

**Directorate for Mathematical and Physical Sciences
Advisory Committee Meeting Minutes
November 6-7, 2003**

Thursday, November 6, 2003

Morning Session

Welcoming Comments

Dr. Jeanne Pemberton, Chair of the Mathematical and Physical Sciences Advisory Committee (MPSAC) called the meeting to order at 8:00 AM. Pemberton made brief remarks concerning the logistics for the meeting and welcomed the new MPS Assistant Director, Dr. Michael Turner. The Chair announced that Drs. Colwell and Bordogna, the Director and Deputy Director of the National Science Foundation (NSF) would join the MPSAC for a discussion over lunch at 12:15 PM. Round-the-table introductions of the MPSAC members and guests followed. Attendees at the meeting are listed in Appendix I.

Discussion by Dr. Michael Turner, Assistant Director, MPS

Turner thanked the members of the MPSAC for their service and emphasized that MPSAC activities should be 'meaningful' to MPSAC and 'helpful' to MPS. He began with a summary of his observations on NSF and MPS after his first full month as Assistant Director, and articulated the following challenges:

1. Creating and articulating an MPS vision;
2. Laying out a roadmap for pursuing it;
3. Large-scale science:
 - a. Rethinking how MPS does big projects;
 - b. Strategy for a suite of new projects;
 - c. Mid-scale instrumentation;
4. Building a grants program to match this vision and that of the community;
5. Health of high energy physics; and,
6. Workforce diversity.

He noted that issues relating to the NSF's workforce such as program officer workload, *etc.* should probably not be discussed by the MPSAC given the ongoing studies at NSF by Booz Allen Hamilton and the National Academy of Public Administration (NAPA).

In the discussion that followed, issues included:

1. *The relevance of Priority Areas.* Dr. Joseph Salah asked whether these stood on their own merits or were means to convince Congress of the importance of the fundamental research. Turner responded that they maintained a delicate balance between Congressional sensitivity and day-to-day funding and program development. Dr. John Huchra asked how the NSF approach to priority areas compared to, for example, the National Institutes of Health (NIH). It was noted that NIH had a somewhat easier task of justifying its funding since "everybody gets sick." Turner commented that Congress sees NSF as a "model of a nimble agency."
2. *The overall success rate for unsolicited proposals.* Was the overall success rate for proposals within MPS of approximately 33% appropriate? Several MPSAC members felt that the rate was too low and as a result investigators spent too much time writing proposals at the expense of their research time. Turner noted that he felt that competition is good for science and one must also consider the typical value of dollars/researcher in evaluating the grants program. It was also noted that the agency was trying to address some of these concerns by emphasizing the importance of grant size and duration – aiming for typical grant sizes of \$250,000 over five years. Dr. Morris Aizenman, the Senior Science Associate for MPS, commented that one also needs to consider the demographics of the principal investigator (PI)

population. For example, the success rate for young investigators is lower than for those who had held prior awards.

3. *Is the NSF risk averse?* Several MPSAC members expressed the opinion that it is. In this regard, the NSF program “*Small Grants for Exploratory Research*” (SGER) was discussed briefly. The question arose as to whether risk aversion is in fact deeper-seated, *i.e.*, is aversion to taking chances in high-risk areas actually engendered in the academic system?
4. *Is proposal-writing overhead deleterious to education?* This subject is directly related to the question of the appropriateness of the success rate of proposals submitted to MPS. It was generally held that the typical young investigator spends too much valuable time writing proposals. Given the perceived necessity to carry out research programs, this then erodes their time available for education. Dr. John Huchra pointed out that there is an additional term in the equation – the ‘missed opportunity costs,’ *i.e.*, what is the cost of things that are not getting done due to the overhead of proposal writing, reporting, *etc.*?
5. *What percentage of MPS dollars goes to individual investigator grants?* No number was given for the MPS-wide fraction but several of the MPS divisions provided data. The fraction varies dramatically from division to division. For example, within the Division of Mathematical Sciences (DMS), about 60% of its budget is spent on grants and about 20% goes to centers. Within the Division of Astronomical Sciences (AST) about 25% of the budget goes to individual grants while about 67% goes to facilities. When the question was raised as to whether the balance was correct, the general consensus of the MPSAC was that this was a function of the mission of each division and probably should not be evaluated on a MPS-wide basis.
6. *Do group grants shelter investigators who would not be funded as individual investigators?* Dr. Joseph Dehmer, Director of the Division of Physics (PHY) stated that PHY reviews each PI of a collaborative proposal independently and it was certainly not the case that if one PI on a collaborative proposal was funded then all would be. Dr. David Morrison stated that this was not an issue in mathematics.
7. *Why is it that, while business schools, law schools, and medical schools have made significant progress in diversifying their student population in the last 30 years, it appears that the physical sciences have not?* The MPSAC felt that the physical sciences have a long way to go in increasing the diversity of the workforce in the physical sciences, but it was noted that there are significant variations between disciplines.

