase II national conference invites industry and investors, and welcomes faculty too. Also, universities are using the NSF Innovation Corps process to understand value proposition, market availability, and commercial readiness and inform decisions whether to seek patents or pursue startups.

The Committee discussed which potential types of members, such as angel investors, might provide additional knowledge about the early-stage, high-risk investor landscape to the Subcommittee, since many larger venture capitalists are moving investments downstream.

Dr. Martin-Vega suggested making the SBIR Subcommittee activities a regular item on the Engineering Advisory Committee meeting agenda.

DIVISION OF INDUSTRIAL INNOVATION AND PARTNERSHIPS (IIP) OVERVIEW

Dr. Johnson introduced the IIP team, mission, and vision, which align IIP activities with NSF's strategic goals. He provided data about the growing numbers of IIP proposals and awards, and the Division's increasing budget. He summarized the academic programs: Grant Opportunities for Academic Liaison with Industry (GOALI), Industry–University Cooperative Research Centers (IUCRC), Partnerships for Innovation: Accelerating Innovation Research (PFI:AIR), Partnerships for Innovation: Building Innovation Capacity (PFI:BIC), and Innovation Corps (I-Corps). He also described the NSF Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, whose goals and funding levels are set in Congressional authorizations.

Discussion
Advisory Committee members asked about the NSF 1:2 match to third-party investment through the SBIR Phase IIB award, which a grantee may receive in addition to Phase II funds. Dr. Johnson explained that grantees may receive up to approximately $1.5 million in Phase I, Phase II and Phase IIB awards together, and with other supplements can reach close to $2 million in total NSF non-dilutive investment (with no royalties or equity to NSF) to overcome technology hurdles.

Members also asked about the level of follow-on funding for I-Corps and SBIR grantees. Staff explained that NSF investments are very early-stage, and NSF wants to provide startups' first money. I-Corps grantees typically launch startups at the end of their grants. Of NSF SBIR Phase I grantees, approximately 87% have fewer than 5 employees, and approximately 75% have never received federal funds of any sort before NSF.

IIP COMMITTEE OF VISITORS REPORT

Dr. Brig Moudgil and **Dr. Ann Savoca**, co-chairs of the IIP Committee of Visitors, reported on the Committee's findings in their study of the period 2013-2015. They expressed appreciation for the

support from IIP management and staff. They introduced the members and process of the COV. The committee examined the quality and effectiveness of merit review, reviewer selection, program management, the award portfolio, and other topics. Two subcommittees, on academic actions and on SBIR-STTR actions, conducted work remotely and held scheduled phone calls for several months, and then the full committee met at NSF; the COV recommend IIP continue this approach. They advised capturing richer commercial commentary in SBIR-STTR proposal reviews, which could be facilitated through the review template. They encouraged IIP to provide robust feedback to principal investigators to help them perform better in the future, and to better capture debriefs and correspondence with investigators in the NSF eJacket proposal management system. Reviewers and programs are well-managed, however the committee is concerned about the workload on program directors. Overall, IIP performs very well, and the COV's suggestions are to continue improving diversity of grantees and streamlining processes through information systems.

Discussion
Dr. Butts, who served on the COV, added that program directors do a far better job than is evident in eJacket — the NSF document systems are not adequately capturing this information.

Advisory Committee members asked the COV co-chairs to clarify what kind of reviewer feedback is expected in order to improve proposals. COV members explained that program directors can give constructive feedback about why a proposal wasn't funded, for example, where the proposal wasn't clear or if a better technology already exists. Most SBIR Phase I principal investigators have never submitted an NSF proposal before and don't have an institutional support system.

Advisory Committee members discussed the amount of commercialization commentary in SBIR Phase I and Phase II award proposal reviews. No program director can know the IP scenario or market space for every technology out there. The COV co-chairs said that program directors are very experienced and good judges of idea quality; however a bigger pool of commercial reviewers would be helpful for Phase I proposals. While, commercialization plans in Phase II proposals are appropriately weighted more heavily, sensitizing grantees earlier on is important. Panels discuss commercialization aspects of proposals, but specific commercial criteria are not laid out for documentation in eJacket.

