Minutes
MPS Advisory Committee Meeting
November 4-5, 2010
National Science Foundation

Thursday, November 4, 2010
Morning Session

Dr. James Berger, Chair of the Mathematical and Physical Sciences Advisory Committee (MPSAC) opened the meeting at 8:30 a.m.

Welcome and Introductions

Dr. Morris L. Aizenman, Senior Science Associate of the Directorate for Mathematical and Physical Sciences (MPS) introduced the Chair of the Mathematical and Physical Sciences Advisory Committee (MPSAC), Dr. James Berger of Duke University. Dr. Berger welcomed committee members. He discussed the agenda and noted that there would be a report from the Facilities Subcommittee that would be followed by a discussion and vote on the recommendations to be presented by the subcommittee. While there would be breakout sessions where MPSAC members would be with Divisional staff, there would not be reports from these meetings as there had been in the past. Rather, discussions of items resulting from these meetings would be integrated into other discussions. A major part of the meeting would consist of a discussion of reports from working groups formed last year. Some of these would be "in progress" reports from MSPAC members, Program Officers, and other co-leaders, while some of the reports would be in final form. He then asked Dr. H. Edward Seidel, the Assistant Director of MPS, to address the meeting.

Remarks by MPS Assistant Director

Dr. Seidel began by noting the importance of the MPSAC's work and that MPSAC activities from the previous year had considerable impact. He noted the names of members who had rotated off the MPSAC, as well as members who were now joining MPSAC. He then described staff changes within NSF and MPS. Dr. Subra Suresh of the Massachusetts Institute of Technology had become the Director of NSF, Dr. Matthew Platz of Ohio State University was now the Director of the Division of Chemistry (CHE), Dr. Sastry Pantula of North Carolina State University was now the Director of the Division of Mathematical Sciences (DMS), and Dr. Ian Robertson of the University of Illinois' Urbana Campus would become the Director of the Division of Materials Research (DMR) at the beginning of January 2011. Recruitments were underway for the Deputy Director, Division of Astronomical Sciences (AST) and the Deputy Assistant Director of MPS.

He noted that the National Academy of Sciences Decadal Survey had been completed. This survey, which had been underway for two years, provides recommendations to NSF, NASA, and the Department of Energy (DoE) on priority areas in the astronomical sciences for the decade. These recommendations include future large-scale facilities, midscale activities, and the core programs of the agencies. Seidel then commented on a scientific highlight: the discovery of a planet orbiting the star Gliese 581 was at a distance where liquid water might exist (the "habitable zone"), had a mass approximately three times that of the Earth, and a diameter 1.3 times that of the Earth.

He then provided scientific highlights from each of the MPS Divisions. He noted that data collection from LIGO had been completed and preparations for Advanced LIGO had begun. NSF has approved discussions with Australia concerning installation of gravitational wave detectors. With respect to the Large Hadronic Collider (LHC), the ATLAS and CMS were now in operation.

Seidel then described the current budget situation. Although we are already in Fiscal Year (FY) 2011, NSF is operating under a continuing resolution. The operating budget is at the FY 2010 level less than 10%. The FY 2012 budget has been submitted to the Office of Management and Budgets (OMB), and NSF expected to receive a passback to this budget in the next couple of months. He could not comment on any aspect of the FY 2012 budget as it is embargoed.

He then turned to challenge the Directorate faces. The MPS Directorate is the largest in NSF, with a budget request of $1.4 billion for FY 2011. It has the largest staff, and has five different divisions. It is quite heterogeneous, in the sense that there are cultural differences in the sciences that MPS supports and the extent to which facilities are supported. As a result, it is difficult to articulate the top priorities and find common themes

for the Directorate as a whole. However, within each Division the core sciences maintain a critical role. Seidel noted that MPS spans the space of all science, and is fundamental to many activities across NSF. Data/computation is also a common thread throughout all of the divisions.

Seidel also noted that the Divisional breakouts that are part of the MPSAC meetings are critical in advising the Divisions on the disciplines they serve. The MPSAC subcommittees that were created last year (Basic research; Climate; Energy; Broadening Participation; Computation; Data-Enabled Science; Life Sciences; Science and Engineering Beyond Moore's Law (SEBML)/Quantum Information Systems (QIS); Matter by Design; Facilities) and that were aligned with MPS working groups, held workshops and written white papers. In particular, the white paper on basic research has had a substantial impact on discussions within NSF. Following up on this, he then described NSF activities that would involve all of NSF. These included Science, Engineering and Education for Sustainability (SEES) and the Cyberinfrastrcture Framework for 21st Century Science and Engineering (CIF21). All NSF units are participating in these, they will be multi-year investments, and MPS can play a major role in each. The MPSAC working groups will help inform MPS on how to focus its activities in these areas.

Continuing on this theme, Seidel stated that MPS needed the advice of the MPSAC. Specific advice was needed on the Large Synoptic Survey Telescope (LSST), facilities, divisional programs, and multidisciplinary work. This could be done through the creation of white papers or workshops. He was also interested in seeing the organization of joint activities with other NSF advisory committees. For example, Broadening Participation could involve MPS, the Education and Human Resources (EHR) Directorate, and the Social, Behavioral and Economic (SBE) Sciences Directorate. The SEES activity could involve these and other NSF Directorate advisory committees (ERE, GEO, BIO, ENG, and SBE). In the Life Sciences area, this would involve MPS, BIO, and possibly CISE, and in the area of Computation/Data-Enabled Science (CDS&E), it would involve the Advisory Committee on Cyber Infrastructure (ACCI).

Finally, he was looking to the MPSAC to assist in the development of an MPS vision document, based on the white papers that had already been produced. In this regard he felt that an Executive Committee made up of the MPSAC Chairs of the working groups should be formed to serve in this capacity.

Seidel concluded his remarks by noting that science was in a major transition period. It was becoming more collaborative and dominated by computational methods and data. In addition, there was much transition at NSF. There was a new NSF Director, a number of new Assistant Directors, Division Directors, and there was considerable transition in government. It was noteworthy that there had never been a president with such an awareness of the importance of science, and MPS needed the help of the MPSAC to move forward in the best possible way.

In the discussion period following Seidel's presentation, Berger asked for a definition of what was meant by mid-scale programs. Seidel responded that midscale is roughly between 4-6million awards – these are smaller than large facilities and larger than normal principal investigator grants. There was some discussion on currently-funded large and mid-scale projects. Dr. Sharon Glotzer asked if NSF had any discussions on the recent Chinese announcement of the world's fastest computer. Seidel commented that although possessing such hardware is important, one must also have the software that makes use of the capabilities of such a computer. Dr. Michael Norman commented that there will be a meeting to discuss the Chinese supercomputer. Dr. Leland Jameson of the Division of Mathematical Sciences commented that when Japan announced its super computer in 2000 not only were their computers fast, they were easy to program.

MPS Response and Actions Resulting from MPSAC White Paper on Computation and the Computation Workshop on Data Enabled Sciences

Jameson's presentation began by noting that there had been both a white paper submitted by the MPSAC working group on May 14, 2010, and that a workshop on Data-Enabled Science in the Mathematical and Physical Sciences had been held at NSF March 29-30, 2010. He described each of the recommendations and the response from MPS. Questions addressed by the working group included: what should MPS be doing in Computational Science and what critical activities in Computational Science are important to the community, but not adequately (or at all) addressed or supported by MPS or elsewhere at NSF.

Recommendation 1: MPS (as well as all of NSF) should embrace Computational Science as a "discipline" in its own right - it has its own identity that should be recognized and nurtured as such.

MPS Response: MPS agrees. MPS will establish a CSD&E group immediately and use this group as a mechanism to fund CDS&E type projects with co-funding through the Office of Cyberinfrastructure (OCI). It was hoped that the CDS&E group would evolve into a program.

Recommendation 2: MPS must commit to long term support of the computational science community, and put in place permanent programs that provide substantive, long term, pan-generational funding and support for endeavors for which scientific impact may be many years off, with appropriate reward metrics.