The discussion then turned to the role of the MPSAC. Turner reiterated his desire that MPSAC activities be meaningful to the MPSAC and useful for MPS. He enumerated a number of areas in which their considerations could be meaningful:

1. The interface between MPS and the Directorate for Education and Human Resources (EHR);
2. Issues pertaining to the Grants program;
3. Science vision and strategic planning;
4. Supplying advice to the Divisions;
5. Workforce diversity; and,
6. Large-scale science.

Turner noted that tactical advice is more difficult to give and use. He then presented his first draft of an MPS Vision Statement that emphasizes “*Discovery, Innovation, Training and Education.*” Specifically, the draft calls for coordinated research in the following areas:

1. Big Bang to DNA and beyond;
2. Nature of matter, space, time and energy;
3. The basic forces and processes that govern biological activity;
4. Materials for the 21st century;

5. Tools for discovery and innovation from mathematics through advanced instruments; and,
6. Strong, flexible MPS divisions that can respond to complex and changing boundaries.

In the discussion that followed, the following points were made:

1. The evolution in information technology is not included in the draft vision statement. It is possible to interpret it as being implicit in the NSF's mission to provide the best 'tools' for doing science.
2. No mention is made of the NSF's role in enhancing national security. It was noted that the agency and specifically MPS have taken steps to address this important component in, for example, the MPS-wide Approaches to Combat Terrorism (ACT) program.
3. No specific mention is made of the impacts of MPS activities on society as a whole.
4. Mathematics role as the "queen of the sciences" should be included along with its role as the "handmaiden of the sciences." That is, it is important to support both the core of mathematics as well as its application in support of other disciplines.
5. Computational science is not addressed in the mission statement. It was generally agreed that this was not being carried out in the Directorate for Computer and Information Science and Engineering (CISE) where the activity is generally concentrated on enhancing and augmenting cyberinfrastructure rather than 'cyberscience.'
6. A comment was made that the vision statement should emphasize the coupling between theory, experiment, and *simulation*. This obviously bears on the topic of cyberscience.
7. It was suggested that the word "molecular" should be added immediately before the word "processes" so as to emphasize the role of chemistry and specifically molecular science.

Turner felt that a vision statement for MPS was important. In response to a question as to the audience for such a statement, he responded that NSF is the audience.

The discussion then returned to the role of the MPSAC.

Salah noted that scientists as a group are not particularly good at articulating the value of the "core," and so MPS programs are often promoted on their societal impacts. While this is not in itself bad, it does not emphasize one of the principal goals of MPS – to improve and grow the core disciplines. It was noted that communicating the value of the core disciplines to Congress is very difficult when members may be most interested in the impacts of the funding on their constituency. There was general agreement that this is an important goal to pursue but no specific ideas were presented.

The question of how the MPSAC should best use its time was discussed. In response to the question as to whether subcommittees were allowed and/or useful vehicles, it was noted that formal subcommittees are probably not a good idea but it would be appropriate to charge informal subgroups of the MPSAC with specific tasks as the need for them arose.

Dr. Gary Sanders asked that more time be spent during the meeting days for breakout sessions with the Divisions. It was noted that, in fact, this meeting did allow for more time with the divisions. This was perceived as an improvement over previous meetings.

Dr. Judy Sunley, MPS Executive Officer, suggested that, while the MPSAC fills an important role as a conduit *from* the community to MPS, it is equally important that it develop itself as a conduit *back to* the community from MPS. Turner seconded this remark and offered a challenge to the MPSAC to develop concrete methods for this *via* small town meetings, email, *etc.* It was noted that a potentially important part of this interaction could be

served by the MPSAC members identifying themselves as members of the MPSAC to investigators at their home institutions in disciplines other than their own.

A break followed at 10:00 AM.

Joint EHR/MPS Advisory Committee Meeting: Education Activities and Work Force Issues

• **Overview of the Directorate of Education and Human Resources**

The Directorate for Education and Human Resources Advisory Committee (EHRAC), which was also meeting at NSF, joined the MPSAC for a discussion of topics of mutual interest.

Dr. Judith Ramaley, Assistant Director of EHR, gave an overview of EHR, which included the challenges faced by the field and efforts by EHR to address them.

With respect to challenges, items included education and workforce issues, the transition between generations, that fact that the entire nation is going to college and that pathways to obtaining credentials are becoming increasingly complex. The supply of trained workers will remain limited unless the U.S. solves inequities in the system. The U.S. cannot continue to depend on foreign-born talent to solve this problem. Young people are ill prepared to meet the challenges of the modern world.

In discussing the core themes within the EHR portfolio, she commented that the nature of science is changing; there is a convergence of disciplines; and students are learning a science that no longer exists. Core investment areas in the EHR portfolio include attracting and preparing U.S. citizens for science, technology, engineering and mathematics (STEM) careers, developing K-12 teachers and STEM faculty, increasing institutional capacity to provide STEM education, and preparing STEM professionals.

In particular, she spoke of EHR's strategies to create "capacity" for the individual, for the institution and in collaborations. Capacity building strategies include preparing and supporting STEM teachers and faculty and providing them with materials and strategies. One had to invest in research in the science of learning, translating this research into practice, and developing models of change at various institutional levels through networking, partnership, alliances, and collaboratives. One had to ensure that the STEM community is broadly representative of the nation and identify effective ways, both formal and informal, to address the STEM knowledge requirements of adults.

