

Minutes
MPS Advisory Committee Meeting
April 5-6, 2012
National Science Foundation

Thursday, April 5, 2012

Morning Session

Welcome and Introductions

Dr. James Berger, Chair of the Mathematical and Physical Sciences Advisory Committee (MPSAC) opened the meeting at 9:00 a.m. He welcomed members to the meeting, and after introductions, he invited Dr. H. Edward Seidel, the Assistant Director of MPS to address the Advisory Committee.

Remarks by MPS Assistant Director

Dr. Seidel began by reviewing the agenda for the meeting. After his update, on which he would report on the FY 2012, FY 2013 budgets, and framing Issues for FY 2014, MPSAC would receive the report of the Division of Physics Committee of Visitors (COV) report. This would be followed by an interim report on the Division of Materials Research (DMR) NSF Materials 2022 subcommittee. After this report, there would be a report by the Mathematics Name subcommittee report. The afternoon would have the traditional breakout sessions, where MPSAC member would meet with the MPS Divisions. There would be considerable time devoted to preparing for FY 2013 – 2014 and beyond, and positioning MPS and its communities for the future. He noted that the Director of NSF, Dr. Subra Suresh, had created the concept of OneNSF, and a central question was how to position MPS as an engine for OneNSF.

He then presented a number of MPS scientific highlights, including the fact that the three individuals who had received the 2011 Nobel Prize in Physics for their discovery of the accelerating expansion of the universe had all been supported by MPS, as had a 2011 National Medal of Science recipient. He described research on organic aerosols and climate cooling supported by the Division of Chemistry (CHE), innovative data storage techniques developed by the Large Synoptic Survey Telescope (LSST) team supported by the Division of Astronomical Sciences (AST), the recent work on brain pathways supported by the Division of Physics (PHY), the highest magnetic fields created on earth by the National High Magnetic Field Laboratory supported by the Division of Materials Research (DMR) and the Department of Energy (DOE), and work supported in the Division of Mathematical Sciences (DMS) on the development of a powerful tool to approximate smooth regions using many-sided polygons.

Turning to personnel matters, he noted that this was his last meeting with the MPSAC as his term as Assistant Director concluded at the end of August, 2012. Dr. Matthew Platz, the Division Director for CHE would be leaving at the end of December 2012 to assume a position at the University of Hawaii, Hilo and a search for a replacement would begin soon. Within the MPS Office of the Assistant Director (OAD) Dr. Dean Evasius had been appointed Senior Advisor for Science and Head of the Office of Multidisciplinary Activities (OMA). Dr. Tanja Pietrass had been appointed Deputy Division Director in CHE, and Dr. Hank Warchall had been appointed Deputy Division Director in DMS. A search for a Deputy Division Director in AST would begin soon.

Dr. Seidel then gave an overview of the NSF FY 2013 budget request. The current FY 2012 estimate for NSF is \$7.033 billion, and the total FY 2013 NSF budget request is for \$7.375 billion, an increase of 4.8%. MPS is the largest directorate within NSF, and has a budget request in FY 2013 of \$1.35 billion. He noted that MPS spans the space of all science, has five very different divisions, and has a heterogeneous culture and programs. As a result it is difficult to articulate a few top priorities or to determine common themes. He introduced the concept of OneMPS aimed at developing a more coherent, more central approach to activities within MPS. He then described some aspects of the NSF FY 2013 budget that had MPS participation. These included Cyber-Enable Materials Manufacturing

and Smart Systems (CEMMSS - \$50 million in FY 2013), Science, Engineering, and Education for Sustainability (SEES - \$27.2 million), Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21 -\$19.5 million), Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS - \$11.6 million), and Enhancing Access to the Radio Spectrum (EARS - \$12.0 million).

Seidel mentioned NSF programs that are meant to encourage multidisciplinary research across NSF: INSPIRE, to support high-risk/high regard research across disciplines, the Innovation Corps (I-Corps), designed to encourage entrepreneurship, and Science Across Virtual Institutes (SAVI) to establish networking between groups in the US and other countries. Two of NSF's first 3 awards for SAVI were in MPS. The program Expeditions in Education (E²) is meant to transform STEM learning through new partnerships between the research directorates and the Education and Human Resources (EHR) Directorate.

Seidel then turned to the MPS large facility request in FY 2013. The request for MPS facilities is \$263 million, \$2.8 million above FY 2012 (1.1%). He described recent project accomplishments of the LSST. Turning to discussions that would take place during the remainder of the meeting, he noted that the OneNSF approach is real, that the MPS focus on fundamentals is critical as an enabler for all other activities at NSF. Central questions for the advisory committee were how to better develop MPS as an engine for OneNSF, and how to best harness MPS ability to span science as a coherent and central force for science.

In closing, he noted that the advisory committee had been "absolutely terrific" in helping MPS move forward, that research is radically changing and becoming more integrative and interdisciplinary, and that it is essential to make MPS an coherent central engine for science at NSF.

In the discussion period following the presentation Dr. Daniela Bortoletto asked a question concerning the MPSAC white paper on basic research, referred to as "Foundation of the Foundation." The paper addresses the balance between basic and targeted research but the presentation seemed to have a number of specific, targeted programs. How is the Foundation responding with regard to the balance between basic and mission-oriented research? Seidel responded that the paper has had a lot of impact not just in MPS, but across NSF. It has led to funding from OSTP and from the Director's office that is untargeted and aimed specifically at funding the core programs. At the same time, other issues do bubble up, and if MPS only focuses on basic research, it may miss out on some streams of funding. In response to a question by Dr. Juan de Pablo, he commented that the white papers developed by the MPSAC had been presented to OSTP, and that they have impacted thinking at the highest levels.

Dr. Frank DiSalvo felt that one should discuss how basic research can contribute to solving problems, rather than focusing on disciplines and how one would promote conversations among the different, multidisciplinary groups. Dr. Geoffrey West wondered what mechanisms existed to encourage interaction within and outside MPS. Seidel responded that there will be more discussion on the topic tomorrow.

Report of the Division of Physics Committee of Visitors

Dr. Jose Onuchic, the Chair of the Division of Physics Committee of Visitors accessed the meeting via webex, and presented the COV report.

He began by noting that the charge to the COV was to examine and report on the integrity and efficacy of processes used to solicit, review, recommend, and document proposal actions; the quality and significance of the results of the Division's programmatic investments; the relationship between award decisions, program goals, and Foundation-wide programs and strategic goals; the Division's balance, priorities, and future directions; the Division's response to the prior COV report of 2009; and any other issues that the COV feels are relevant to the review.

The COV was unanimous in their overall assessment that the management of the Physics Division was excellent. Much of this success was attributed to the PHY senior management team of Division Director Joe Dehmer and Deputy Division Director Denise Caldwell.

With respect to the quality and effectiveness of the review process, there was consensus among the committee members that the three-tier review process is a critical component of excellence in review. Both merit review criteria are always addressed at all levels of evaluation. Some reviewers, however, had difficulty in properly weighting the “broader impacts” criterion.

In discussing the program portfolio and balance and the creation of new programs, he noted that according to the Division’s master plan, at least 50% of its budget is allocated to grants to investigators funded by these programs. The actual percentage is slightly larger. The COV paid special attention to the new programs and was clearly satisfied with most of what they have been achieving. There was strong support for the Physics Frontier Centers.

Onuchic noted that the impact of physics in creating the new technologies that have revolutionized our society during the last 50 years has been enormous. The interesting aspect is that most of these technological advances did not happen by design. They came as a consequence of basic research in physics, and he strongly recommended reading this section of the report as there were amazing examples of success.

With respect to facilities and instrumentation there was consensus by all of the COV subpanels in supporting an instrumentation program across a scale that could benefit all disciplinary programs. While different programs have different needs for such a program, lack of such a program is impacting what science can be done.

He then discussed broadening participation and commented that although PHY has put much effort toward increasing broadening participation, there was a general consensus by the COV that much more needs to be done. While the participation of woman in PHY grants appears to be acceptable, the participation of underrepresented minorities is still very problematic. Furthermore, mechanisms for the evaluation of the effects of broadening participation are quite limited.