MPS Response: If we can establish a CDS&E program then this will provide the long-term support that is needed. The goal should be to establish this program before next summer.

Recommendation 3: Software development and stewardship must be supported by MPS for the critical infrastructure that it is.

MPS Response: Software support would be an integral part of the CDS&E program.

Recommendation 4: MPS should encourage interdisciplinary interactions between domain scientists and mathematicians on the topic of uncertainty quantification, verification and validation, risk assessment, and decision making.

MPS Response: The DOE SciDAC program is the model for such an interdisciplinary program. We could easily make this a part of a CDS&E program.

Recommendation 5: MPS should support workforce development at all levels to expand literacy and broaden participation in computational science.

MPS Response: This would be an integral part of the CDS&E program.

Recommendation 6: MPS should support unconventional and high risk activities in computational science, and be nimble to evolve while maintaining a long-term, pan-generational commitment, to achieve transformative change.

MPS Response: This could be explicitly written into the CDS&E program description.

Jameson then turned to a description of the Data-Enabled Workshop that had been held at NSF. The charge to the workshop was that it should provide a high-level assessment of the needs of the MPS communities, including anticipated data generation, capability and inability to mine the data for science, strengths and weaknesses of current efforts, and work on developing new algorithms and mathematical approaches; and provide an assessment of the resource requirements for addressing these needs over the next five years.

The overall recommendation of the workshop was that it urged MPS to obtain significant additional funding to support data-enabled science. This could be used for new initiatives, and/or to provide targeted additional support to the MPS Divisions for data-enabled science activities that could be applied to individual investigator awards, group grants, centers, and facilities as the individual deemed most appropriate.

There are recommendations for each of the MPS Divisions and it is noted that funding of data-enabled science will require the same process care by NSF program officers as funding for interdisciplinary research. There are specific recommendations with respect to review panels and workforce enhancement.

The discussion that followed Dr. Naomi Halas noted that the issue of computation and data-enabled science has impacted all sciences, and asked if this activity was for MPS only or whether other directorates were also involved. Jameson responded that all directorates are collaborating in this area. Seidel added that everything would be discussed the next day at a CF21 workshop. This workshop would be chaired by OCI and would involve all of the Directorates. It involved many programs throughout NSF as well as postdoctoral programs. However, there is no funding at this point. Dr. Sharon Glotzer commented that this was a great response. Dr. Joseph DeSimone asked how to reach out to the private sector, such as Microsoft, Google, *etc*. He added that he was sure that Congress would press to get the private sectors involved. Dr. Michael Normal congratulated MPS on its response to the white paper. Dr. Ramesh Narayan commented that all universities are struggling on how to structure data, including computing and archiving. University departmental and faculty structures will change. One has to consider how things should be reorganized to be inline with universities and the research communities. Halas asked whether this program will be at the expense of some other programs and, if so, what

those programs might be. Seidel responded that funding would be in the traditional way: through the regular programs, with funds from OCI as an augmentation. In the future, NSF would need to generate new funds. Dr. Juan Meza commented that there is a need to fund such a program -- there is a need for computational resources and need think how to provide more resources. Jameson noted that the Livermore had attracted funds from DOE. He hoped the Chinese announcement would help to generate funds.

Glotzer felt that the National Science Board (NSB) should be involved in making policy changes on how to make data available. NSF should provide with guidance. Seidel pointed that divisional guidance will be provided. The Advisory Committee can also provide help to MPS and Divisions on data management plan guidance. Narayan asked about long-term data storage plans, and Seidel responded that creating data over long time frame is a challenge. As an example, much of the data originally stored on floppy disks is no longer readable.

Discussion and Recommendations of MPSAC Facilities Subcommittee

Dr. G. Wayne van Citters set the context for the discussion with an opening presentation on facilities planning within NSF. He began by noting that MREFC projects are central to MPS science and that projects of this magnitude no longer happen only in MPS. The scientific, fiscal, managerial, and political impacts are carefully examined and actively managed by the Assistant Director's office across all of MPS.

In terms of determining priorities, consideration is given, among other things, to the science case, the role of the facility in the discipline, the role of the division in the discipline, the priority as established by the discipline(s), and its technological and management readiness. There is also the matter of the financial scale of the project and if it is manageable throughout the life-cycle.

He described the formal steps in the MREFC process and the role of the MPSAC in this process. In this regard, he quoted from the NSF *Large Facilities Manual*, noting that "The Assistant Director or Office Head relies on community inputs, discipline-specific studies, advisory committee recommendations and internal NSF considerations to prioritize the opportunities represented by the project relative to competing opportunities and demands for resources." Furthermore, NSF requires that "The project has been reviewed by the research community and by NSF, in consultation with Directorate Advisory Committees, and has been assigned a very high priority." Van Citters emphasized that such a recommendation was not a commitment to construction.

Dr. James Ulvestad followed with a presentation on the Large Synoptic Survey Telescope (LSST). The telescope will have an 8.4-meter primary mirror, a 3.3 gigapixel digital camera, a 3.5 degree field -of-view, and will collect about 30 terabytes of data nightly. It will provide complete coverage of the visible sky twice per week. It is projected to have a nominal 10-year lifetime and will be located on Cerro Pachon in Chile. Its broad science drivers range from studies of the solar system to the structure of the universe. The LSST will have an enormous "discovery space" for transient objects along with the ability to carry out key dark energy-related science and identify near-Earth objects (NEO). It has wide implications for data-handling, archiving, and automated event-identification.

Ulvestad commented that LSST was ranked first of the major ground-based projects in the Astronomy Decadal Survey Astro2010 released in August 2010. There are four founding partners of the LSST Corporation, and 34 member institutions. A significant amount of design & development has been completed, with greater than $50 million funding from all partners. The primary mirror has already been cast. The total construction cost of the LSST is approximately $465 million in FY 2010 dollars, as estimated by Astro2010. The project would require approximately $300 million from NSF/AST for the telescope, site, and data handling. A site has been approved by Chile, and it is very close to the location of Gemini-South.

An optimistic schedule would have the LSST initially funded by the MREFC in 2014. Construction of the LSST will require close NSF/DOE collaboration, with the cost of the telescope being provided by NSF, and the cost of the camera by DOE (SLAC). It is unlikely that the NSB will approve LSST to move forward into the MREFC queue without solid agreements on camera. Furthermore, entry into MREFC will require firm agreements on all LSST partner responsibilities; a final "not to exceed" cost (MREFC policy), risk reduction on data handling, a robust operations plan, cost, commitments, and budget room in the MREFC line.

Ulvestad noted that Astro2010 recommends Federal funding of two-thirds of $42 million, with two-thirds of that from AST (or about $19 million per year). The telescope and site are low risk, and no telescope hardware upgrades will be needed in the10-year primary mission. He commented that annual spending on LSST, the Giant

Segmented Telescopes (GSMT) concepts, and the Square Kilometer Array (SKA) development has been approximately $12 million per year, so $19 million per year should available from AST even in flat budget scenarios. However, allocating $42 million per year from AST ($250 million total budget) would require closure of numerous facilities, so a robust operations cost plan would have to be in place at time of MREFC approval.

Ulvestad concluded his presentation by noting that strong relations are in place with DOE, and DOE has committed informally to funding the LSST camera and a share of operations. The project appears ready for preliminary design review (PDR) and for subsequent MREFC approval, once the detailed construction and operations plans are in place.

Ulvestad's presentation was followed by a presentation by Dr. Taft Armandroff, Chair of the MPSAC facilities subcommittee. The subcommittee finds the science expected to result from LSST to be very exciting. It is a unique project with very high predicted scientific impact. The project has numerous community endorsements, and the subcommittee sees strong differentiation between LSST and existing observatories. The LSST data will add value to existing observatories by providing them unique datasets for spectroscopic and other needed follow-up that LSST cannot carry out itself. In addition, the subcommittee viewed the planned DOE contributions and private contributions to LSST as important and beneficial to NSF and LSST. Furthermore, the subcommittee noted that LSST has data rates and volumes that dwarf other projects in astronomy and MPS. Dealing with such data volumes has practical applications. As a result, LSST may have merit based on cyberinfrastructure as well as pure astronomy and physics merit.