She discussed EHR's goals for the current fiscal year, one of which is to enhance the role of research and evaluation in their activities. Ramaley noted that with respect to NSF's strategic outcome goals of People, Ideas, and Tools, each involves the workforce, learning, and innovation. EHR was planning to integrate internal work with regard to its structure and programming, and would intensify interactions with other directorates rather than being a separate entity. EHR intended to evaluate its portfolio with regard to People, Ideas, and Tools, enhance the role of research and evaluation in its activities, integrate basic research and education, and expand the research focus in EHR.

To accomplish these goals, EHR's strategies include programs based on national reports and the research literature. EHR is re-evaluating its current portfolio, its current forms of review, and its use of Committee of Visitors and third-party evaluations, which currently focus on a single program. She felt that none of the current approaches really encompasses a portfolio model.

Another major point of her talk was EHR's efforts to evaluate or review their portfolio, which she defined as "a pattern of investment, and what you hope to accomplish with it." In determining an appropriate portfolio model, EHR will adopt a thematic approach and utilize an external panel of researchers and educators. It will conduct two reviews a year, each requiring about six months of effort, and will select topics based on changes in NSF priorities, emerging opportunities, strong public interest and budget availability. The first review will be on mathematics education, while the second will be on technology in education. Additional topics will be developed

in consultation with the EHRAC. The reviews would assess the condition of the field with regard to challenges and opportunities, review criteria, relevance, quality, and performance.

Dr. Ramaley closed her talk by restating two major challenges facing EHR:

- Balance between research and innovation in portfolio and projects; and
- Very large national investment in an old system of education.

In the discussion period that followed, she was asked what the target audience for these programs would be. She responded that the audience was people who prepare the next generation of the STEM workforce. A comment was made that the structure of EHR, being different from other science directorates, is visible in the problems principal investigators are having with NSF Merit Review Criterion two. She responded that there is a need to create infrastructure that researchers can connect to and then institutions can link to centers for support.

Ramaley was asked about the role of colleges and universities in education research. She responded by asking who trains the K-12 teachers, where is the STEM workforce going to come from. She noted that continuing education (knowledge transfer) is voluntary (*i.e.* it doesn't reach a large enough audience) and felt that new kinds of knowledge transfer are needed for students and teachers and this had to be provided by experts.

She was asked whether, in order to attract U.S. citizens to STEM, did one need to reach out more to K-12? She replied that there were three things one had to consider as strategies for impact:

- What you do yourself;
- How you collaborate with others; and
- What you try to get someone else to do.

- **Report on EHRAC/MPSAC Subcommittee Activities**

Pemberton serves as the Chair of the EHR-MPS Joint Subcommittee of the Advisory Committees to Review Undergraduate Education in the Math and Physical Sciences (JSAC). The purpose of her address was to inform the committee members of the subcommittee's history, as well as their efforts since the last meeting. The subcommittee membership has been finalized, and an outline of questions has been created with respect to the four pillars of MPS undergraduate education. Dr. Pemberton gave a tentative timeline of subcommittee activities, as well as projections for possible uses of the results.

During the discussion period it was noted that a large number of non-science majors take an astronomy course as their required science course. Why is this not included in the JSAC analysis? Pemberton responded that JSAC is focusing only on science majors leading to STEM professionals. She was asked as to JSAC's interpretation of NSF Merit Criterion 2. She responded that this particular issue should come to the forefront during discussion of the boundary between research and education, but is not specifically in the focus of the study. Ramaley commented that Criterion 2 is not specific to EHR. It reads "broader societal impacts" and applies to all proposals submitted to NSF. Asked whether the JSAC study would include other countries, she replied that JSAC will study only the U.S. since that is the NSF focus.

Documents associated with the JSAC study can be found in Appendix II.

Joint MPSAC/EHRAC Lunch with the NSF Director and Deputy Director

The Director of the National Science Foundation, Dr. Rita Colwell and the Deputy Director, Dr. Joseph Bordogna joined the joint MPSAC/EHRAC session for lunch. Colwell thanked the member of the MPSAC and the EHRAC for participating in the meeting. She pointed out what a rare occasion it was to have scientists and educators meet to discuss important issues. She commented on the situation with respect to graduate student enrollment at U.S. universities. Recent studies concerned with graduate education have shown that foreign-educated scientists, mathematicians, and computer experts comprise an important part of the American workforce. She noted that visa applications from foreign nationals wishing to enter U.S. universities are, for the

moment, predominantly from South Korea and India. At this time Europeans are making fewer applications. In fact, Japan is recruiting Japanese nationals from U.S. science and engineering positions. She stressed that the lack of sufficient numbers of American scientists will create a problem for the U.S. in the coming decade.

Another problem that has surfaced recently is that although the U.S. has been fairly successful in bringing women into the workforce, a recent article in the New York Times Magazine documented the new phenomenon of women going back home and abandoning their technical and other careers in favor of raising children. Although one sees fewer cases of sexual harassment in the workplace these days, one sees a new problem surfacing—that of the “two body” problem. Society may need to come up with creative solutions that will allow one or the other member of a couple to take time off to care for children. In other words, create new career tracks for men or women who wish to take part in raising their families. The problem is cultural and social. We must have American citizens in the military, in the student body at the universities, and in the intelligence agencies. We need American scientists and engineers. Recently the National Science Board (NSB) released a report that stated that the country did not lack for jobs, but that national security dictated that more American workers fill such jobs.