In the discussion period that followed the presentation Dr. Frank DiSalvo commented that basic science often leads to applications that may not have been foreseen. Is there an efficient and timely system for taking basic discoveries and getting them incorporated into new technology? Onuchic responded that this was an important issue and gave as an example a program at Rice University that was examining a portfolio of discoveries in the context of new technological developments, and help bridge the “valley of death” between basic research discovery, innovation, and technological development. This might be an interesting concept for MPS and NSF at large to investigate. Dr. Bortoletto stated that the assertion in the COV report that in terms of broadening participation, women’s issues are largely taken care of now is not correct. There are still many shortcomings in hiring and retention of women scientists. Onuchic responded that she was correct and the point the COV wished to make is that in comparison, issues with respect to underrepresented minorities are even more acute. The issue is certainly not ideal for either women or minorities. Dr. Elsa Reichmanis commented that on the topic of transitioning discoveries into new technology, there are two new National Research Council (NRC) studies on the topic of metrics to evaluate the impact of investments in fundamental research. One relates to evaluating research and development (R&D) organizations, the other deals with measuring the impact of investments in the national nanotechnology initiative. Dr. Luis Orozco, the MPSAC representative to the Physics COV noted that PHY is already implementing portions of the report.

The MPSAC unanimously accepted the PHY COV Report.

**Status Report on the MPSAC Subcommittee on Division of Materials Research (DMR)
“Materials 2022” Study**

Dr. Roger Falcone, Co-chair of the DMR “Materials 2022” subcommittee, accessed the meeting via webex, presented a status report on the subcommittee’s activities. He began by noting that DMR has a special role in NSF in instrument development, facilities development, and stewardship. DMR plays a critical role in the nation to engage universities in these areas. DMR has been successful as stewards of facilities. Recently DMR has not been able to offer midscale instrumentation and instrument acquisition programs that the community strongly requests. He then turned to the charge to the subcommittee.

The subcommittee was to examine how DMR could best utilize its resources to meet national needs in instrumentation; provide access to unique instrumentation capabilities through user programs at national facilities; enable multi-user instrumentation for the materials community, including operations and maintenance, taking into account programs by other agencies; identify opportunities for development of new instrumentation and facilities; and meet needs for workforce development. It was to consider these issues but was not to consider proposals for future, individual projects nor to consider how funds are to be distributed among individual ongoing efforts. The subcommittee was to obtain community input as part of its activities.

Membership of the subcommittee was finalized in September 2011 and teleconferences were held in November and December 2011. An onsite meeting at NSF was held in December 2011 and a webinar was conducted with the community in February 2012, with an additional onsite meeting at NSF held in March 2012. He noted that good community input was obtained through a webinar and emails – there were 160 written responses received from the community.

At this point, the webinar connection between the meeting and Dr. Falcone was lost.

Dr. Ian Robertson, the DMR Division Director reviewed the 2011 COV report that called for study of the balance of DMR's instrumentation and facilities investments. The report had two specific recommendations with respect to instrumentation: DMR should balance its instrumentation portfolio so that all scales of instruments are provided, ranging from \$30 thousand to more than \$10 million, and it should develop a facilities stewardship strategy. Additionally, DMR should develop instrumentation networks and possibly a national network, along the lines of the Materials Research Facilities Network (MRFN) developed by the Major Research Science and Engineering Centers (MRSECs).

Dr. George Crabtree, a member of the Materials 2022 subcommittee, then provided the remainder of Dr. Falcone’s presentation. The challenges to the subcommittee were to identify compelling scientific cases for instrumentation programs as well as stewardship/ partnership in national user facilities; identify the compelling broader impacts for instrumentation programs as well as stewardship/ partnership in national user facilities; and provide recommendations as to the nature of instrumentation and facility programs that should be supported within the division.

Goals for DMR should include the following:

1) *Make instrumentation that drives DMR scientific progress accessible to active university-based research programs.* Such an instrumentation program must ensure development of and access to cutting-edge instrumentation, ranging from \$10 thousand commercially accessible equipment to \$1 billion national facilities. There was a need to teach students to develop and use instrumentation.

2) *Promote development of new instrumentation that advances experimental frontiers and enables scientific progress.* It was noted that scientific instrumentation development has a tenuous standing in academia, and it is here that the NSF-DMR instrumentation program is important to promote the academic stature of instrumentation development and attract new talent. Once a midscale technique is developed, it needs to be commercialized.

3) *Enhance access to unique experimental capabilities that are beyond the scale of individual investigator laboratories.* Large-scale facilities provide access to neutrons, intense x-ray and light sources, and high magnetic fields. While other agencies [notably DOE and the Department of Commerce (DOC)] operate most of these facilities, NSF funded individual investigators represent a dominant fraction of the user community with access through peer review. Here relatively modest NSF investments can have disproportionately large effects on accessibility for users and their engagement in large-scale instrumentation development projects.

4) *Provide access to a full range of cutting-edge commercial instrumentation.* Maintenance, reconfiguration, and upgrades to existing instrumentation can greatly enhance research productivity and should – though it is not sufficient at present – be part of NSF-DMR's role in instrumentation. Among the recommendations the subcommittee is developing are that DMR consider increased funding for MRI proposals and developing a mechanism for the acquisition and stewardship of equipment in the \$100,000-\$500,000 range – allowing bundling of smaller pieces of equipment together to fulfill a suite of related characterization problems. These proposals are already reviewed and in-house and many good proposals go unfunded. A critical component should be the training of users, availability to outside users and long-term viability of equipment and these should be criteria for funding. DMR should recognize the critical role that professional staffing plays in the successful operation of instrumentation and characterization tools. Models/programs should be developed that allow for this impact to extend over the full DMR portfolio. NSF should find ways to help shorten the timeline for getting instrumentation from development in universities to commercialization, so that more scientists and industry can benefit from the new instrumentation.

With respect to mechanisms for collaboration, sharing and access, DMR should consider a network of centers – termed *Materials Discovery Centers* – MDCs - that may focus on either the provision of a broad instrumentation portfolio to the external community or to fulfill a specific need/expertise (i.e. X-ray, microscopy, crystal growth). Critical features of an MDC are a focus on professional staffing for training, user support, research and education. Viable and successful models include the NNIN and MRFN where capacity and utilization is already near 100%. It should recognize the need for the expanded usage of equipment and facilities beyond the principal investigator's (PI) host institution. Another recommendation is to develop a database about the MDC instrument network so PIs will know what and where instruments are located.

DMR should continue to support acquisition and development of instrumentation at all scales (single-user, institutional, regional, and major facilities) including the development of the infrastructure for instrumentation networks (e.g. clouds), support for instrumentation access (travel costs, users fees), and student training and experience on shared instruments. With respect to mid-level instrumentation centers, such centers should be geographically diverse and regionally inclusive and should have adequate staffing, user training, and operational support.

The subcommittee is developing a vision for enhancing instrumentation supported by a network of Materials Discovery Centers. DMR should use national strategies such as the Materials Genome Initiative (MGI) to drive the vision of building instrumentation. A major investment in instrumentation for materials characterization is needed, with an initial significant investment for multiple years (say 5 at least) to catch up with deferred investments, and a continuing and sustained investment to build and make available to the community the next generation of world-leading instruments. An initial surge in funding is critical to establish a vibrant program.

During the discussion period following this presentation, Seidel commented that this was a great opportunity to incorporate regional centers with cyberinfrastructure for sharing data. Crabtree responded that the issue of data was very important to the committee. A comment was made of the importance of having students involved with instrumentation. Crabtree noted that one idea is to tag onto MRSECS that already have facilities. A challenge is that investments have been deferred in the past so we need to make up the ground that was lost. While there has been much attention paid by DOE to facilities, this kind of attention has not been made for midscale instrumentation. Bortoletto noted that NSF typically provides instrumentation funds but not support for the people maintaining the instrumentation. Was the subcommittee considering this problem? Crabtree responded that about

25% of the discussion centered on this – the subcommittee is unanimous in considering this important and that there be professional staff to care for and upgrade the instruments. Reichmanis commented that regional characterization facilities are a useful concept and maintenance contracts and staff will go a long way to alleviating problems.