The subcommittee did, however, have several concerns. These involved project / program management, the firmness of DOE and private support, how one would handle the visibility of national security assets in LSST data, and the maturity of the data handling, archiving and curation plans. It was also important to clearly understand LSST data policy and its consistency with NSF and DOE policy. Also, was there a coordinated national plan for spectroscopic follow-up of LSST data needed to achieve LSST's full scientific potential?

A discussion of the presentations followed. Dr. Luis Orozco commented that he was overwhelmed by the task ahead when he saw how much data was to be produced. He was happy to hear that there had been an overall discussion of this. Dr. Juan Meza asked if the capability to get the data off the telescope is already part of the price tag. Dr. Nigel Sharp, who was introduced as the new Program Director in charge of the LSST project, commented that this can be done with existing technology. He noted that the LSST will be connected to the second largest data center in Chile. Dr. Craig Foltz added that data is already being sent to and from the mountain.

Dr. Juan de Pablo asked what persuaded the Decadal Study to change its mind between 2000 and 2010 in terms of priority of the LSST which resulted in moving the project from third in priority to first priority. Ulvestad replied that the primary driver of the change was probably the recognition that the LSST would enable the community to move in entirely different directions, citing the impact of dark energy studies as a prime example.

Dr. John Peoples expressed his confidence in the firmness of the DOE and private support. He referred to the joint NSF and DOE support of the dark energy survey and the Sloan Digital Sky Survey (SDSS). He noted that, once the DOE has committed to a project, it becomes a line item in the budget. He believes that the Joint Operations Group (JOG) is functioning well. With regard to data, he commented that getting the data off the telescope is the easiest thing to do. The real challenge is management of the data in such a way that people who did not actually take the data get access to and use it. In this regard NSF has lots of experience.

Dr. Naomi Halas posed several questions. Who will use the data? How will the data sets be communicated to the community? What are the plans for outreach to the community? What is the spectrum? Ulvestad replied that the LSST is not a user facility. The "user facility" is the database. Access to the database is part of the planning. Foltz stressed that developing the outreach components has been part of the planning from the beginning and has been built into every step of the process. Ulvestad indicated that the spectral range of the LSST would extend from visible to near infrared wavelengths.

Dr. Daniela Bortoletto commented that because the science is of interest to both astronomers and physicists, it is important that there be a good connection to both communities in order to take advantage of complementary expertise. She then commented that in astronomy the practice is that universities pay fees to be members of collaboration and get access to data. How does this work in the era of open data?

Ulvestad responded that to the zeroth order the data will be open to the U.S. and Chile free of charge, and to the rest of the world after a proprietary period of about one year. Anyone from outside the US would have to write a proposal to get access. The hope is that they would be willing to put in some funds to gain free access to all the data. The anticipation, however, is that certain data alerts would be broadly publicized as they occur.

Dr. Suzanne Hawley pointed out that the results of the SDSS also changed the view of the priority of the LSST between 2000 and 2010. She stressed that most of the publications from the SDSS are published by people who had nothing to do with taking the data. This has added to the willingness to move the LSST forward in the decadal survey. She further noted that the University of Washington, her home institution, has never been concerned that people have access to data without paying for it. Their interest has been on being in on the ground floor of a project and being part of the decision-making. This makes it worthwhile.

Norman thought that the LSST was "a fantastic project." He referred to having sat in on an earlier review of the project in which one question was not addressed: How much does $465 million buy one? In one sense it buys a data base. But other forms of funding will be necessary to extract the science from the database. It is critical that the community think about how the science will be funded, and this must be initiated at a very early phase.

Seidel indicated that his question has come up often. One suggestion that has been made is to have a science center for the LSST that incorporates members from across many fields of science. Ulvestad replied that there are three levels of the project that take this into account, getting data on the fly, building up processing pipelines, and the final science.

Dr. Geoffrey West agreed with Norman that the LSST was a fantastic project. His main concern, however, about the data-driven science is the interrelationship between areas that produce enormous amounts of data and the development of the underlying science and conceptual ideas. He thinks that the LSST could be a case study in how to address this. He then asked who has provided the private support, what were the second and third priorities in Astro2010, and why?

Foltz replied that the private funds included a donation from the family that had developed curved windshield glass, from the Gates Foundation, the Research Corporation, and from Google. Ulvestad said that the second priority was a midscale innovation program and the third was the Giant Segmented Mirror Telescope. The latter was moved down from its first position in the 2000 Decadal Survey because two groups were still vying for the site and the technology. This was a decision that could take another two years.

Preparation for Meeting with Director and Acting Deputy Director

Jim Berger then moved the discussion to preparations for the meeting with the Director and Acting Deputy Director of NSF. He indicated that he felt that the Director would probably like to begin with his own remarks and then open the floor for questions. The discussion that followed concerned the nature of the questions that would be asked of the Director and Acting Deputy Director.

Joint Session of the MPS Advisory Committee and the EHR Advisory Committees

The MPSAC and Education and Hunan Directorate (EHR) Advisory Committee met in a joint session. Dr. Joan Ferrini-Mundy, Acting Assistant Director of EHR welcomed both advisory committees. Seidel added his welcome and introduced Dr. Cora Marrett, NSF's Acting Deputy Director.

Neal provided a summary and discussion of the white paper "New Directions for Broadening Participation (BP) in MPS," written by the MPSAC subcommittee with participation by MPS staff. Neal began by introducing the working group (WG) members. She then presented an outline of her presentation, which is posted on the MPSAC web site. Her presentation included the following major points: The WG first asked where are we in terms of BP? And where do we want to go? BP is a long term goal. We need to somehow incentivize BP and get more buy in. What do we need to achieve this? She commented that the book *The Difference* by Scott Page, shows that in team achievement, diversity trumps ability. This was identified as the most important outcome.

Neal then listed three reflections and six recommendations that summarized the essence of the WG deliberations:

Reflection 1: Persistence of narrow participation (NP) - change has not been adequate.

Reflection 2: Economic incentive – technological improvement is believed to be responsible for 50% of the Gross Domestic Product (GDP), and 67% of productivity growth in the U.S. since 1946.

Reflection 3: Although BP is multidimensional, challenges that limit progress get little attention.

She commented that the process used in developing the white paper was to summarize MPS activities, review initiatives outside MPS, and then make the following recommendations:

Recommendation 1: Reframe BP incentives for innovation culture development, not only as a demographic threat – this was the top priority.

Recommendation 2: Apply scientific method to the design and implementation of BP programs, *e.g*., the MPS Assistant Director would retain a portfolio analyst to review MPS practices and integrate these practices into a framework.

Recommendation 3: Sustain successful BP programs, which can die when no longer "innovative."

Recommendation 4: Increase participation in innovative programs. This can mean making awards to minority serving institutions (MSI), but there are problems that need more intervention.

Recommendation 5: Strengthen community college to four-year college transitions.

Recommendation 6: Promote more effective mentoring and role-mentoring (*e.g*. extend the postdoc mentoring part of the America Competes Act to graduate students in the areas of BP.)

She concluded by providing a brief overview of the white paper focus areas.

Her presentation was followed by Dr. Willie Pearson, Jr. who gave an overview of BP activities in EHR. There were four major points in his presentation:

1) There is a long history in EHR of addressing the issues involved with BP. They have practices that work well, and more dialog is needed.

2) It is important to focus on evidence-based deliberation, and he gave the MPSAC white paper as an example. Most discussion on this topic are not evidence-based.

3) In the area of BP, EHR has supported social scientists and relevant disciplines in terms of assessment of their activities.