Colwell noted that in the 1970's EHR ran summer programs for high school teachers. These were criticized for being “summer camps for high school teachers,” and were eventually discontinued. NSF intends to resurrect these programs in the near future. NSF also runs summer programs for high school students, particularly for underrepresented groups. Attendance is a problem since it is not “cool” to be computer and mathematics literate.

In commenting on the state of the NSF budget in Congress, Colwell hoped that this would be the sixth year of clear financial support. She was cautiously optimistic and hoped for a 15% budget increase over last year. She said that the current success rate for proposals was too low, threatening to discourage young scientists. Mathematics has doubled its budget in the last six years, and she stressed that the emphasis on human and social dimensions across directorates remained strong. However, the central problem remained that of the workforce in the 21st century.

Dr. Joseph Bordogna, Deputy Director of NSF, said that a central issue associated with workforce participation is the mix of participants in the workforce. Minorities remain underrepresented. The NSF traineeship program aims at providing a boundary-crossing experience that will create new scientists from participants. The CAREER program also stresses educational innovation as well as scientific contribution.

In the question period that followed these remarks, someone asked whether the summer programs for high school students would be reinstated. Colwell responded in the affirmative, and noted that NSF had just announced a new position for a program director whose primary concern would be workforce issues. This individual would coordinate programs and educational components that are associated with workforce issues. Bordogna noted that NSF's aim was to attempt to change the professoriate so that it is mixed, and that will eventually lead to changing the workforce and make it mixed. NSF will do that by creating a partnership with academics.

The Chair of the EHRAC commented that a large number of minorities are found in community colleges. However, this population loses interest very early (around fourth grade) in science and mathematics. There is no lack of interest in grades one through four. Another person commented that in most institutions there is no mathematics requirement. Furthermore, at the local level the issue is how to connect to institutions that cover these grades. NSF should conceptualize the problem.

In response, Colwell noted that NSF already has programs in combining science and the teaching experience. However, one needs vertical integration. Kids must be exposed to museums and aquariums while at school. Bright high school kids should be able to take community college classes. Vertical integration through undergraduate education is also part of the CAREER program.

A member commented that in the early 1980's schools used to have a program called “*Saturday to Saturday*” for 4th to 8th graders. It involved integrated science. Was it possible to fund such programs again? Colwell responded that these community organization initiatives are very important and must be supported. Bordogna added that the

“*Workforce for the 21st Century*” initiative is very important, and what is needed is to get organizations to track kids, to write proposals and to ask for support.

A comment was made that the number of women in higher education is increasing while the number of men in higher education is decreasing. How does the NSF deal with that? Colwell replied that NSF rewards academic achievement. She remarked that one way to reach inner city kids is to offer kids money, or offer teachers money for each student who went on to take advanced placement courses.

In further discussion, Colwell noted that NSF has to follow Congress’ directions. Flexibility is very difficult to attain. NSF tries to minimize cost sharing. Also, she believes that the average annualized award size of grants is too small and that it would be more efficient to increase award sizes. This is a long-term goal for NSF.

Dr. Colwell concluded the session by saying that education will remain a focal point of NSF. A major test ahead is the creation of challenging science programs that will draw graduate students into science.

Thursday, November 6, 2003

Afternoon Session

Divisional Meetings

Subgroups of the MPSAC met with MPS divisions to discuss a common list of questions (see Appendix III).

Committee of Visitors Report on the Office of Multidisciplinary Activities

Nicholas J. Turro of Columbia University, who chaired the Committee of Visitors for the MPS Office of Multidisciplinary Activities (OMA) presented its report. The COV met at NSF April 24-25, 2003 to review actions taken by OMA in the period FY 1997 - FY 2002. The committee had a briefing from Henry Blount, Head of the OMA, and reviewed a representative sample of jackets for awards and declinations in which OMA had participated during that time period. The COV had also met with representatives of the MPS divisions to discuss their interaction with OMA.

OMA was set up in 1995 to encourage and serve as a facilitator for MPS-related interdisciplinary and multidisciplinary research activities. Over time this has evolved to include a strong role in collaborations with an educational mission. OMA serves as a “venture capitalist” for MPS by assisting in the initial funding of high-risk but potentially high-return projects in partnership with the MPS divisions. Some of the projects are “owned” by divisions and some are run by OMA. Examples of activities seeded or otherwise fostered by OMA include: SOLIS in Astronomy, VIGRE in Mathematics, RSEC in Chemistry, QuarkNet and Physics Frontier Centers in Physics, and the Research Experiences for Teachers program MPS-wide. The OMA budget has ranged from about 5% to about 3% of the total MPS budget.