Report of the MPSAC Subcommittee on the Name of the Division of Mathematical Sciences

Dr. Fred Roberts reported on the MPSAC Subcommittee on the Name of the Division of Mathematical Sciences (DMS). Membership of the subcommittee consisted of James Berger (Duke University), Emery Brown (Massachusetts Institute of Technology), Kevin Corlette (University of Chicago), Irene Fonseca (Carnegie Mellon University), Juan Meza (University of California-Merced), and Fred Roberts (Rutgers University. -Chair).

The Subcommittee was charged to develop arguments for and against the title "Division of Mathematical and Statistical Sciences" that had been proposed by the Division Director of DMS. The scope of the subcommittee was to include input from the mathematical and statistical societies and from individual members of the community.

He then described the process the subcommittee had used in obtaining input. They had started informally as members of MPSAC and had met with Dr. Sastry Pantula, the DMS Director, and asked him to provide a letter to gather comments from the community. They then wrote to presidents of professional societies seeking input, including the Pantula letter. They also asked societies for summaries of comments they received and their choice of individual comments, appropriately de-identified. The subcommittee also sought input from directors of mathematical sciences research institutes and they left it to societies to gather individual comments.

After becoming an official subcommittee of MPSAC, they rewrote presidents of societies and mathematics institute directors and set up an email address for official comments. In addition to comments in response to these letters, the subcommittee received reports of various community events where the name change idea was discussed.

The decision to seek a name change was the result of discussions about how best to position the Division in light of the trends toward scientific discovery being dependent on massive data and quantitative information. The three disciplines most associated with the "Age of information" are Computer Science, Mathematics, and Statistics. DMS is an important source of funding for two of these, yet the name manifests only one. Putting both disciplines into the name would better position the Division to vie for future resources and be inclusive of the growing statistics community. Data-intensive research will drive many of the major scientific breakthroughs in the coming decades. Statistics is broadly recognized as a data-centric discipline, so having it in the name would be advantageous whenever Big Data and data-sciences investments are discussed internally or externally, and the primary objective was to attract new funds and this would benefit core programs, not reduce them.

The name change was sought because the spectrum of statistical science is highly varied and its progression and culture do not justify its being viewed as one of the mathematical sciences. Statistics is inherently multidisciplinary and inclusion of its name in Division name would enhance collaborations with other disciplines at NSF and the name change would make Division better able to attract resources in sustainability, energy, massive and complex data, economic development, health, environment, and security and provide new opportunities for collaborations between mathematicians and statisticians, and with other domain sciences and engineering.

Comments were received from the American Mathematical Society (AMS), the American Statistical Association (ASA), the Institute of Mathematical Statistics (IMS), the Institute for Operations Research and Management Science (INFORMS), the Mathematical Association of America (MAA), the National Association of Mathematicians (NAM), and the Society for Industrial and Applied Mathematics (SIAM). In addition, comments were received in the form of an open letter from 41 members of National Academy of Science (NAS), a letter from three former DDs of DMS, and six other emails/letters.

Roberts also noted that some professional society communications included hundreds of individual comments which the subcommittee read in preparing its report.

Roberts then summarized the comments the subcommittee received. Professional society responses reflected strong feelings of the community and some harshly worded responses. The AMS officially was against the name change, and all but 13 of 342 comments they received were opposed to the name change. The ASA supported name change. With respect to the MAA, 80% of respondents opposed the name change. SIAM reported that they had received 142 comments opposing the name change, 12 for the name change, and 14 comments that were unclear as to the position being taken with respect to the name change. The IMS stated that the comments they had received reflected a divergence of opinion, with 40 of 57 responses favorable for a change of name. The IMS stated that this diversity was due to a lack of homogeneity of its members. INFORMS said that it had received no comments. The NAM referred that matter to its Board, and there was no recommendation concerning the name change. However, NAM recommended more discussion and exploration of the concept.

Roberts then discussed the letters that the subcommittee had received. The letter from 41 members of NAS expressed “concern and dismay” at the possibility of the name change. The authors of the letter “feel strongly” that name change “would be harmful to all of the mathematical sciences, including Statistics” and they were “concerned that the proposal ... is part of a plan to modify the mission of DMS within the NSF.”

The letter from three former DDs of DMS expressed “concern” regarding the proposal and stated that “While we believe the name change is intended as a sign of inclusiveness, we are concerned that it will have precisely the opposite effect.” They went on to say that the proposed name “creates unhelpful separations and exclusiveness” and they were “convinced the proposed name change will excite negative modes in this community, threatening to undo decades of patient and, we believe, successful advocacy for an inclusive view of the mathematical sciences.” They also stated that their approach has led to “significant budget increases” during their tenure at NSF and that DMS will “continue to thrive if it ... maintains an inclusive view of its role in the ever expanding science enterprise.”

In concluding his summary of the input the subcommittee had received, Roberts said that there were strong feelings within the community concerning the concept. The subcommittee felt that the *“Dialogue has ensued to the point that there are serious issues about the role of statistics in NSF that go well beyond the name change and should be addressed no matter what the decision about the name change will be.”* He noted that the subcommittee had received a letter from three prominent statisticians addressing this point and recommending “a study directed at assessing the current structure of support for the statistical sciences and even more broadly the mathematical and statistical sciences within NSF and perhaps broadly again within the government agencies.”

Roberts then summarized the arguments for the proposed change of name of DMS.

The name change is responsive to the NSF strategic plan in that it emphasizes the interaction and partnership with stakeholder communities. Statisticians form a stakeholder community significantly different from mathematics, with separate departments and separate societies. A name change would be overdue recognition that statistics is its own discipline – not a mathematical discipline, but one that uses mathematics. Also, the primary mention of Statistics on the NSF web site is only in sense of summary indices describing graduates, workforce, budgets, etc. An explicit, inclusive name helps recognize statistical sciences without taking anything away from various areas of mathematics. Statistical sciences would benefit from greater visibility in the scientific community. . It would aid in addressing the shortage of statisticians, and, with respect to junior faculty, would make NSF more of a welcoming place. The name change would acknowledge potential contributions of statistical sciences in the era of Big Data and signal intent of the Division to be a significant contributor to research in Big Data. The name change would place the Division in a better position for new funding in Big Data, rather than most going to computational sciences and CISE. It would show that DMS welcomes grant applications from statisticians which the present name does not make that clear. Furthermore, the

importance of statistics has exploded in disciplines such as finance, economics, medicine, public health, and political science. A name change would enhance collaborations with those disciplines and between directorates at NSF. It would help grow resources for the statistical community by helping DMS build bridges to other areas and encourage cross-disciplinary funding so overall research funding for the mathematical sciences is not reduced.

Roberts concluded his summary of the arguments that had been presented in favor of a name change by noting that it was argued that all disciplines that use or create mathematics (e.g., physics, computer science, even biology) have distinct identities at NSF, just not statistics. A name change will make it easier to recruit good program officers in statistics to NSF and would not in any way reflect a move by NSF to relax its focus on basic research. Almost any subfield of statistics has a basic research component, so the argument that emphasis on statistics implies a lesser emphasis on basic research and a greater emphasis on “mission-oriented” research is flawed.

He then turned to the arguments that had been received against the proposed change of name of DMS.

The current name (DMS) was chosen to be inclusive. A name change threatens extensive efforts to achieve this inclusivity to the benefit of all and would be divisive. In addition, the current name reflects current usage in mathematical and statistical literature. The name change would suggest preferential treatment for one subfield of DMS. Other subfields, e.g., computational science, operations research, mathematical biology, would seem to have an equally strong claim to be explicitly mentioned in an expanded name. Statistics constitutes a small (although significant) proportion of the DMS portfolio in terms of number of programs, number of grant applications, and numbers of grants funded. If the goal of name change is to attract more resources to the Division, this is not clearly attainable in the present budget climate. If it attracts more proposals in statistics, this could draw funding away from other subfields and increase the workload of program officers. Statistics is funded throughout the federal government. Traditional funding of statistics by DMS is appropriate: fundamental research in statistics. Broadening the DMS mission to include more applied statistics would not benefit overall funding of mathematical sciences. If a name change signifies a change of funding focus for the Division, this should only be undertaken with broad-range input from community. This could result in erosion of funding for basic research in mathematical sciences, the traditional target of DMS. If current funding of statistics at DMS is inadequate, then this should be addressed substantively, not by changing labels.