4) The Louis Stokes alliance has a long history of assessment and has led to significant productive outcomes for underrepresented groups. Pearson then gave statistics on African American Bachelor of Science degrees and commented on Latino and Native American experiences.

He concluded his presentation by saying that while programs addressing the issue of BP exist, there is a need to connect these to our communities to facilitate transition of best practices.

In the discussion that followed, Halas comment on assessment and noted the need for progress, not only in terms of gathering statistics, but also in terms of interviews and analysis. She said that focusing on leadership is key, and added that continuity and the tracking of individual career paths was needed, but such a mechanism did not exist at NSF. Ferini-Mundy noted that some states are beginning to track numbers at the state level and Norman asked about the National Academy of Sciences Report (the *Gathering Storm)* and how the working groups had addressed the issues within that report. Aizenman commented that in the Washington metropolitan area, (with respect to recruitment of minorities) at the Thomas Jefferson High School, known throughout the U.S. for its strength in science, recruitment was not improving. The incoming class has 4 African American and 13 Hispanics. At the school the percentage of Asian Americans has been monotonically increasing, American whites decreasing, and there were small numbers of other minorities.

Dr. Joseph DeSimone commented that what we are doing is not working. Rationale for why BP is important is key to the issue, and that was why the MPSAC white paper had made the need for BP a key aspect for innovation in the U.S. and the first bullet in the white paper.

West made three points: (1) We don't have pipeline statistics at all levels; (2) He is struck by units he works with at NSF – they are all white men; and (3) he thinks diversity/perspective is important for innovation. This issue goes beyond gender and into the question of diversity of ideas, *i.e.*, multidisciplinary science.

A member of the EHR Advisory Committee commented that he was glad to see/hear about the progress being made and that diversity means better, not just more. He noted that GK-12 showed the power of science input in K12, an effect of having graduate students teaching in local schools. He said there is a need for a full throttle

approach at universities to GK-20 to have a curriculum manifestation, a multidisciplinary approach. Halas stressed the need to recognize the global setting of life in this discussion and Dr. Fred Roberts brought up a related but different form of BP – multidisciplinary science. He said this needs to start in K - 12. Neal noted that underrepresented groups are overrepresented in multidisciplinary settings. Dr. Matt Platz stressed that more graduate fellowships could help prepare a global workforce.

The discussions of the joint advisory committees concluded by Seidel committing to follow-up these interactions with conferences by working groups and future MSP-SBE-EHR meetings. These working groups will help inform how MPS focuses its activities in these areas, and advice on how to organize activities and joint activities in this area is welcome.

Lunch Adjournment Followed by Divisional Breakout Sessions

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

Thursday, April 4, 2010
Afternoon Session

Meeting with NSF Director and Acting Deputy Director

The MPSAC reconvened in plenary session at 4:00 PM. Berger welcomed the Director of NSF, Dr. Subra Suresh, and the Acting Deputy Director of NSF, Dr. Cora Marrett. Members of the MPSAC were introduced, and he invited Dr. Suresh to make some comments.

Suresh expressed his appreciation to members of the MPSAC for their service on the MPSAC. He said that he was interested in knowing what MPSAC members are concerned with or have to say about NSF programs. Prior to coming to MPS he had met with as many MPS Directorate staff as possible. In addition, he had received many suggestions, thoughts, and input prior to arriving that provided a sense of the scientific communities concerns. These meetings had helped in calibrating internal & external concerns and prioritizing activities. There will be a senior NSF leadership retreat coming soon to discuss a number of items. He would pose some provocative questions such as what if NSF was starting from scratch? How would it be structured?

Hawley commented that MPSAC has organized a number of working groups to discuss cross-disciplinary topics and that MPSAC is concerned that these items are mission-oriented topics. She asked Suresh what his vision is of what NSF should be doing and how he viewed the balance of applied vs. basic research. He responded that NSF has a mission not to focus on any particular areas but to study all fields of science and engineering. There is a need to strike a balance to serve the community well, and this is particularly important given current budget constraints. NSF needs to address long-term issues and how basic research on a subject has led to innovation in another area years later. NSF cannot afford to short-change basic research.

Glotzer commented that the MPSAC had noticed there were a number of new people at NSF who were in 'acting' capacities. There seemed to be too much turnover and upheaval within staffing at NSF and there was need for reflection on the systemic long-term issues surrounding this issue. She asked if Suresh had any thoughts on this and wanted to know the current ratio of temporary to permanent staff at NSF. Suresh responded that this issue continues to be discussed at NSF and there appears to be more turn over now than in the past. NSF needs to improve its succession planning and begin earlier to recruit the best into vacant positions. He said that serving at NSF is a form of national service for those in the scientific community and his priorities were getting the best and brightest at NSF at all levels of staff, making coming to NSF attractive for faculty in light of the personal sacrifices and challenges faced when leaving a home base. NSF needs to have conversations with and get buy-in from university administrators, and NSF can be more proactive on this.

West said that the NSF policy that Division Directors may serve no more than 4 years is restrictive and leads to discontinuity and a lack of institutional memory. Suresh and Marrett responded that while there are some things that NSF can do, some were out of NSF hands. For example, the Intergovernmental Personnel Act (IPA) limits IPAs to a 3 year appointment and there are other legal constraints and dynamics at work as well. The National Science Board (NSB) policy allows Assistant Directors to serve for up to 6 years. However, in bringing university faculty to serve as NSF staff, lengthy stays bring up concerns with possible loss of tenure.

Furthermore, bringing in executive level staff via mechanisms outside of the IPA act often will lead to a severe pay cut for the individual.

Halas brought up the topic of interdisciplinary research. She said that with proposal pressure increasing and tension between managing the current programs, the MPSAC was concerned about NSF's ability to handle cross-cutting work. The MPSAC had the impression that program directors did not understand the severity of the MPSAC concerns. For example, are high-risk/high-payoff proposals being managed and reviewed appropriately? There is a need to be thinking about a NSF structure that will strengthen multi-, inter-, and cross-disciplinary efforts.

Suresh responded that ideas concerning multidisciplinary research are very important and would be a discussion topic at the upcoming Assistant Director's retreat. NSF needs to know the community perception about this, but there are many activities in this area that occur at the interagency level and at the university level.

West commented that panel reviews are not always effective for cross-disciplinary research. NSF needs to think through its review processes and procedures and determine possible pitfalls to existing practices. Along with that questions should be asked concerning whether NSF is judging proposals with effective metrics and whether NSF really wants to take risks.

Suresh responded that NSF can learn from various university practices (*e.g.* scoring recruits and watching their progress). Also, certain activities don't seem to catch on in a multidisciplinary environment, and the problem is how to review such ideas so that they don't slip through the cracks. NSF needs to look at the overall impact and novelty of the concept.

Dr. Fred Roberts asked how one would evaluate interdisciplinary programs effectively at NSF. Suresh responded that NSF needs to determine what long-term metrics for evaluating work. It needs to think of scientific, empirical ways to do evaluation and will need more consideration and discussion

DeSimone asked what NSF is doing concerning broadening participation given that it currently is not working. Suresh responded that NSF can take leadership in this area. He needs to get a grasp on the existing portfolio and to establish as a priority at all levels of NSF as a 1st step. There are some simple things that NSF can do to improve communication.

Norman commented that NSF supports a few supercomputer centers and noted that the new paradigm is data-enabled/intensive science. Can NSF lead in this area? Suresh said that he appreciated the significance of the massive amounts of data and the need to respond to this issue. There is also a need for students and faculty to keep up with the literature and technology at all levels. In addition, the need to mine data is very critical.

A member of MPS staff commented that the current structure of university departments is a hindrance to multidisciplinary research. There is the question of the future structure of universities and whether NSF will be part of the change. Does NSF wait for the universities to reorganize or should NSF lead and nudge universities in certain directions? Suresh responded that there are many parallels between NSF and universities. There are challenges, and NSF is discussing possible future structures. Also, inter-, intra-, and international collaborations will be important in moving forward. This will be on his agenda.