AdCom members observed that how commercialization criteria and scope in Phase I proposals are evaluated is important. Focusing on time to market, for example, based on artificial commercialization potential may have unintended consequences and harm innovation. The COV co-chairs responded that their discussion focused on IP and IP analysis over monetary commercial potential.

NSF staff commented that companies at this early stage often totally misestimate their market, so it's important to focus on an idea's value proposition and on the feasibility of the technology concept. For exceedingly high-risk concepts, principal investigators tend to underestimate markets, which are still emerging. The program directors are sophisticated and understand dynamic markets, but it's a fair point about documentation. The COV co-chairs added that a statement about competing technologies and navigating the commercial landscape would be helpful.

Regarding the portfolio, Advisory Committee members asked for clarification about road-mapping innovations. The COV co-chairs said they are not looking for a detailed roadmap of innovation, but rather the intent of investing in areas of strategic importance to the country and then portfolio tracking.

AdCom members asked when in the COV process did the subcommittees merge their thoughts. The COV co-chairs explained that, other than phone calls between the co-chairs, the subcommittees operated independently until the whole group met in person. Connecting the two subcommittees in some way prior to the face-to-face meeting could help them reconcile their ideas more easily at that meeting.

The committee unanimously voted in favor of accepting the IIP COV report.

Dr. Wang thanked the COV members for their work.

NSF INCLUDES/COMMITTEE ON EQUAL OPPORTUNITIES IN SCIENCE AND ENGINEERING (CEOSE)

Dr. Sylvia James, Division Director, Division of Human Resource Development, Directorate for Education and Human Resources (EHR), updated the Committee on NSF INCLUDES. The INCLUDES effort has involved almost 60 program directors and 30 staff across NSF. During fiscal year 2016, the group managed multiple panels and workshops, and NSF awarded 37 design and development launch pilots and 11 conference grants; more are planned for the first quarter of fiscal year 2017, resulting in a total of 40 pilots and 15 workshops. The next activities will be a meeting of principal investigators of the pilots, workshops to inform the design of INCLUDES backbone organizations, and a new NSF INCLUDES solicitation for the INCLUDES pilots, alliances, and backbones.

Dr. Suzanne Iacono, Office Head, Office of Integrative Activities, described how NSF INCLUDES responds to a prior CEOSE biannual reports to Congress that called for a bold new initiative for more significant progress. The Committee is now working on a report focused on an accountability framework for NSF, universities, and other institutions.

Dr. Joan Ferrini-Mundy, Assistant Director for EHR, described NSF INCLUDES as an experiment in collaboration, networking and planning. She asked the Advisory Committee to think about NSF INCLUDES from a systems perspective. Dr. Córdova is deeply engaged in INCLUDES and encourages other leaders to be personally involved. NSF is interested in how its overall broadening participation investment can help push INCLUDES forward and what other NSF programs can learn from INCLUDES.

Dr. Martin-Vega remarked that INCLUDES is a scientific effort to address a big problem. The community has fundamental questions to understand in the domain of broadening participation, and the mechanisms of INCLUDES will evolve as we learn. Ultimately, inclusion and broadening participation are cultural, and contributions from all sectors of society are needed.

Discussion
Advisory Committee members commented on the presentation of NSF INCLUDES as one of the foundational, process NSF Big Ideas, and suggested that it may more accurately be presented as a pervasive or core Big Idea. Dr. Ferrini-Mundy replied that they are hearing consistently that inclusion is at the center, and that science will depend upon broadening participation, equity, and inclusion.

Members also discussed the particular need for greater diversity and inclusion in engineering. Dr. Iacono stated that INCLUDES tries not to be prescriptive and invites communities to come together in workshops to figure out how to adopt social innovations. NSF and the INCLUDES grantees are now working to develop on-ramps to NSF INCLUDES alliances.

Members also expressed the need to protect NSF INCLUDES and prevent it from becoming just a checkbox, without real commitment or engagement from institutions.

Dr. Martin-Vega asked NSF to follow up on INCLUDES at the next Advisory Committee meeting.