The major conclusions of the COV report included that:

- The integrity and efficiency of OMA’s processes were of high quality;
- The OMA portfolio was balanced and high quality;
- OMA has made numerous important contributions to the NSF outcome goals of People, Ideas, and Tools;
- OMA is effective in pursuit of its mission as an enabler and facilitator of research, education, multidisciplinary, diversity, and internationality in MPS;
- OMA is notably effective as an integrator of research and education;
- OMA is an able steward of its resources;
- OMA is considered to be “owned” by the MPS divisions although some additional communication between OMA and the divisions, especially for new rotators, is desirable; and
- The resources available to OMA have been “flat-flat” but the COV did not hear that they should be increased.

Following questions and a relatively brief discussion by the MPSAC, the report was unanimously accepted and the COV was thanked for its service. (The letter from the MPSAC Chair concerning the MPSAC review of the OMA report can be found in Appendix IV.)

Invited Talk by Lyman Page, Princeton University: "The Oldest Light in the Universe"

Dr. Lyman Page of Princeton University gave an invited talk entitled: "*The Oldest Light in the Universe.*" The abstract of his talk follows:

The cosmic microwave background (CMB) is the remnant radiation from the big bang that has cooled with the expansion of the universe to 2.7 K. One may think of the CMB as coming to us from a surface at the edge of the observable universe. The absolute temperature of the radiation varies from spot to spot on this surface by roughly by a part in 100,000. Encoded in these tiny spatial variations, called the anisotropy, are the values of the parameters that describe the contents and evolution of the universe. Additionally, an image of the surface literally gives us a picture of the infant universe with the temperature variations corresponding to seeds that gave rise to all the galaxies and clusters of galaxies that we observe today.

Adjournment

The meeting was adjourned at 5:45 P.M.

Friday, November 7, 2003

Morning Session

Pemberton convened the meeting of the MPSAC at 8:30 am. Huchra could not be present at meeting but participated via teleconference.

Long Range Planning: Reports from Divisional Meetings

Prior to discussion of the reports, Pemberton indicated that the planned MPSAC meeting on April 1 and 2 in 2004 would be postponed because of a conflict with an American Chemical Society (ACS) meeting. An alternate Thursday and Friday in April would be selected and announced to the membership.

Division of Astronomical Sciences (AST)

Salah commented that his subgroup wished there had been more time to meet with AST and learn about the Division and its activities. The subgroup felt that the guidelines AST had in place looked good, particularly with respect to the NSF strategic outcome goals of People, Idea and Tools. There was no need for change in these areas. However, there is a need for implementation policies with respect to large projects with increasing construction costs and other related expenses. There is also a need for larger investments and increased budgets for these large projects and facilities than that within the Major Research Equipment and Facilities Construction (MREFC) area. There should be a variety of ways to enhance the implementation and operation plans with respect to construction costs. There are no quick-fix solutions in sight. A concern is that small projects that fall between the Major Research Instrumentation (MRI—projects whose total cost is less than \$2,000,000) and the MREFC category (projects with total costs exceeding \$100,000,000) have no separate budget category within NSF. It would be better to allocate funds for these projects at the divisional level rather than at higher levels within NSF in order to allow the most flexibility in prioritizing and determining the needs within each discipline.. These are major challenges to be faced in developing implementation plans for projects of this type.

He noted that astronomy priority areas in cyberinfrastructure (CI) include data mining, data analysis, programming, hardware, and related information technology areas.

Pemberton commented that CI is not a priority area yet. Turner noted that cyberinfrastructure initiatives should not lose sight of the science initiatives. He felt that MPS was way ahead of the curve in computer applications in

science. Sanders agreed, noting that it is important to keep science in cyberinfrastructure. Dr. Roger Blandford stated that use of CI in Ideas/Tools related to science should be made more effective. Mentoring and helping students/postdocs in the applications of computer sciences should be encouraged. Scientists and faculty should be experienced in computer sciences and their applications. Dr. Francis Hellman added that CI should develop a platform for broad-based functions in all science fields such as biological sciences, chemistry, mathematics, physics, *etc.* These sciences need to have core people who can develop the tools for cyberscience. This is not well represented in CI. Turner commented that MPS would like the CI initiative to have the core science areas within it, and MPS was paying attention to this. Salah wondered whether MPS wanted to be more involved in defining CI, and wanted to place it on the agenda for future discussion.

Sunley said that Congress had not finalized the FY 2004 allocation of funds for human development. The House had deleted \$8,000,000 for human development but the Senate version of the NSF bill still contained it. It is important that MPS sees itself involved in these activities. Furthermore, the MPS community is very much involved in workforce development through Science and Technology Centers (STC), other MPS centers, institutes and individual awards. Turner asked about programs in AST for post-doctoral fellowships, and Huchra (via telephone) responded that the subgroup had not discussed this.

Salah continued with the report of his subgroup. He noted that the subgroup felt that community outreach activities within AST are important, and, overall, the subgroup was quite upbeat about AST programs. He felt that interactions with high school teachers and students are important and should be encouraged.