Dr. Esther Takeuchi brought up the question of energy research. She commented that there were other agencies working on similar areas so there were opportunities to collaborate with these agencies and NSF should not be excluded. She asked for his thoughts on this subject. Suresh responded that NSF could not afford to be excluded and not at the table. NSF has to participate in the area of energy research, although NSF cannot claim leadership in this area. Basic research is NSF's main area of strength, and there are many unexpected applications for our support in this area. He will be meeting with the heads of other agencies in the coming weeks to discuss many issues like this.

Dr. Taft Armandroff commented on the just completed National Academy of Sciences Decadal Survey. He noted that there are many science-rich applications at the midscale cost range between individual investigator awards (IIA) and facilities. There was a question on the distribution of grants and grant size while the astronomy

community was talking about the need for midscale infrastructure. Marrett responded by saying that she agreed that this is a big issue at NSF and there was a need for something in the NSF portfolio for this size award. At present NSF has a task force on this issue.

There was further discussion concerning the Decadal Survey, the need of a dedicated telescope, on midscale innovations, and the search for habitable planets. It was noted the Division of Mathematical Sciences (DMS) can take a strong role in data-enabled science, and that DMS has an active role in CIF21 efforts. There was a need for more staff and that the LSST will be a flagship with respect to data management but that it was limited to a small area of science.

Berger thanked the Director and Acting Deputy Director for taking the time out of their schedules to meet with the MPSAC.

In the discussion that followed the meeting with the Director and Acting Deputy Director, the topic of data-enabled science was discussed, and a committee member brought up the importance of building an instrument for collecting and bringing data to the community. This is likely to be more than a directorate problem. It is a problem NSF must be concerned about as it is a global problem and will be ongoing. Seidel responded that a working group comprised of Division Directors has been looking at what can be done on a directorate level, which may in turn influence NSF as a whole.

A committee member asked how MPS deals with budget uncertainties. Seidel responded that MPS prepares budget scenarios and makes plans to show that this has been thought about in advance. There would be more discussion on this the next day.

Reports from MPS Life Sciences Working Group

Dr. Mary Ann Horn, Co-Chair of the joint MPS-BIO working group on the life sciences, began her presentation by noting that Program Directors from all of MPS and BIO (except Astronomy) divisions met to discuss the potential in the FY 11 for joint funding in the biological and physical sciences. She provided the funding history of jointly funded awards over the last five years between the Directorate for Biological Sciences (BIO) and MPS. In FY 2006 the amount was $7.78 million, and in FY 2010 this had increased to $10.29 million.

The two directorates have issued a joint Dear Colleague letter inviting the two communities to submit proposals to deal in one of the following three areas: The physical and chemical mechanisms and mathematical/statistical theories that underlie biological processes; the physical, chemical, mathematical and statistical basis of biology involving one or more levels of biological interaction or complexity; and the physical, chemical, genetic, and epigenetic principles that constrain how living systems adapt to changing environments. Proposals to be co-funded must be approved by at least one program officer in both BIO and MPS and, where appropriate and feasible, co-review will be done and can be through any combination of panel and/or ad hoc review. However, this is not mandatory. Divisions would prioritize the proposals for possible co-funding based on division-level insights and perspectives about the significance of the research, and the suitability to this activity. Also, those proposals where funding from both BIO and MPS would be contributing would receive priority. A more target solicitation is planned for 2012.

In response to a question concerning success rates, she responded that success rates were not tracked because the programs vary greatly. A member of the MPSAC expressed concern that NSF is 10-20 years behind in funding this interface based on the member's perception of research and interest in the community. Horn responded that program directors have recently seen exciting research submitted in this area and were exploring funding opportunities.

Report from MPS Broadening Participation Working Group

Dr. Charles Pibel, Chair of the MPS working group on broadening participation (BP), began his presentation by noting that MPSAC BP had made the following recommendations: MPS should be promoting better BP evaluation and assessment, MPS/SBE broadening participation collaborations, BP program sustainability, increasing participation in innovative programs, strengthening community college to four-year institution transitions, and more effective mentoring and role modeling. He said that in FY 2009, the Office of Multidisciplinary Activities had provided funding of $100 thousand for a contract to the Science and Technology Policy Institute (STPI) to conduct a preliminary feasibility study to inform MPS on this activity. In October there had been a meeting the MPS BP working group STPI staff aimed at a focused study on the suite of MPS broadening participation activities. Community colleges serve a disproportionate number and Research Experiences for Undergraduates (REU) could be used as a vehicle to move students from community colleges into four-year colleges/universities. At an REU NSF-wide coordinating meeting, the group discussed collaboration with community colleges as a means of broadening participation and there was broad agreement that this should be pursued via, for example, discussions with Leadership Groups, Dear Colleague Letters, *etc*.

Adjournment

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

Friday, April 5, 2010
Morning Session

The MPSAC convened at 8:15 A.M.

Advisory Committee for Environmental Research and Education (ERE)

Dr. Fred Roberts, the MPSAC representative to the ERE Advisory Committee, gave a summary of the ERE AC meeting of 8-9 September, 2010. He began by noting that the ERE AC had been founded in 2000 and until 2010 its primary job has been interpreted to be "advocacy" for the topics it deals with. However, with substantial new initiatives at NSF on environmental research and education, the role of the ERE AC is moving from advocacy to implementation. The new role will require rethinking of the tasks of the committee as the new NSF Science, Engineering and Education for Sustainability (SEES) initiative illustrates how environmental research at NSF is now closely related to energy research.

Much of the discussion at the meeting centered on the new NSF SEES Initiative, and as SEES integrates issues of environment, energy, and economics, they are concerned with the two-way interaction of human activity with environmental processes. The SEES budget was $660 million in FY 2010 and is estimated to be approximately $750 million per year in FY 2011 – FY2015.

SEES began in FY2010 as the Climate Change Initiative and included five major FY 2010 climate research programs: Dimensions of Biodiversity; Water Sustainability and Climate; Ocean Acidification; Decadal and Regional Climate Prediction Using Earth System Models; and Climate Change Education. While MPS in FY10 was only involved in the Earth System Models initiative, it was clear from the discussion that MPS disciplines are relevant to all five initiatives as all of these initiatives involve data analysis, modeling, simulation, and decision making enhanced by advanced computation.

It is hoped that the SEES activity will involve larger grants, longer-term programs, interdisciplinary activities and teams, as well as the involvement of other federal agencies (*e.g.* data sharing). Goals for SEES include advancing climate and energy science research, education for long-term sustainability, fostering insights into environment-energy-economy nexus, and modeling at regional and local scales. In FY2011 there will be emphasis on energy, scientific workforce needs and the integration of energy and climate change research, environment and economic research, engaging social, natural, and engineering sciences in collaborations and interdisciplinary networks, and enhancing public literacy on sustainability.

The FY 2011 Dear Colleague Letter discusses research on Energy-environment-society, data analysis and visualization, decision support; research enabled by observational networks, workforce development, and

coupled natural and human systems. In FY 2012 – 2015 emphasis will be on complex systems, energy (including fundamental knowledge, energy alternatives, and vulnerabilities in our energy system), international networks and collaborations, and partnerships with other agencies (*e.g.*, DOE, NOAA, USDA). Research challenges related to SEES include the need to analyze causal models, the visual exploration of data, and measuring the impact of the research (*e.g*., towards creating a green economy).

Roberts noted that there were a number of challenges for the ERE AC. These included how to enhance community awareness about SEES, how to ensure that "Dear Colleague" letters in multi-disciplinary areas like SEES reach the appropriate audience, and how to develop the needed human capital to work on such problems. He commented that there was considerable emphasis on the role of SBE and the many problems of decision making, human responses, land use patterns, etc. that are intimately related with environment, energy, and climate change. There are, therefore, opportunities for MPS/SBE interconnections.