Roberts concluded his summary of the arguments that had been presented against a name change by noting that it was argued that large-scale data analysis benefits from research by the statistics community, but contributions by statistics are greatly enhanced by collaborations with other mathematical sciences, which would be impeded by emphasizing the different nature of statistics. Also, the case for a name change has not been adequately made by NSF. The community expects more evidence of a problem and more discussion of possible consequences before such a potentially divisive proposal is made or acted upon.

Roberts, having concluded his discussion of the input the subcommittee had received, turned to what the subcommittee felt should be the next steps in considering the question of a name change. He said that the issues raised by dialogue go well beyond name change itself. Two primary themes had been noted in what the subcommittee had received:

Community involvement at the beginning is crucial. The process did not have sufficient initial community involvement and the process going forward should be carefully thought out, with the relevant communities involved at beginning, and transparent to all. *Tensions in the community need to be alleviated,* and the name change discussions have highlighted and exacerbated tensions in the community. Steps are needed to alleviate this tension, with NSF leadership clearly needed. In order to relieve tensions one must develop an undertaking to effectively define Mathematical Sciences so as to highlight and promote strengths and versatility of this group of disciplines, which includes statistical sciences. One must also ask what about the proper positioning of statistics and Big Data at NSF.

The question is whether statistics is a separate discipline from mathematics. The statistics community overwhelmingly thinks so. There are nearly 100 independent statistics departments at research universities; Statistics produces 1/3 of all PhDs in mathematical and statistical sciences; and the ratio of faculty in statistics departments to faculty in mathematics departments in universities with older statistics departments ranges from 50% to 75%. While statistics has a theoretical underpinning, the heart of subject is that it interfaces to the real world. Many other sciences view statistics as separate and have created subdisciplines at the interface with statistics (biometrics, psychometrics, econometrics, etc.). The US has a Chief Statistician and 14 statistical agencies; the K-12 common core standards include statistics and statistical literacy; over 100,000 students take the AP Stat exam; and the ASA has 18,500 members. Of the last 20 COPSS Award winner (comparable to Fields medalists), only one would have been granted tenure in a mathematics department -- and vice versa.

Roberts noted that over time, disciplines diverge (mathematics was once part of philosophy). For example, operations research and computer science have separated themselves from mathematics. So whether the separation of statistics and mathematics is desirable, it has happened.

He then turned to statistics and Big Data. Scientific opportunities and challenges of Big Data are crucial for the NSF mission and it is this that is a primary motivation to consider "next steps." Big Data provides a strong need for statistical research and the same is true for other branches of the mathematical sciences. Because of the increasing demands from Big Data, statistical science itself is changing rapidly.

The current situation of statistics at NSF is that Statistics is represented by one program at DMS (about 1/10 of DMS portfolio). There is a smaller program in the SBE Directorate, and statistics is scattered over other programs at NSF. Statisticians do not consider this adequate. The current situation leaves statistics with little flexibility to respond to massive changes caused by Big Data, and important areas of statistics can fall through the cracks because of current positioning in NSF. However, some have worried about harm to non-data areas of mathematics if Big Data initiative diverts funds – but this tension might be lessened if statistics was on its own. A similar situation with computer science eventually led NSF to create a separate computer sciences directorate.

Roberts then discussed some reorganization suggestions. One could make statistics a separate division, and this has been suggested by many. Or one could make the Office of Cyberinfrastructure (OCI) the home of statistics and Big Data. One might combine various statistics programs at NSF with operations research, machine learning, and various "informatics" programs to create a Directorate of Informatics and Statistics. Another approach might be to create a Directorate of Mathematical Sciences, with divisions of applied and computational mathematics, pure mathematics, statistics, and computer sciences.

Roberts concluded his presentation by noting that the letter from three leading statisticians suggested a study of current structure of support for (mathematical and) statistical sciences at NSF and more broadly in government agencies. Such a study could consider issues such as big science vs. little science; group science vs. individual investigator. It could take into account the new forms mathematical and statistical science are taking, and a more effective organizational structure, while maintaining the integrity of the small science core. One could ask the community to identify research directions that do not fit well into the current structure. There could be a review of the organization of support at NSF for statistical sciences (and possibly mathematical sciences), and this would not only involve DMS. Professional organizations should have a role in the study. Finally, the study could be used to reestablish trust among organizations that seem to have been lost under the current controversy.

After the presentation both Seidel and Pantula thanked the subcommittee for the outstanding job they had done and stated that next steps will be taken.

Lunch Adjournment Followed by Divisional Breakout Sessions

MPSAC members had lunch with the MPS Divisions in the divisional breakout sessions.

Reports from Divisional Breakout Sessions

Division of Physics (PHY)

Dr. Luis Orozco presented the PHY report. He noted that fundamental science is the number one enabler of scientific progress. Mid-scale instrumentation is a high priority for the Physics division and is very important to its communities. It is a missing component in most universities. The Accelerator Physics and Physics Instrumentation (APPI) program in PHY is way to bring capitalization for mid-scale instrumentation. However, details of mid-scale instrumentation need to be worked out and they expect that coordination with MPS will take place as NSF starts to explore its budget drivers for 2014.

Division of Astronomical Science (AST)

Dr. Taft Armandroff presented the AST report. AST's budget is trailing with respect to the NSF budget. One reason is that AST does not do as well as other divisions in initiatives. As a result, the AST budget is of major concern for its community. The AST Portfolio Review is very important to the astronomy community and there has been considerable input from the community to the subcommittee. It is expected that the subcommittee will complete a draft report in May and that it will be delivered in July. The AST Portfolio Review subcommittee report will need to be presented and accepted at a full meeting of the MPSAC in late summer. The charge to this subcommittee is to recommend critical capabilities for the period 2012-2025 and to recommend the balance of investments that meets two budget scenarios (including closing facilities).

Armandroff described the budget Impacts on the AST grant programs in FY 2012 -2013. Astronomy and astrophysics grants proposals are up dramatically (in FY 2012 there were 713 proposals received, and it is estimated that in FY 2013 there will be 785. The projected success rate for 2012 is 15%. Budget impacts on facilities for FY 2012 – FY 2013 are that the National Solar Observatory (NSO) and the National Optical Astronomy Observatories (NOAO) will have significant cuts. There will be delays in the Advanced Technology Solar Telescope (ATST) due to administrative matters involving the State of Hawaii.

He then described AST planning for facility management competitions. NSF has mandated that there be competition of cooperative agreement (CA) renewals. As a result, several important facilities will be competed as these CAs end in 2014 - 2015. These competitions raise many interesting and important issues and involve a significant workload on the program officers involved in these competitions.

The Atacama Large Millimeter Array (ALMA) began scientific observations on September 30, 2011. Two ALMA papers are on the preprint servers, and 58 of the full complement of 66 antennas are now in Chile.

The Large Synoptic Survey Telescope (LSST) was the top priority of Astronomy Decadal Survey and it is hoped that new construction can begin in FY 2014. Site leveling has been completed and the project had a successful preliminary design review (PDR) in August 2011. Operations of the LSST should begin in late 2021.

The group also discussed ways that AST can collaborate in NSF-wide initiatives and one area was that of Big Data. An example will be the LSST, which will generate huge data bases. Other areas might include STEM, as astronomy serves as a key gateway for inspiring students to enter science careers.

Division of Chemistry (CHE)

Dr. Jerzy Leszczynski presented the CHE report. There will a search for a new Division Director for CHE as Dr. Matt Platz will leave CHE by Jan 1, 2012. The group had a briefing from Dr. Platz who informed them that the National Science Board had determined that the two merit review criteria would remain unchanged but that the definitions have been revised. There had been small fluctuations

during the last two years in Chemistry funding. In terms of distributions of funds. About 75% goes to individual investigator programs but an increase in the funding for the CHE centers had been suggested for FY 2013.

CHE faces a number of challenges, including adopting an interdisciplinary approach. Ways of promoting interactions among various groups were being examined. There was the challenge of global food security for the 21st Century as well as the recovery and recycling of phosphorous. Big Data was another challenge, as was broadening participation in the chemical sciences. CHE was examining creative ways to treat the renewal of proposals and considering the concept of shorter proposal with up to 6 reprints of previous research.