Turner commented that he wanted to encourage more members of the MPSAC to help MPS with input on a regular basis. For example, when MPSAC members were present at discipline-specific meetings they might make presentations concerning activities of the MPSAC. Pemberton agreed, and recommended that all MPSAC members provide the Office of the Assistant Director (OAD) with newsletters and other inputs on a regular basis by means of electronic mail. Dr. Shenda Baker added that she believed MPSAC members should serve as advocates to the community. Hellman thought that members of the American Physical Society (APS) should get information from MPSAC members. Turner commented that newsletters and electronic mails to APS members should be sent from MPSAC members, and not from MPS. The APS email distribution list might be used. Hellman noted it was important that this not appear as one's individual opinion, and Sunley suggested that it could be phrased as an individual assessment of information you have as members of the MPSAC.

Morrison commented that members should focus on informing their communities of the directions NSF and MPS are taking and provide feedback to MPS of community reactions. Dr. Tom Weber, Director of the Division of Materials Research (DMR), commented that it would be useful for MPSAC members to articulate issues with the community, as this would have a positive impact.

Morrison then raised the concern of the community with respect to NSF Merit Review Criterion 2 involving education and outreach within research proposals. He felt that the MPSAC should provide independent and constructive comments to MPS and NSF on this topic for the benefit of the community. Pemberton noted that with respect to this, there were some issues raised in previous COV reports received by the MPSAC. Dr. Art Ellis, Director of the Chemistry Division (CHE) felt there are a number of ways the chemistry community could address the issue of broader impact, and this information was sent to the community by a "*Dear Colleague Letter.*" Dr. William Pulleyblank suggested that the MPSAC should form subcommittees to discuss these issues.

Division of Physics (PHY)

Sanders reported on the meeting with PHY. He noted that PHY should have further discussions with Turner concerning large facilities. The subgroup was pleased to see that PHY has institutionalized new core programs in biophysics, accelerator physics and instrumentation, and these were an enabling platform for research. PHY has responded to the new and increased emphasis in information science frontiers and mid-scale instrumentation. However, maintaining the strength of core areas in physics was essential as newly developing areas in science and engineering depend on the strength in core. He noted that to date there had not been a response from PHY with respect to quantum science and technology, and it had not developed into a formal program. However, with respect to information technology research, an important area, there were a number of activities within PHY

involving the GRID initiative and inter-agency interactions. There had been little discussion by the subgroup concerning nanotechnology activities, and there appeared to be little activity in PHY in the human and social dynamics area.

Areas and topics that the subgroup planned to discuss with PHY at the next meeting included:

- Programmatic issues;
- Lattice gauge theory and how to proceed in this area;
- Determination of the demographics in various fields;
- Inter-agency programs and how to identify agency interest;
- Underground laboratories;
- Life-cycle costs;
- Cyberinfrastructure and how PHY should proceed in this area in order to fulfill the NSF mission; and
- The theory program.

Hillborn commented that it would be helpful to the MPSAC for MPS divisions to communicate in advance what they planned to discuss with the subgroups in coming meetings. Morrison felt that a longer time is needed for divisional subgroup meetings. He also commented that although he was a mathematician, and had been asked to serve on the PHY subgroup, it had been an interesting experience to participate in the subgroup as an “outsider.”

Division of Chemistry (CHE)

Dr. Jean Futrell reported on the interactions of his subgroup with CHE. The subgroup congratulated Ellis for energizing CHE since joining CHE as Division Director. In contrast to the astronomical sciences, where the grand challenges do not appear to change, grand challenges in chemistry change frequently (perhaps annually). Nevertheless, the concept of grand challenges is worthwhile, and it is desirable to ask about grand challenges in chemistry.

The subgroup commented that while the NSF priority areas can lead to increased funding for the core through stimulating interest and excitement in the sciences, it is important to watch that they do not lead to erosion of the core programs.

Areas with chemistry that should be focused on in the future include:

- Control of chemical reactions;
- The need for new kinds of spectroscopy;
- Advanced instrumentation and chemical synthesis;
- Understanding biological phenomena at the molecular level; and
- National security issues.

Major and mid-scale instrumentation are quite important in chemistry. However, the community does not appreciate its importance. Infrastructure costs are an increasing concern, but it will be a serious blunder if operations costs are not planned for at the time of initiation of construction. Furthermore, there is a competition between large facilities, mid-scale, and small instrumentation. The subgroup was intrigued by recent workshops on the miniaturization of instruments and spectrometers. The low cost of these instruments means that they might even be affordable by high schools. There is a need for a workshop on advanced instrumentation.

CHE, PHY and the Directorate for Biological Sciences (BIO) need to collaborate at interfaces of these sciences. Furthermore, ways and means for encouraging risk taking should be explored. No solution is apparent at this time.

Other issues that were discussed included neurosciences, discovery-based science, terahertz (THz) lasers, and tabletop lasers. Construction of kinetic databases (such as those in crystallography, or the NIST Thermo database) will be useful to the community.

Finally, the subgroup volunteered to do an experiment for the MPSAC. The subgroup is prepared to hold a meeting between the two annual MPSAC meetings and report back to the MPSAC.

Turner felt this would be excellent. He commented on the concept of “grand challenges.” He felt it was very important to articulate what MPS is doing and why it is important. Looking for the smallest particle (“seed”) is not going to impress the public, nor is it going to lead to increased support. It is essential that one come up with a list of research topics that are exciting and need to be addressed. The shorter the list the better. Realistically there would have to be some hard decisions made. Mid-scale instrumentation is very important. MPS can put it as a priority, but if so, there would be other things MPS would not be able to do.