With respect to integrating social scientists into environmental research, social scientists study systems, decisions, and patterns of decisions over space and time. Units of analysis range from individuals to households and from neighborhoods to entities defined by social interaction (cities, countries). Because of these different scales, methods that are used are mixed, including field-based research, experimental research, and survey research.

Roberts described other topics that took place within the ERE AC meeting. Most of NSF's energy portfolio is in ENG and MPS, some spread through BIO and other directorates. Current initiatives in sustainable energy at MPS include multiscale modeling & electro-kinematics, fuel cells, catalysis, solar cell materials, renewable energy materials, and battery technologies. ENG areas of emphasis include fuel cells, hydrogen storage, ceramic materials, nano materials, microbial fuel cells, wind turbines, conversion of biomass to usable fuels, energy-efficient devices, and sensors and sensing systems to increase efficiency of energy use. At OMB, priorities for FY 2012 include reduction of greenhouse gas emissions; understanding, mitigating, and adapting to global climate change; managing demands on land, water, and resources for production of food; biofuels, and ecosystem services based on biodiversity.

Roberts then described activities of the MPSAC working group on climate. The group prepared a white paper. The group saw the interconnections among climate, energy, environment, *etc,* discussed the possibility of combining the MPSAC working groups on climate and on energy, and then decided to plan a workshop to identify research challenges. The first workshop was to be on "Mathematical Challenges for Sustainability", sponsored by six mathematical sciences research institutes in US and Canada (DIMACS, PIMS, SAMSI, CRM, IPAM, NimBios), scheduled for November 15 – 17 2010, at DIMACS at Rutgers University. The workshop would address four themes: Human Well-being and the Natural Environment; Human-Environment Systems as Complex Adaptive Systems; Measuring and Monitoring Progress toward Sustainability; and Managing Human-Environment Systems for Sustainability. There would also be a special focus group on mathematical challenges in energy.

NSF's Science, Engineering and Education for Sustainability (SEES) Activity for FY 2011

Dr. Celeste Rohlfing, Head of the Office of Multidisciplinary Activities began by describing SEES activities in FY 2010. These included the solicitation for the Solar program supported by CHE, DMR, and DMS. Several workshops were sponsored, including one partnered with Germany and the Department of Energy (DOE), while another focused on informatics issues. In addition, principal investigators supported by the SEES program met in March 2010.

SEES activities planned in FY 2011 include reissuance of the Solar solicitation, and Dear colleague Letter from NSF Assistant Directors explaining SEES and what to expect. The letter will be directed to existing opportunities. Seidel noted that the energy working group in energy would be expanded to include participation by ENG. It is expected that in FY 2012 there will be solicitation, and the MPSAC can assist in identifying topics for workshops.

During the discussion, there were comments on the benefits of principal investigator (PI) workshops. However, as there may be over 2000 PIs NSF-wide, there was concern that larger meetings would break into groups self-organized by sub-disciplines, losing the broad coverage. Perhaps plenary talks plus breakouts would help.

There was discussion of the smart grid and safety issues for workers if power is being fed into the grid from home systems or of power outages from the grid caused by events at home systems. There was the need for a big picture understanding of how the power grid works and how one would integrate renewable sources.

Within the context of interdisciplinary issues, there was a question of whether one could share postdocs with DOE. It was noted that within MPS, SEES is centered within CHE, DMR, and DMS. How could one involve physicists who would not normally be involved within any of the above three directorates as well as how MNPS organized division-based investments to leverage additional investments? On the issue of climate change, it was noted that a significant segment of society did not believe in the existence of climate change, and how did this affect the SEES program? It was felt that a major NSF role would be to present evidence and assist in public education in this area. Furthermore sustainability is much broader than climate change, and climate change doubters may still be supportive of research on other sustainability issues. In addition, AST is not thought to play a role, but astrobiology and studies of climate issues on other planets may apply within SEES.

Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) Concepts

Seidel described the current NSF concepts for CIF21. He began by noting that science is being radically revolutionized by computation. Modern science has become data- and compute-intensive, and because of the complexity of problems, there are now multiscale collaborations involving individuals, groups, themes and communities. CIF21 has as its goal bringing people, software, data and resources together, collapsing the barriers of distance and geographic location, providing end-to-end integrated resources, and the engagement of the public at large in science. It will be an organizing fabric and foundation for science, engineering and education.

As an example, he noted that the astronomical sciences were now entering the time domain, where one would be seeing and recording events as they occur. Unprecedented amounts of data would be collected across planet at optical and radio wavelengths, through cosmic ray observations, and by gravitational wave detection. Research teams would be notified of events by social networks, and mobile devices. This would require completely new algorithms, methods, and tools. Multiple communities will have to engage rapidly, integrate observations and share data, software and visualizations in real time.

Seidel then described the NSF CIF21 strategic planning Process. Each Directorate and Office has been participating in a Cyberinfrastructure Committee for the last 3 years. The NSF Advisory Committee on Cyberinfrastructure established 6 Task Forces for CI recommendations. A Dear Colleague Letter was published in December 2009 announcing CIF21 plans, and the NSF Executive leadership has been deeply involved in CIF21 discussions and strategic planning. It has been discussed extensively at retreats, and joint planning documents were developed. A new CF21 Working group has been established to guide CIF21 strategies and specific implementations with two members from each NSF directorate or office.

Major components that have been identified are: Data-enabled science – Computational Science (CDS&E); Community Research Networks; New Computational Cyberinfrastructure; and Access and Connections to Facilities.

In the discussion that followed Seidel's presentation it was noted that pioneering work in this area has come from high-energy physicists, who have been moving lots of data for years. There were questions on how already-functioning facilities were to be integrated into a new paradigm of the future and the storage and maintenance of data in the long term. Given the immense amount of data being accumulated how does one decide which data should be kept, and with the immense increase of knowledge in every field, how does one combine all of this knowledge. A comment was made that NSF should become involved in making scientific knowledge more usable. At present, in collecting large amounts of data, researchers don't have the technology to extract everything meaningful from the data.

Further Discussion of MPSAC Facilities Subcommittee Recommendation on the LSST

The discussion began with a presentation by Dr. G. Wayne Van Citters, Jr. the MPS Senior Advisor. This presentation was being made to answer questions that had arisen from the previous day and to provide a background on NSF facilities planning. The Major Research and Engineering Facilities Construction (MREFC) projects are central to MPS science and projects of this magnitude no longer just happen to MPS. Scientific, fiscal, managerial, and political impacts are carefully examined and actively managed across all of MPS. He noted that the time from concept to operations of a project can stretch 10 – 15 years, and because of this there is a need to foster a stable planning environment. MPS was refining the process of active life-cycle management and projects were being planned from concept, to operations, to decommissioning. As construction decisions can be 3 – 10 years away such decisions must be informed by effective design and development (D&D) activity, and as much as $150 million can be spent on a project before there is a go/no-go decision.

When one speaks of research infrastructure there are a number of different budgetary areas that are included: Major Research and Engineering Facilities Construction (MREFC), Research and Related Activity (R&RA), currently operating facilities, and pre-construction requests. At the present time the MREFC Account (with a total FY 2011 request of $54.5 million) consists of the Atacama Large Millimeter Array (ALMA), and the Advanced Laser Interferometric Gravity Wave Observatory (AdvLIGO). The Research and Related Activities (R&RA) for MREFC facilities under Construction (with a total FY 2011 request of $25.50 million) consists of ALMA and the Advanced Technology Solar Telescope (ATST). The FY 2011 request for currently operating facilities is $291.66 million. Pre-Construction Requests (with a total FY 2011 request of $31.94 million) are for the Energy Recovery Linac, the Deep Underground Science and Engineering Laboratory (DUSEL), the Giant Segmented Mirror Telescope (GSMT), the Large-Aperture Synoptic Survey Telescope (LSST), and the Square Kilometer Array (SKA).