Aizenman commented that NSF had, for years, the option of submitting Accomplishment Based Renewal (ABR) proposals, but few have availed themselves of this possibility. Reichmanis said that if NSF changed proposal requirements from a 15 page project description line limit to 5-7 pages, it would reduce reviewer load, improve panel quality, improve the panel review process, lead to higher quality proposals, and these would be easier to review.

Division of Astronomical Materials Research (DMR)

Dr. Elsa Reichmanis presented the DMR report. The breakout session began with presentations by DMR program directors describing activities defining emerging areas within DMR. A biomaterials workshop had been held as was a CAREER workshop. Dr. Lynnette Madsen described emerging areas in ceramics, and Dr. Eric Taleff described emerging areas in metals. A data charrette was described by Dr. Diana Farkas and a workshop entitled "*Opportunities Enabled by the Materials Innovation infrastructure*" was described by Dr. Daryl Hess.

The breakout group then reviewed the portfolio within DMR. The international activities within the DMR Office of Special Programs were described. Within this program one has the Materials World Network (MWN), the International Materials Institutes (IMI), as well other activities. The instrumentation program and the computational and data driven materials research activities within the Division were described and it was noted that there is now a materials research explosion taking place in the materials research sciences.

The breakout group was briefed on the ongoing NSF DMR Materials 2022 MPSAC subcommittee study. The subcommittee would be addressing how DMR can best utilize its resources to meet national needs in instrumentation, provide access to unique instrumentation capabilities through user programs at national facilities, support acquisition of multi-user instrumentation for the materials community, develop new instrumentation and facilities, and support workforce development. In examining these questions, certain constraints had to be placed. There was to be no discussion of current or future individual projects nor was the subcommittee to determine how funds are to be distributed among individual ongoing efforts. The breakout group heard some of the initial DMR responses to preliminary findings of the subcommittee. Also, DMR intends to create a new program "Computational and Data-Driven Materials Research (CDMR) to deal with the explosion of data in materials research.

Division of Mathematical Sciences (DMS)

Dr. Fred Roberts presented the DMS report. There will be 7 new Program Officers expected in the coming year. Unfortunately, DMS' budget had suffered a \$5 million decrease in FY 2012, but the Division was hoping for a 3% increase in FY2013. There may be cuts to travel monies in future fiscal years and this will impact the conduct of review panels. He described possible budget drivers for FY 2014, with uncertainty qualifications expected to be a major topic for the future. Grand challenges included the need to ensure the privacy of data, and dealing with Big Data.

Division of Astronomical Sciences Portfolio Review Subcommittee

Dr. James Ulvestad, Director of the Division of Astronomical Science, and Dr. Daniel Eisenstein of Harvard University, Chair of the AST Portfolio Review subcommittee, provided the current status of the activities of this subcommittee. The decision had been made to conduct a portfolio review because, for the foreseeable future, budgets would not be sufficient to meet the aspirations of the astronomical community. The National Research Council (NRC) Decadal Survey in Astronomy & Astrophysics advised: "If ... budget is truly flat ... there is no possibility of implementing ... the recommended program ... without ... enacting the recommendations of the first 2006 senior review and/or ... a second more drastic ... review before mid-decade." (p. 240).

The boundary conditions for the review were that there would be no revisiting the ordering of decadal survey recommendations, and no revisiting of their science priorities. The decadal surveys were to be taken as a "given," and the subcommittee was to interleave their recommendations with existing AST capabilities, where "capabilities" includes facilities, programs (including grants), and the state of the profession. Community Input had been solicited by AST until Jan 31, 2012. Additional questions were asked of the Directors of national facilities and major university observatories, and national facilities were also invited to submit plans/visions for their facilities in light of the decadal surveys.

The charge to the subcommittee was two-fold:

- (1) Recommend the critical capabilities needed over the period from 2015 to 2025 that would enable progress on the science program articulated in the Astronomy & Astrophysics and Planetary Decadal Surveys; and
- (2) Recommend the balance of investments in new and in existing, but evolved, facilities, grants programs, and other activities that would deliver the needed capabilities within the constraints of each of the provided budgetary scenarios.

The subcommittee's activities to date had included weekly full-committee telecons since September 2011, with the first face-to-face meeting having taken place October 21 – 23, 2011. There had been numerous working-group telecons since October, and the community had been briefed at a January 2012 American Astronomical Society Town Hall meeting. There had been a second face-to-face meeting January 12 – 14, 2012.

The future timeline for the subcommittee was a third face-to-face meeting scheduled for April 12 – 14, 2012, with the final report scheduled for completion in the June – July 2012 timeframe. The report would be presented to the MPSAC for acceptance in either July or August, 2012, and an AST implementation plan was expected in November 2012.

Adjournment

The meeting was adjourned at 6:00 P.M.

Friday, April 6, 2011

Morning Session

The MPSAC convened at 9:00 A.M.

As the Chair of the MPSAC, Dr. James Berger could not be present due to prior commitments, Dr. Irene Fonseca served as Chair for this session.

Report of Committee on Equal Opportunity in Science and Engineering (CEOSE) Meeting

Dr. Eugenia Paulus, the CEOSE representative to the MPSAC, reported on the CEOSE meeting that had taken place February 28 - 29, 2012. The meeting had begun with a summary by the CEOSE Chair, Dr. Ladner. CEOSE recognized the services of Dr. Margaret Tolbert, who had retired. Dr. Ladner noted that CEOSE was no longer under the Office of Integrative Activities (OIA) but now report to the Office of the Director. The CEOSE Biennial Report was due to Congress next year.

A major issue and challenge is implementation of broadening participation (BP). In the new budget it appears that there is a reduction of money earmarked for BP. Reports on broadening participation activities were presented by NSF Directorates. A common thread in these presentations was the need to improve communications. With respect to the Biennial Report, CEOSE is required to present a biennial report to Congress every two years. The report will be finished in November 2012 and will go to press in January 2013. The report must have prioritized recommendations and there must be a summary of the 20 years of committee work, progress on the implementation of recommendations, as well as the current status of these recommendations.

At the CEOSE meeting there were reports from Federal agency liaisons on broadening participation activities within the agencies. Agenda items for the June CEOSE meeting include implementation of BP as well as presentation on BP from NSF Assistant Directors. A mini-symposium on "Broadening Participation" is scheduled for November 1st and 2nd, 2012.

Discussion with the NSF Director included how CEOSE could be more effective and how transparency between NSF and CEOSE could be improved.

CEOSE also had a discussion with Dr. Freeman Hrabowski, president of the University of Maryland, Baltimore County. Topics included improving the efficiency of programs for BP, improving impact, and strategic investments.

During the question period following Paulus' presentation, Seidel commented that economic factors are a reason upward mobility may be limited. What NSF does is small in scale. Are economists looking at this? Paulus responded that the economic factor was very true at community colleges, and students at community colleges would be more successful if the economic factor could be dealt with.

Report of the Advisory Committee for Environmental Research and Education Advisory Committee (ACERE)

Dr. Fred Roberts reported on the Advisory Committee for Environmental Research and Education (ACERE) meeting. The ACERE was founded in 2000, and up until 2010, its primary job had been interpreted to be "advocacy" for the topics it deals with. Given the substantial new initiatives at NSF on environmental research and education, the role of the ACERE is moving from advocacy to implementation. The major NSF Initiative SEES (Science, Engineering & Education for Sustainability) has become a highly visible and significant part of the NSF endeavor – and this puts a new responsibility on the ACERE. The potential increase in NSF budget for FY13 is seen in part as result of the kinds of initiatives recommended by ACERE. THE ACERE has been taking on an environmental perspective as SEES is a key part of this: cross-NSF investment, portfolio of existing and new programs. Rapid, multi-faceted global change is challenging human well-being and this can

be used to inspire NSF's educational programs. The goal is to bring young people and, in particular, minorities into environmental science.

Education and workforce development in sustainability requires multifaceted approaches focusing on understanding change and projections of impact, adaptation methods and technologies, mitigation actions and technologies, and human well-being on a crowded planet. The role of science and technology will be to inform decision making to drive policy, create new products and capabilities with deep societal impact, and prepare a workforce to address global change. Grand challenges in sustainability education must address fundamental issues in science education such as how the Nation trains and develops its workforce, how teaching and learning science is done in the 21st century, how a science-literate citizenry is created, how NSF broadens and deepens participation in science and engineering, and how NSF can most effectively deploy its resources in STEM education.