Division of Mathematical Sciences (DMS)

Pulleyblank, reporting on his subgroups meeting with DMS, stated that DMS was a model division. It has great strength in that it is part of so many things. The NSF priority areas pose a significant challenge to the core areas.

With respect to the interaction of mathematics with biology, the new areas involve quantitative biology, not traditional biostatistics. As a result, significant mathematics issues are involved, and new core mathematics needs to be developed. DMS program directors need to be funding these projects. The focal area for these activities will be the postdocs. This is an exciting area and the subgroup is very supportive of it. In fact, mathematics may be approaching a time when a review of this activity is needed.

With respect to cyberinfrastructure, it serves as a tool for scientists, and it serves as an excellent tool for outreach and education. It is important that DMS be involved, as the ITR priority area is being phased out. However, DMS is well positioned to continue these activities.

In discussing DMS concerns, he noted that the NSF budgets providing significant increases at the interfaces were causing real stress to DMS program directors. There was a need to increase award size rather than coverage.

Pulleyblank also noted that his subgroup felt there was a need for more time for the subgroup to meet with the DMS. He commended DMS staff and concluded by saying that the subgroup was interested in continuing this kind of discussion.

Turner commented that he was impressed with the fundamental change that had taken place in DMS. He asked how the community was responding to this. Pulleyblank responded that increased financial resources were driving the excitement. He noted that the structure and the manner in which DMS programs are set up were good and responsive to community needs.

Division of Materials Research (DMR)

Baker presented the report of the subgroup meeting with DMR. She noted that DMR is very broadly distributed, is crosscutting by definition, and her subgroup could easily have been a chemistry, physics or engineering subgroup. Because of this it is difficult to set priorities because of the disparate communities being served.

She noted that it was important to increase core support. Increases in computation are required to support topics such as quantum computation and predicting macroscopic behavior from microscopic properties. Activities in bioengineering, especially in implementation and design, involve DMR. DMR’s partnerships with developing countries are ahead of other divisions in MPS. Mid-size instrumentation is an area of increasing importance, while CI and national security issues are of less relevance. DMR is already involved in research and education in engineering, where there is community enthusiasm, and in international programs, partnering US scientists with scientists from all over the world. She noted that DMR had received 48 thoughtful proposals in this area, but, because of financial restraints, only three could be funded. There was obviously a strong need in this area.

Priority setting within the division is a challenge as there is neither a single community nor a single professional society with which to consult. Some ranking is done within workshops which, however, tend to be very topical. Some priorities emerge from other divisions. The usual challenges exist such as balancing the portfolio between

centers and core programs and allowing seamless funding for continuing programs while allowing the development of new programs.

DMR is already significantly involved in major instrumentation, and the problems are not the same as those that arise with respect to major facilities. With respect to major instrumentation, it needs a “care and feeding” plan in place after the construction ends. The subgroup felt that having a viable plan for supporting the instrument after its construction should be part of the funding decision.

With respect to participation by diverse groups in DMR activities, the subgroup felt that DMR has made a good start and has some new ideas.

DMR intends to expand the successful international program, and this is based on the obvious degree of interest in the community. One new concept is for the development of Materials Research Institutes that would be able to respond more quickly and easily to new results and breakthroughs. There are also many instances where undergraduates can play a role, such as having the opportunity for faculty at predominantly undergraduate institutions to get divisional discretionary funding.

The use of MPSAC members as a conduit to the community was also discussed.

Hellman noted that the DMR subgroup meeting was too brief and too rushed. The division is struggling with a 30% success rate and this is both challenging and frustrating. The increase in the number of investigators has occurred without an increase in funding. Baker commented that DMR has successfully involved EHR and industrial funding in some programs in informal education. These activities are widely noticed and successful and represent good coordination with the community (see, for example, <http://strangematterexhibit.com>).

Turner asked if there had been any discussion of condensed matter theory. Dr. Venkatesh Narayanamurti responded that it had been discussed, and he felt strongly that its proper place is in DMR. Perhaps it should be referred to as “condensed matter and materials theory” to make it clearer. There was some beautiful physics in this area and it was an issue of recognition. Hellman seconded this suggestion. Weber commented that DMR should probably change a few other titles for the same reasons.

Hellman said she intended to poll the community about how they felt about being in materials research versus physics. Narayanamurti commented that there was a related sociological issue concerning computation and computational materials scientists as well as a physics bias against computation. Turner encouraged Hellman to follow up on this. He felt that theorists were under-appreciated, and he felt that future ideas came from theory. Hellman did not agree.

Pemberton wondered whether this topic should be the subject of a joint divisional discussion at the next meeting. Hellman felt that this feeds back into the issue of priority setting. She said that the data suggest that more theorists are being funded, given that they are experiencing 40% success rate on proposals versus 30% for experimenters.

Discussion of Updated Directorate Long-Range Planning Guidelines

Pemberton introduced this discussion by noting that Pulleyblank chaired a subcommittee that had studied the long range planning process and that the MPSAC had produced a series of white papers spelling out MPS priorities. She noted that the MPSAC had a copy of the directorate response to that report (see Appendix V) and asked for comments.