The elements of priority decisions include the science case, the role of facility in discipline, the role of the division in the discipline, the priority as established by discipline(s), and the technological and management readiness of the project. He noted that MPS has to examine its current inventory of facilities and balance its current capability against emerging opportunities. Facilities make up approximately 25% of the MPS portfolio and this boundary is "impermeable."

Projected existing and developing MPS facilities through 2022 will need a 7% compounded budget growth to maintain all current projects and to start two new major ones. However, with 3% compounded growth this would not be possible. Contingency/risks include: imperfect operations models/budgets – usually these grow by a factor of two to three from the initial concept to actual construction finish; the budget process – which is difficult to accurately plan and optimize maintenance and other important risks including partnership reliability, exchange rates, and other economic issues. Van Citters concluded with the presentation of possible MREFC growth models.

After this presentation the discussion turned to the LSST project and Berger noted that the $19 million LSST operations share for MPS was based on current estimate of a total operating budget of $42 million but this was contingent on the other partners in the project maintaining their contributions. Bortoletto asked how reliable other sources were. There was additional discussion concerning costs for decommissioning the project and whether such decommissioning costs have to be included in the planning.

At the conclusion of this discussion Berger asked if the MPSAC was prepared to recommend to NSF that the LSST move forward to the next stage (Preliminary Design Review – PDR) in the NSF MREFC facilities process. Two MPSAC members (Peoples and Cornell) abstained from the vote, with all other MPSAC members present voting in favor of the motion.

MPS Response to the MPSAC Basic Research White Paper

Seidel began by noting that the white papers produced by the MPSAC had been discussed at an MPS retreat and had impact. The white papers had sharpened thinking within MPS, and every one had influence that extended beyond MPS. The white papers had been passed around to all ADs. Some had been circulated to OSTP and had been part of the NSF Assistant Directors retreat.

He commented that the NSF mission is actually *basic research* in Science and Engineering (S&E). It is the only agency with this mission, across all subjects; it fuels the innovation economy, and provides the raw materials for "mission-specific" agencies. He said that many agencies depend on NSF, and the economy will depend more on this innovation in the future than the past. In addition, national defense and health depend on basic research. He gave examples of basic research, such as the laser, which is now the heart of the optics industry; MRI, which has revolutionized medicine; and number theory, which is essential for national security. He noted that each innovation has led to major breakthroughs far from the intended field of study and if there had been a call for research into better transportation in 1850, we might have been doing research on "locomotives with wings…"

The white paper on basic research had been discussed at a very high level, and he would like to see a public version of the original MPS version. It should form the basis for the foundation of the MPS Vision Document

Norman asked about high risk programs and Seidel responded that we look for it in reviews, and that there are certain mechanisms such as the EAGER awards that may be a better fit for such proposals.

MPS Response to the MPSAC Science and Engineering Beyond Moore's Law White Paper

Dr. Charles Bouldin, a Program Director in the Division of Materials Research began his discussion by noting that Moore's Law (1965) is the empirical observation that the number of transistors on an integrated circuit doubles about every 2 years, and that computer speed doubles about every 2 years. There have been about 11 such doublings since 1970. Also, the physical foundations of computing have changed from mechanical, to tubes, to transistors, and we may soon see the beginnings of molecular and quantum computers. As we move to this towards these types of computers we will need new materials, architectures, algorithms, software, paradigms, and awareness about energy efficiency of these new devices.

Bouldin noted that the white paper aligns with priorities in the *NSF Strategic Plan for 2006-2011*, and that a solicitation entitled "Nanoelectronics for 2020 and Beyond (NEB)" had been issued in 2010. This solicitation was for proposals that would develop new materials and processes that would extend the current paradigm, as well as proposals that would go beyond Moore's Law and into the quantum realm. The FY 2011 budget request includes a request for funding by ENG $7 million, MPS $7 million, OCI $2 million, CISE $2 million, and $2 million from the the Nanoelectronics Research Initiative (Semiconductor Research Consortium). In FY 2012 it was the consensus of the working group that the focus should be on quantum computing and other paradigm shifts, and NSF will be seeking interagency partnerships with NSA, NIST, and DOE.

Norman asked how these programs intersect with DARPA UHPC (Ubiquitous High Performance Computing) initiative that is looking for low voltage, low energy uses. Bouldin replied that DARPA's initiative would probably fit under "More Moore" because the ideas are based on the same general computing structure as today's computers. Halas commented that the "nanoelectronics" term is narrow. Optical computing is promising and there is room here for optical computing in this concept. Bouldin responded that proposals based on optical computing are of interest and words to that effect are in the solicitation. West commented that it is interesting to think about where Moore's law comes from and why it has held up so well, and what its origins are.

MPS Response to the MPSAC Matter by Design White Paper

Dr. Celeste Rohlfing commented on MPS activities in this area. There is currently no active working group so a response to the recommendations of the white paper has been least developed. However, there are strong ties with computational science, energy, and other working groups. Since September there have been discussions with other agencies – DOE, NIST, and DOD with emphasis on computational aspects, but other agencies are interested in other areas – NIST is interested in the informatics needs.

Fonseca commented that it is important to include modeling of the problems and analysis. Halas felt there was a need for a strong experimental component to the activity. Sharon Neal asked how has this had evolved and why the focus was on computation. Rohlfing responded that OSTP initially made computation the focus of the activity. Reichmanis wanted to encourage coupling modeling and experiment since having this work together would enable more rapid progress. Dr. James Murday of the University of Southern California said that there was the National Nanotechnology Initiative that involved 26 federal agencies working toward this goal. He

urged the group to talk to nano-scale engineering subcommittee. Rohlfing commented that the MPS focus was broader than on the nano aspects. Norman stated that he was on an advisory committee for DOE for the Fusion Simulation Program that includes predictive modeling for plasmas. As a result experimentalists have data and do talk to those doing the computations, and this would be a good example for NSF. Rohlfing noted that the program will be integrated with engineering and possibly with biology. Seidel said that while the computational aspect was moving forward, steps were being taken to ensure that experiment is included. De Pablo asked if other
De Pablo asked if other agencies were involved and if they could contribute to this effort and Seidel responded that MPS was holding discussions with other agencies.

Future Activities of MPSAC Working Group

Berger thanked everyone who had worked on the white papers. Seidel commented that the activities that had been started last year are being taken seriously by MPS. He would like to see the ideas within the white papers put together into a document for MPS long range planning. In order to so, he would have the leaders of the MPSAC working groups form an executive committee of leaders of working groups to work on such a document. There was also the question of which working groups should continue and whether additional working groups should be created. There would be a teleconference with this executive committee.

Reichmanis said that a vision document for MPS was overdue, agreed with Seidel that the vision document should include the different activities developed in the working group white papers, and that she felt that the existing working groups should continue. Halas felt that the basic science white paper is a very good standard for the executive committee, but it should include how engineering depends on basic science and this could serve as a way of building a bridge between MPS and ENG. In addition, in the vision document interdisciplinary science should be a priority as there was the issue of how to get interdisciplinary proposals reviewed. Seidel thought that there may be a need for a separate group for interdisciplinary issues as this was an issue throughout NSF. West agreed and suggested the topic of complex adaptive systems (CAS). This topic has a big impact on social sciences, business, and emerges from fundamental science. Perhaps there should be a white paper of a section of a white paper on CAS.

Dr. Denise Caldwell, the Deputy Division Director of Physics commented that NSF had a committee discussing the issue of interdisciplinary research and Dr. Deborah Lockhart, the Deputy Division Director of Mathematical Sciences commented on two programs that had been created to deal with proposal involving interdisciplinary research. Dr. Tom Russell of the Office of Integrated Activities added that an interdisciplinary research portal exists now (on NSF homepage http://www.nsf.gov/od/oia/additional_resources/interdisciplinary_research/). This website provides information on who to contact if one wishes to submit an interdisipclinary proposal. There is one contact in each directorate to manage the proposal and NSF is committed to unsolicited interdisciplinary research.