NSF STRATEGIC PLANNING PROCESS

Dr. Stephen Meacham introduced the NSF strategic planning process and timeline. For the first time, Federal agencies are coordinating the preparation of their strategic plans through the White House Office of Management and Budget (OMB). NSF's initial draft is due to OMB in May 2017, and the final plan will published in February 2018. NSF is asking its Advisory Committees to consider providing input to the plan, which will outline the NSF vision, values, goals and high-level objectives. Advisory Committees may wish to comment on the current strategic plan language to help ensure that the language speaks effectively to all the people it must talk to.

Discussion
Advisory Committee members remarked that NSF's plan should speak to the public and Congress to help them understand the value proposition of NSF, and needs to be written in accessible language. Dr. Meacham noted that the new plan is likely to include illustrations of what NSF does and its importance.

Dr. Meacham advised the group that language and feedback will be most useful in next 3-4 weeks. Dr. Martin-Vega recommended that committee members send their feedback directly to Dr. Wang and Dr. Johnson at NSF, who can compile it and submit it on behalf of the committee.

ROUNDTABLE ON NSF BIG IDEAS AND STRATEGIC RECOMMENDATIONS FOR ENGINEERING

Dr. Martin-Vega opened the floor to the Advisory Committee members.

Advisory Committee members discussed the importance of inclusivity as NSF Big Ideas and the NSF strategic plan are being developed. To get the best ideas onto the table requires an environment, culture, and mechanisms that ensure all voices are being heard, at all levels. This goes beyond race and ethnicity to include gender, sexual orientation, disability, economics, and education, and beyond checking a box. INCLUDES is absolutely fundamental — the best science and solutions come only through diversity of thought.

The NSF Big Ideas overall are fertile and address national needs. Strategically, letting a thousand flowers bloom is important, but so is a certain amount of top-down guidance for fundamental research. NSF Advisory Committees can help NSF develop Big Ideas strategy and concepts.

How the Big Ideas are communicated is very important. NSF is wise to create simple topics and graphics about them; however the current descriptions of the Big Ideas are written for scientific cognoscenti, not the general public or highly-educated people in Congress or other fields. Also, seeing pervasive activities like INCLUDES in separate boxes suggests it is a box one can check, or ignore.

Among the research ideas, three (New Arctic, Rules of Life, Windows on the Universe) could be described as discovering new knowledge, and the other three (Data Science, Human–Technology Frontier, Quantum Leap) could be described as designing, making, and solving. They may be more powerful if portrayed as part of a virtuous cycle for human benefit, where new technologies lead in turn

to new areas of fundamental inquiry, creating an integrative whole and a continuing cycle of discovery and innovation.

Some ideas are absent: environmental change, carbon sequestration, and clean energy; principles of evolution; regionalism versus urbanization; oceans, climate, and protein sources; next-generation computing and the end of Moore's law. Each of these areas has profound questions.

Engineering offers a connection between global challenges and the NSF Big Ideas. The six research Big Ideas need engineering, which integrates with other sciences, to make the Ideas have an impact. Students want to make a difference for society and are seeking an engineering foundation to make it possible. The number of students who enter engineering programs has been growing for 10 years; we can take advantage of the current interest in engineering and present the Big Ideas as moonshots.

Regarding engineering education and practice, often engineering design is reduced to detail design, but conceptual design, where creative ideas are essential, is absolutely critical. Creativity offers another way to be inclusive and attract people, and Congress and the public may recognize its value in our everyday lives. Agility also has to be part of the entire enterprise, and education must get future scientists and engineers to understand that we are in a very dynamic environment. Major transformations will come from big data, high-performance computing, and other areas at the intersections of disciplines, and engineering has to embrace this fact.

This is a moment of opportunity for engineering due to a national surge in interest. People understand that you create real wealth by making things. Let's not be shy about engineering coming through in NSF messages and the NSF strategic plan.

CLOSING REMARKS AND WRAP-UP

Dr. Wang offered thanks to the committee members, COV co-chairs, and the NSF team. Dr. Wang reminded everyone that the next Directorate for Engineering Advisory Committee meeting will be on April 18-19, 2017.

The meeting adjourned at 12:13 p.m.