He then described discussions at the ACERE on the NSF initiative entitled Expeditions in Education (E²). It is a new NSF cross-directorate interdisciplinary effort with NSF-wide collaborations. The discussion was how to use SEES and other programs to infuse cutting edge science and engineering into preparation of a world-class science workforce in the 21st century. E² has three focus areas initially -- transforming undergrad STEM learning; learning and understanding sustainability; and cyber-learning, data, and observation for STEM education. E² focus areas for 2013 will be to revitalize first- and second-year experiences of undergraduate science and engineering, improve interdisciplinary learning and systems analysis expertise using sustainability topics as a proving ground, and capitalizing on cyberlearning tools and Big Data to enhance learning. The challenge: will be how to use the relatively small amount of funding for the launch of E² to get the most "bang for the buck" in sustainability. There will be education and workforce development in sustainability leveraging NSF Education & Workforce programs.

Roberts then described international global environmental change research and the 2009 Belmont Conference. In 2009, NSF and the United Kingdom Natural Environment Research Council held a conference to identify global change research priorities and how cooperation might address them. As a result, the Belmont Forum was created, consisting of key international players with the US as co-chair and it now has 16 members, including China, India, Brazil, and South Africa.

The Belmont Challenge is to deliver knowledge needed for action to mitigate and adapt to detrimental environmental change and extreme hazardous events. This requires advanced observing systems providing information on state of the environment, assessments of risks, impacts and vulnerabilities, enhanced environmental information service providers to users, inter- and trans-disciplinary research, taking account of coupled natural, social, and economic systems, and effective integration and coordination to address interdependencies and marshal resources.

The Belmont International Opportunities Fund enables the international research community to rapidly propose ideas. There was a joint call mechanism with broad thematic areas for proposals with a target date of April 15, 2012 and a single website for submission of proposals with each of the Belmont Forum members funding their eligible researchers and 17 million Euros committed to date.

In addition, an Alliance has been formed consisting of a strategic partnership of international community: funders, operational service providers, users of global environmental change science with the goal of establishing a joint strategy and work together on common priorities that create and use the knowledge that societies need to adapt and mitigate to hazardous global environmental change. Members of the Alliance include the Belmont Forum, the UN Environment Program, UNESCO, International Council for Science (ICSU) and several others. The Alliance is an international, multi-sectoral partnership that will undertake collaborative research, building and enhancing capacity in developing countries. There will be emphasis on regional networks, and enhanced mechanisms for transnational funding. With respect to international activities, the current focus is on Africa.

Turning to SEES, Roberts noted that SEES was established in FY 2010, integrates issues of environment, energy, and economics, and is concerned with the 2-way interaction of human activity with environmental processes. It is a cross-directorate NSF investment and consists of a portfolio of

existing, new, and upcoming programs that encourage systems-based approaches. Its goals are building the knowledge base, growing the workforce of the future, and forging critical partnerships. During the first two years of this effort (FY 2010 and FY 2011) specific programs included Ocean Acidification, Climate Change Education, Decadal and Regional Climate Prediction using Earth System Models, Dimensions of Biodiversity, Water Sustainability and Climate (WSC). Research Coordination Networks – SEES track (RCN), and Dynamics of Coupled Natural and Human Systems (CNH). One hundred and thirteen awards were made totaling \$99 million. He described activities in FY 2012 and FY 2013. In FY 2012 the focus is on SEES Fellows (183 proposals received, and about 19 - 20 expected to be awarded), Sustainability Research Networks (205 preproposals received), Sustainable Energy Pathways (311 proposals received, and 15 - 18 awards expected to be made). There will be a SEES focus in PIRE. The RCN SEES track, CNH SEES track and climate-related competitions continue.

In the fourth year (FY 2013) the focus areas in MPS will be chemistry and materials, In the Engineering Directorate it will be renewable, non-toxic materials and process improvements. Research in Coastal and Arctic Regions will focus on vulnerability, resilience and cultural impacts. With respect to Hazards and Disasters studies will be concerned with risk assessment and decision making, and in Information Science and Engineering studies will be concerned with energy consumption and clean computing. There is also a significant educational component in the sense that every SEES solicitation has an educational component, one half of the IGERTs have a sustainability focus, PIRE is designed to have engagement of students, and education is expected to be a major theme of the FY 2014 SEES

Roberts then discussed Cyberinfrastructure for the 21st Century (CIF21) and EarthCube. The CIF challenge is “Science and Society Transformed by Data.” Modern science is data-intensive and we experience a deluge of data. Observations, which will be increasingly sensor driven, will have distributed central repositories, The trends in computer architectures will show a growth in the number of cores and the development of more complex memory systems. Power consumption is becoming more and more important, and clouds and data centers will play an increasingly large role. Software challenges include simulation and model scalability, uncertainty quantification, cybersecurity as well as a focus on sustainability of software. With respect to the ACERE, topics involve understanding the earth, clean energy, climate prediction, complex networks, and disaster recovery.

With respect to EarthCube, it is necessary to have a cyber-infrastructure for the Earth System developed for the geosciences. The approach will involve many existing activities involving the community and the object will be “To understand more deeply the planet and its interactions will require an increasingly holistic approach, exploring knowledge coming from all scientific and engineering disciplines.” (NSF’s GEO Vision report). The EarthCube Vision uses geosciences as a model and its goal is to transform the conduct of geosciences by supporting development of community-guided cyberinfrastructure to integrate data and information for knowledge management across the geosciences. It is hoped that EarthCube outcomes will transform practices within the geosciences community, provide unprecedented new capabilities to researchers and educators, vastly improve community productivity, accelerate earth system research, and provide uniform knowledge management framework for all of geosciences.

The ACERE had a meeting with NSF Director Dr. Subra Suresh who noted that there is bipartisan congressional support for science and NSF budget testimony was organized around OneNSF. SEES is the major activity of OneNSF, with sustainability a key challenge of our generation. With respect to the international arena, other countries are investing heavily in science, and this is posing challenges for NSF. International partners look to NSF for leadership and it is important to leverage international resources for scientific activities. In commenting on the growing trend to interdisciplinary research, Dr. Suresh commented that support for such research does not have to come out of the core sciences, and work in one’s field that would affect other fields but still be core research in that field. With respect to Big Data, a question he posed was whether it can be used to scale up educational activities at NSF.

In conclusion, Roberts noted that ERE challenges cut across all areas of science and NSF, that the administration recognizes the importance of these topics, and that NSF has made these challenges a

priority. The international community is ahead of the US in recognizing the problem and massing resources to address it. While the US has made a lot of progress, there has not been enough, and a sense of urgency is missing. This is really critical for humanity.

Planning Needs for FY 2014 and Beyond

Seidel introduced this session by commenting that he would like a lively discussion during this session as to future areas MPS should consider. He said that one should think first of MPS priority areas that could be used to make activities more coherent and a catalyst for OneMPS. There were four priority areas that would be discussed: Complexity, Mid-Scale Instrumentation (in a collaborative sense, Expeditions in Education (E²), and Grand Challenges (Integration of activities on a collaborative science project). He hoped that in all of the discussions the MPSAC would think in terms of OneMPS and noted that MPS is the engine supporting all science. He then went on to describe the annual MPS budget planning cycle.

Each of the MPS priority areas had involved a working group within the MPSAC, and Aizenman had organized these groups and ensured that they meet via telcon in preparation of their reports. The chairs of these working groups presented the results of their meetings and discussions.

Complexity

Dr. Dennis Matthews chaired this working group. His presentation was entitled “*Emergence – Frontier Research in Complex Adaptive Systems*” and he began by noting the primary challenge was one of making this area an MPS-led initiative and make it compelling to OMB and the Congress. One would have to explain it in understandable terms and why it was important. One has to begin with the definition of complexity/complex systems and of emergence. He stated that the study of complex systems refers to the emergence of collective properties in systems with a large number of components in interaction among them. These elements can be atoms or macromolecules in a physical or biological context, or machines or companies in a socio-economic context, or people in social networks. The science of complexity tries to discover the nature of the emerging behavior of complex systems, often invisible to the traditional reductionist approach, by focusing on the structure of the interconnections and the general architecture of systems, rather than on the individual components. Examples of complex adaptive systems include economies, Sociology, Biology, and geological sciences.