Norman congratulated Berger on the data-enabled white paper report; he volunteered to join that working group. Berger suggested that the various working groups get together to discuss whether or not they want to continue, and new members may want to join working groups to replace those that have rotated off. Seidel suggested that Halas form a multidisciplinary working group, and Glotzer agreed with the need for such a committee. West was willing to volunteer for such a committee as long as CAS is included. Takeuchi volunteered for the multidisciplinary and energy working groups.

Neal felt that broadening participation should be a more important focus in each of the working groups, and Halas commented that an interdisciplinary group could be a good way to include this, as research is showing that more underrepresented groups are gravitating to interdisciplinary work. Glotzer said that the computational science white paper would be improved by including broadening participation and recommending what types of activities should be started. He went on to say that broadening participation should be part of all MPS activities and the white papers. Seidel added that there would be follow up activities with EHR and SBE as they also have great interest in broadening participation.

A list of current members of the working groups is given in Appendix III.

Berger and Seidel thanked members of the MPSAC and MPS staff for their participation in the meeting.

Adjournment

The meeting was adjourned at 12:15 PM.

APPENDIX I

ATTENDEES

MPSAC Members Present at NSF
Taft Armandroff, W. M. Keck Observatory
James Berger, Duke University
Daniela Bortoletto, Purdue University
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
Irene Fonseca, Carnegie Mellon University
Sharon C. Glotzer, University of Michigan
Naomi Halas, Rice University
Suzanne Hawley, University of Washington
Jerzy Leszczynski, Jackson State University
Juan Meza, Lawrence Berkeley National Laboratory
Ramesh Narayan, Harvard-Smithsonian Center for Astrophysics and Harvard University
Sharon L. Neal, University of Delaware
Michael Norman, University of California, San Diego
Luis Orozco, University of Maryland
John Peoples, Jr. Fermilab
Elsa Reichmanis, Georgia Institute of Technology
Fred S. Roberts, Rutgers University
Esther Takeuchi, SUNY, Buffalo
Geoffrey West, Santa Fe Institute

MPSAC Members Present via Telecom
Eric Cornell, JILA and the University of Colorado
Dennis L. Matthews, University of California, Davis

MPSAC Members Absent
George Crabtree, Argonne Laboratories
Barbara J. Finlayson-Pitts, University of California, Irvine
Eugenia Paulus, North Hennepin Community College

MPS Staff
Morris Aizenman, Senior Science Associate, MPS
Charles Bouldin, Program Director, Division of Materials Research
Denise Caldwell, Deputy Division Director, Division of Physics
Thomas Carruthers, Program Director, Division of Physics
Kathryn Covert, Acting Deputy Director, Division of Chemistry, MPS
Joseph Dehmer, Director, Division of Physics
R. Scott Fisher, Program Director, Division of Astronomical Sciences
Craig Foltz, Program Director, Division of Astronomical Sciences
Tomas Gergely, Electomagnetic Spectrum Manager, Division of Astronomical Sciences
Jane Gilman, Program Director, Division of Mathematical Sciences
Janice Hicks, Deputy Division Director, Division of Materials Research
Mary Ann Horn, Program Director, Division of Mathematical Sciences
Lee Jameson, Program Director, Division of Mathematical Sciences, MPS
Zakya Kafafi, Senior Advisor, Division of Chemistry
Dana Lehr, Program Director, Division of Astronomical Sciences
Deborah Lockhart, Executive Officer, Division of Mathematical Sciences
Lynette Madsen, Program Director, Division of Materials Research
Kathleen McCloud, Program Director, Division of Physics

Patricia Page, Division of Mathematical Sciences
Sastry Pantula, Director, Division of Mathematical Sciences
Charles Pibel, Program Director, Division of Chemistry
Matthew Platz, Director, Division of Chemistry
Moishe Pripstein, Program Director, Division of Physics
Thomas Russell, Program Director, Office of Integrative Activities
Celeste Rohlfing, Head, Office of Integrative Activities
Edward Seidel, Assistant Director, MPS
Elizabeth Strickland, National Science Board Office
Guebre Tessema, Program Director, Division of Materials Research
James Ulvestad, Director, Division of Astronomical Sciences
Tanya Vassilevska, Program Director, Division of Mathematical Sciences
G. Wayne van Citters, Jr., Senior Advisor, Facilities, MPS

Visitors
Bridget Glynn, Lewis-Burke Associates
Ruth Lee, British Embassy
James Murday, University of Southern California
David Pittman, C&EN
Naomi Weber, British Embassy

APPENDIX II

BREAKOUT SESSION ROOMS
MPS Advisory Committee Meeting
Thursday Afternoon, November 4, 2010

			DIVISIONAL ASSIGNMENTS FOR MPSAC MEMBERS					
			AST	**PHY**	**CHE**	**DMR**	**DMS**	
			Room	**Room**	**Room**	**Room**	**Room**	
			1020	**1060**	**320**	**330**	**370**	
Term Ends 09/30/11								
	BERGER						X	
	BORTOLETTO			X				
	CORNELL			X				
A	FINLAYSON-PITTS				X			
	FONSECA						X	
	HAWLEY		X					
	NARAYAN		X					
	NEAL				X			
	PEOPLES		X					
A	MATTHEWS			X				
	REICHMANIS					X		
	WEST			X				
Term Ends 09/30/12								
	ARMANDROFF		X					
	CORLETTE						X	
	DE PABLO					X		
	DESIMONE				X			
	GLOTZER					X		
	LESZCZYNSKI				X			
	OROZCO			X				
	ROBERTS						X	
Term Ends 09/30/12								
	BUTLER		X					
A	CRABTREE					X		
	HALAS					X		
	MEZA						X	
	NORMAN		X					
A	PAULUS				X			
	TAKEUCHI			X				
A	Absent							

APPENDIX III

MPSAC Working Group Membership FY 2011

Computation - DES	Climate	Energy	SEBML	Life Sciences	Broadening Participation
Glotzer - Berger	**Finlayson-Pitts**	**Takeuchi**	**Orozco**	**Matthews**	**Neal**
de Pablo	Armandroff	Bartoletto	Cornell	Berger	de Pablo
Fonseca	Berger	Crabtree	Corlette	Butler	DeSimone
Hawley	Butler	Fonseca	DeSimone	de Pablo	Hawley
Leszczynski	Norman	Peoples		Narayan	Leszczynski
Meza	Reichmanis	West			Matthews
Norman	Roberts				Paulus
Lee Jameson (DMS)	**Zeev Rosenzweig (CHE)**	**Linda Sapochak (DMR)**	**Charles Bouldin (DMR)**	**Mary Ann Horn (DMS)**	**Charles Pibel (PHY)**
703-292-4833	703-292-7719	703-292-4945	703-292-4920	703-292-4879	703-292-4971
ljameson@nsf.gov	zrosenzw@nsf.gov	lsapocha@nsf.gov	cbouldin@nsf.gov	mhorn@nsf.gov	cpibel@nsf.gov

MPSAC Working Group Membership FY 2011

Matter by Design	Basic Research	Facilities	Cross-Disciplinary
De Pablo	**Cornell**	**Armandroff**	**Halas**
Glotzer	Bartoletto	DeSimone	Glotzer
Halas	Corlette	Fonseca	Takeuchi
Leszczynski	DeSimone	Matthews	West
Reichmanis	Fonseca	Orozco	
	Hawley		
	Reichmanis		
Andy Lovinger (DMR)	**Morris Aizenman (OAD)**	**Wayne van Citters (OAD)**	**TBD**
703-292-4933	703-292-8807	703-292-	
alovinge@nsf.gov	maizenman@nsf.gov	gvancitt@nsf.gov	

APPENDIX IV

March 9, 2011

Dr. H. Edward Seidel,
Acting 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 November 4-5, 2010 (attached), and am pleased to certify the accuracy of these minutes.

Sincerely,

Signed

Jim Berger
Chair, Mathematical and Physical Sciences Advisory Committee