A fundamental question is determining the physical laws that govern complex systems and emergence. For biological systems, these are usually governed by minimized energy consumption and reproduction. With respect to what causes emergence, he commented that emergence is the appearance of similar or identical structure, occurrences, and phenomena on totally different systems such as black holes at the center of galaxies, or the eye of hurricane. Other examples include the effects of perturbations to the economy, such as policy decisions which influence banking/stock markets. He noted that the Federal Reserve Bank has started a research program into this area.

He then discussed the merits of making this area an MPS-led initiative, arguing that it would benefit from fundamental MPS science, predictive models and validation methods, and he said that physical science/mathematical methods are necessary to understand and predict emergence. One would also need high performance computing methodologies/technologies. Understanding complexity is a “Grand Challenge.”

He then described a possible implementation plan for an initiative in this area. In the period from June to September 2012, possible activities could include the exploration of potential partnerships with other funding units within NSF, the drafting of concept white paper by partner funding units, and bringing the concept for discussion with other Assistant Directors. During FY 2013 one can consider setting up community workshops that would provide a report that would formalize recommendations for funding activities. This would be followed, if there were a decision to proceed, with drafting a solicitation for proposals in this area and moving towards having the solicitation cleared.

After his presentation, Mathews asked Dr/ Geoffrey West for comments. West indicated that Roberts' report on the ACERE and Seidel's descriptions of the MPS budget cycle were good introductions to complexity. West noted that in a complex system there are many-many components. The fundamental question is: "Are there any laws?" and it was his opinion that there are such laws. He gave a few examples of complexity and felt that new methods were required to study complexity and the interconnection between systems. It was noted that putting related systems together would be a challenge.

Mid-Scale Instrumentation

Dr. Frank DiSalvo chaired this working group and made the presentation. At the request of the MPS directorate, nine members of MPSAC were asked to prepare for a discussion concerning a possible MPS initiative in mid-scale instrumentation. This group of nine included: Frank DiSalvo (discussion leader), Taft Armandroff, Daniela Bortoletto, George Crabtree, Juan de Pablo, Bruce Elmegreen, Michael Norman, Luis Orozco, and Esther Takeuchi. Following some discussion by email and a single conference call, the group proposes that MPSAC discuss the following points of a "straw man" proposal at this meeting:

- There are significant scientific opportunities and needs for instrumentation that cost more than the MRI program can support (a few million dollars perhaps), but less than typical large scale programs, e.g. MREFC (more than 10 % of the directorate budget = \$ 140 million for MPS).
- European and Asian (China, Japan) scientists are significantly ahead in addressing this need, since they have mechanisms for such funding.
- Coming up-to-speed quickly and addressing pent up need/demand will require a "jump start" to the program.
- In a steady state, such a program at MPS would be on the order of \$100 to \$ 150 million/year. A fast ramp up might begin with 60% of that amount in the first year, 85% in the second year and then 100% in the third year and beyond.
- Each division within MPS would call for unsolicited proposals in their Annual Dear Colleague Letter and each would handle the first review, in collaboration with other Divisions as appropriate (and possibly with other Directorates as well).
- Other factors might also be of interest to discuss, including program management for large projects, mechanisms for funding operations and maintenance (if appropriate).

The working group suggests that all MPSAC members read the white paper, consider the above points and any other issues that should be considered, both as criticisms and as strengthening arguments. It would be useful if the MPSAC could point out potential flaws or problems that could blindside MPS in promoting this initiative should MPS go forward with this proposal. He felt that if the MPSAC strongly endorses this concept or a modified proposal, it will likely become the basis for a major initiative at MPS with corresponding requests to OSTP for increases in budgets in FY 2014.

Expeditions in Education (E²)

Elsa Reichmanis, the Chair of this working group, led this discussion by saying that the MPSAC and the Education and Human Resources (EHR) Advisory Committees had created a joint working group that would develop approaches for STEM education, workforce development, and informing an educated public. They want to take a broad view. At present the joint working group members had a teleconference and a dinner meeting in order to get to know each other. She noted that this ties easily into OneNSF and OneMPS. They will have their first real meeting in the afternoon after this session; and she asked for input/suggestions for science education.

Dr. Daniela Bortoletto commented that whereas E² is part of OneMPS and One NSF, universities are compartmentalized. In high energy physics, they are using multivariable methods and she asked how can math/statistics be brought into STEM education so that it can be used in various specialties. Reichmanis agreed and said the MPS-EHR connection can explore how to do STEM education more effectively in order to impact the broader community. In other words, can we improve curricula in

universities to cut across disciplines? Perhaps EHR can help here. Fonseca suggested using cyber technology, Big Data, to help.

Paulus commented that there is data that says undergraduate research helps STEM education. However this is difficult to apply to high school and community colleges. She had three thoughts: First, is it possible to piggy back on grants that produce more data than they use for thesis research to get extra students into labs? Second, she goes to high school science fairs in Minnesota, where she has seen work on data mining on Atlanta Health Care data. There were many more examples, but only two were picked to go forward. Wouldn't it be possible for NSF or its principal investigators to mentor these kids and nudge them towards STEM education? Third, the Gates foundation has funded a Communications Academy with \$35 million; but these are only lectures with no hands on activity. Could MPS or NSF add to this experience?

Dr. Sharon Glotzer noted that she has brought high school students to American Physical Society (APS) meetings with her grant funds and asked if there were a program at NSF to do this. One could let the high school and undergraduate students apply. If they could apply to develop science apps, it could affect thousands of kids. It's important to have students, undergraduate and graduate, think about data differently. Dr. Bruce Elmegeen said he liked the comment about public involvement and thinks one could generate web material for the general public. West said that STEM education for the public is critical. Reichmanis said she really meant to address changing STEM education at middle school level as this would lead to a more literate general public in the future. Roberts noted that some societies have high school sessions, e.g., SIAM; and EHR grants allow taking high school students to present results. Glotzer responded that this takes too much organization and preferred something that could be done more quickly. Reichmanis pointed out that the American Chemical Society (ACS) has programs to involve high school students.

Grand Challenges (GC)

Dr. Sharon Glotzer, Chair of the working group, reported that there is a concept paper for FY 2014 planning with MPS leading the effort. Grand Challenges are big ideas to excite the imagination, build communities, and provide context for investment. All this helps sell science. The working group has done some discussion surrounding the idea of establishing a program to harness CIF21 to take on big problems; and it is natural for MPS to lead and drive a more coherent interaction in OneMPS. This could be a way of integrating MPS and NSF. In the 1990s, MPS led an analogous Grand Challenge program tied to super computers and massively parallel computers. This had a huge impact on computational science. She stressed that MPS should aim for big thoughts, e.g., complexity. NSF does not have a program of five years duration where one can integrate complex problems using CIF21, something that would justify the infrastructure being developed. Such a program would last five years, involve all divisions, at least two directorates, be budgeted at \$200 million, and be NSF-wide. This would build on CIF21 activities. A number of areas could be relevant, but "complexity" seems too large a topic. "Life" is the ultimate complex system. One could create Grand Challenge concepts that would be exciting in areas such as materials or astronomy.

Bortoletto asked if we have examples of success stories from the 1990s Grand Challenge activities. Could a single field have a Grand Challenge? Why should a Grand Challenge be limited to a topic involving many disciplines? Glotzer responded that the Grand Challenges concept developed here would involve many communities.

Seidel commented that the 1990s Grand Challenges presented many sociological problems. The two black hole collision problem was not solved in five years, but ultimately teams formed that solved it. At the time, computation was centered on parallel computers. Now, we have much more, including Big Data and it is a much more fertile environment.

Open Discussion

DiSalvo thought that it might be useful to connect Expeditions in Education with Complexity. Roberts commented that there had been a suggestion to connect Big Data with Expeditions in Education.

Crabtree commented on Mid-Scale instrumentation and felt that it should emphasize new opportunities in this area as well as making a case for why it was needed now. One needed computers in order to evaluate data in real time. The working group report should be made more inspiring. Armandroff mentioned areas such as adaptive optics, infra-red astronomy, and the cost effectiveness of mid-scale instrumentation. West stated that it was important to have examples of grand challenges.

Preparation for Meeting with Director and Deputy Director

The MPSAC then discussed items it would discuss with the NSF Director and Deputy Director.

Lunch Meeting with NSF Director and Deputy Director Dr. Subra Suresh and Dr. Cora Marrett

Fonseca welcomed Dr. Subra Suresh, NSF Director, and Dr. Cora Marrett, NSF Deputy Director. Dr. Suresh thanked the members for being at the meeting and said that he would highlight some activities that had taken place since the November 2011 meeting. He noted that at this time a year ago, NSF had a continuing resolution whereas immediately after the November 2011 meeting of the MPSAC, the President had signed the FY 2012 budget. With respect to this budget, the House had recommended that it be held level with FY 2011 and the Senate had recommended that it be cut by 2.5%. In fact, the final budget had been 2.5% higher than in FY 2011. He noted that the President has continued to emphasize the budgets of NSF, DOE, and NIST.

He then mentioned the search for a new Assistant Director for MPS. Eric Cornell had been named the Chair of the search committee, and Sharon Glotzer was a member. They had begun interviews of prospective candidates, and hoped to have the new Assistant Director in place before August 31st. He commented that the Assistant Director for GEO, Dr. Tim Killeen, would be leaving June 30th. He thanked Dr. Seidel for his service to MPS as Assistant Director and as the Head of the Office of Cyberinfrastructure.

He noted that the strength of MPS is that the MPS disciplines form the core of science – MPS has to celebrate its different aspects, and while they do not need to be aligned, they do not need to be orthogonal to one another. With respect to the concept of oneNSF, it is not that everything must come into one melting pot. Rather, it is that ideas in one field are leveraged in another field, and MPS research is activities such as SEES and CIF21.

DiSalvo described the MPS working group activities on mid-scale instrumentation. Crabtree noted that it would be enabling new science. Reichmanis commented on building user facilities with multiple capabilities. Such facilities would have potential impact across many disciplines as well as serve educational activities. Orozco asked about the status of the LSST and Suresh described his visit to Chile where the telescope, if built, would be located. There had been discussions with the Division of Astronomical Sciences and with DOE. Meza commented on Big Data, statistics, and the discussion concerning a possible name change for the Division of Mathematical Sciences and the increasing role of statistics. Suresh noted that modern instruments were producing more and more data and gave the example of the human genome and the extraordinary reduction in time and costs that now existed in this field. Matthews commented on the science of complex adaptive systems and West stated that complexity transcends everything in MPS and, in fact, covers all of NSF. Reichmanis described the joint working group activity on Expeditions in Education with the EHR Advisory Committee, and Suresh suggested that the joint working group think of one topic that would deliver content with the potential for scalability. Glotzer described the working group efforts on Grand Challenges and Suresh noted that the National Academy of Sciences engineering community had developed a set of grand challenges.

The meeting with Suresh and Marrett concluded with Suresh once again thanking the MPSAC for its work and said that they were looking forward to their suggestions. Dr. Fonseca thanked both the Director and Deputy Director for taking time from their schedules to meet with the Advisory Committee.

Other Business

Fonseca asked if there were any further business to be discussed by the MPSAC. Seidel noted that MPS is an enabler for other areas of NSF, and this has come up all of the discussions. West expressed concern about Seidel's departure.

Adjournment

The meeting was adjourned at 1:00 PM.

APPENDIX I

ATTENDEES

MPSAC Members Present at NSF

Taft Armandroff, W. M. Keck Observatory
James Berger, Duke University
Daniela Bortoletto, Purdue University
Eric Cornell, JILA and the University of Colorado
George Crabtree, Argonne National Laboratory
Francis DiSalvo, Jr., Cornell University
Bruce Elmegreen, IBM
Irene Fonseca, Carnegie Mellon University
Elizabeth Lada, University of Florida (via teleconference)
Jerzy Leszczynski, Jackson State University
Dennis L. Matthews, University of California, Davis (via teleconference)
Juan Meza, Lawrence Berkeley National Laboratory
Luis Orozco, University of Maryland
Eugenia Paulus, North Hennepin Community College
Elsa Reichmanis, Georgia Institute of Technology
Fred S. Roberts, Rutgers University
Geoffrey West, Santa Fe Institute

MPSAC Members Absent

Emery Brown, Massachusetts Institute of Technology
Paul Butler, Carnegie Institution of Washington
Kevin Corlett, University of Chicago
Juan de Pablo, University of Wisconsin-Madison
Joseph DeSimone, University of North Carolina, Chapel Hill
Barbara J. Finlayson-Pitts, University of California, Irvine
Sharon C. Glotzer, University of Michigan
Naomi Halas, Rice University
Michael Norman, University of California, San Diego
Esther Takeuchi, SUNY, Buffalo

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Andrew Clegg, Division of Astronomical Sciences
Kelsey Cook, Division of Chemistry
Keith Dienes, Division of Physics
Hans Engler, Division of Mathematical Sciences
Ann Ferreras, National Academy of Sciences
Marvin Goldberg, Division of Physics
Wendell Hill, Division of Physics
Dana Lehr, Division of Astronomical Sciences
Kathleen McCloud, Division of Physics
Eduardo Misawa, Engineering Directorate
Bruce Palka, Division of Mathematical Sciences
Randy Phelps, Office of Integrative Activities
Charles Pibel, Division of Chemistry
Philip Schwarz, Large Facilities Office, NSF
Joseph Dehmer, Division of Physics
Janice Hicks, Division of Materials Research

Vernon Pankonin, Division of Astronomical Sciences
Sastry Pantula, Division of Mathematical Sciences
Tanja Pietrass, Division of Chemistry
Matthew Platz, Division of Chemistry
Ian Robertson, Division of Materials Research
Edward Seidel, Assistant Director, MPS
James Ulvestad, Division of Astronomical Sciences
Henry Warchall, Division of Mathematical Sciences

Visitors

Robert Dimeo, NIST
Hans Kaper, Argonne National Laboratory
Bridget Krieger, Lewis-Burke Associates
Michael Ledford, Lewis-Burke Associates
Jim Murday, University of Southern California
Dan Newman, NIST
Miriam Quintal, SIAM
Ronald Wasserstein, American Statistical Association
Andrea Widener, Chemical and Engineering News

APPENDIX II
BREAKOUT SESSION ROOMS
MPS Advisory Committee Meeting
Thursday Afternoon, April 5, 2012

		DIVISIONAL ASSIGNMENTS FOR MPSAC MEMBERS						
		AST	PHY	CHE	DMR	DMS		
		Room	Room	Room	Room	Room		
		320	330	1020	1060	370		
Term Ends 09/30/12								
	ARMANDROFF	R						
A	CORLETTE					A		
	DE PABLO				R			
A	DESIMONE			A				
	GLOTZER				X			
	LESZCZYNSKI			R				
	OROZCO		R					
	ROBERTS					R		
Term Ends 09/30/13								
A	BUTLER	A						
	CORNELL		X					
	CRABTREE				X			
	HALAS				X			
	MATTHEWS		X					
	MEZA					X		
A	NORMAN	A						
	PAULUS			X				
A	TAKEUCHI			A				
Term Ends 09/30/14								
	BERGER					X		
	BORTOLETTO		X					
A	BROWN					A		
	DISALVO			X				
	ELMEGREEN	X						
A	FINLAYSON-PITTS			A				
	FONSECA					X		
	LADA	X						
	REICHMANIS				X			
	WEST		X					
A	Absent							
R	Breakout CHAIR, MPSAC member who will summarize Divisional meetings activities to MPSAC							

APPENDIX III

August 08, 2012

Dr. H. Edward Seidel,
Assistant Director
Directorate for Mathematical and Physical Sciences
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Ed,

I have reviewed the final version of the minutes of the Directorate for Mathematical and Physical Sciences Advisory Committee meeting that was held April 5-6, 2012 (attached), and am pleased to certify the accuracy of these minutes.

Sincerely,

Signed

Jim Berger
Chair, Mathematical and Physical Sciences Advisory Committee