Sunley noted that it was not so much a response as an update on where the directorate was in the prioritization process. Pemberton noted that the response was a status report on where the directorate is with respect to the MPSAC recommendations. Morrison noted that FY 2005 was not discussed in the MPS response, and Sunley responded that the FY 2005 budget was still confidential. Salah asked if the document was a follow-up to the April 2003 discussion, and Pemberton responded that long-range planning was the next item on the agenda.

Pemberton wanted to discuss Item 10 of the MPSAC response. This item involves MPS becoming more involved with other agencies with respect to security issues. She noted that there had been a November 2002 workshop involving MPS and the intelligence community. The final report had just been released, and a solicitation, “*Approaches to Combat Terrorism (ACT)*” from MPS and the intelligence community had been issued. De Graaf stated that the ACT competition had been held and grants have been awarded. MPS was still discussing the lessons learned and the best way to proceed.

Pulleyblank commented on the divisional discussions on long-range planning. He felt that the universal response from the divisional subgroups on the success of these meetings meant that MPSAC should consider how it can, in the future, identify and feed back to MPS senior management its concerns. What will happen next?

Salah commented that the MPSAC had written a long-range planning document that had taken a lot of work. He asked whether this document had been useful to the directorate. Turner responded that it had and the MPS response showed that it had. In the future MPS may be changing the way in which it asks for guidance. The MPSAC may not fully appreciate the complexity and length of the budget cycle, so that now is when planning starts and the April/May meeting is the time for the reality check. The budget process has a long gestation.

Pemberton commented that the MPSAC activities needed to map the activities of MPS in budget planning, and she asked Sunley to discuss the NSF/MPS budget process (see Appendix VI).

Sunley noted that there are effectively three budget years happening simultaneously—the current year is being spent, the next year is already at OMB and the year after that is being planned. But long range planning must go well beyond that year. She asked what the MPSAC wanted to do in the gaps between their meetings. She said that much goes on at NSF with respect to the budget throughout the year and MPS was constantly examining its priorities and how what was done now affected what could be done in the future.

Neuhauser asked whether white papers on priorities were important in April. Turner responded by saying they were more important at the November meeting. Ideas should be provided at the November meeting, and guidance on priorities should be provided at the April Meeting. Sunley noted the MPS divisions generate the white papers, and these should be provided to the MPSAC for its November meeting. Neuhauser commented that if so, this was at an early stage in the development of a concept, and there is little time to review these ideas. This meant that they would have to be finalized in April. Sunley agreed, but said that MPS needed to get comments from MPSAC before the April meeting, so that the April meeting becomes mostly refinements to the guidance.

Pemberton asked if it would be useful to experiment with a third meeting, using chemistry as a test bed, to see how it would work to help set priorities. Ellis responded that he liked the idea. After some discussion the MPSAC agreed that Futrell would chair a subcommittee that would meet with CHE prior to the April meeting. This subcommittee would consist of the subgroup that had met with CHE on Thursday, November 6 along with the two other chemistry members of the MPSAC, Lineberger and El-Sayed.

Sunley then discussed how MPSAC concerns fit within NSF’s strategic outcome goals of People, Ideas, and Tools. Salah felt that MPS had to remember that core funding was the first priority, and Narayanamurti wondered whether “cyberscience” was the correct word to use in describing MPS involvement in cyberinfrastructure. Turner stated that MPS needed to refine and understand what it meant by “cyberscience” and to make sure that this initiative led to developments that make science possible. Narayanamurti agreed that it was very important. Blandford felt this was something all MPSAC members needed to understand.

Pemberton returned to the question of scheduling of the white papers and asked if the MPSAC was happy with having MPS white papers available at the November meeting. There was no dissent.

The meeting was adjourned for lunch.

Friday, November 7, 2003

Afternoon Session

The meeting of the MPSAC reconvened at 1:00 P.M.

Recommendations for MPSAC Input to MPS Long-Range Planning

This session began with a discussion by Turner and Sunley of the FY 2004 and FY 2005 budget process and the role of MPSAC. With respect to FY 2004, four white papers had input from MPSAC. These were International Activities, MOST, Cyberscience, and Quarks to the Cosmos. The MPSAC also recommended continuing interactions with EHR. Mid-scale infrastructure and instrumentation was included as part of other NSF-wide activities.

Pemberton suggested that each of the Chairs of the divisional subgroups summarize the discussion from the divisional meetings as a starting point for the "ideas" listing for the FY 2006 budget process. Another member suggested that these summaries become a 'living' document that would be maintained and modified. It was also suggested that MPS prioritize items on which it was seeking MPSAC input. Sunley commented that there were some common areas identified in the subgroup presentations. These could be used as the basis for further dialog at the April meeting. These common themes were cyberscience, the workforce, and mid-scale instrumentation.

Turner said that MPS would provide MPSAC with a working document and request feedback in advance of the April meeting. Hellman felt that there was too much focus on budgets, and instead MPSAC should be providing feedback on vision. Sunley agreed, stating that the MPSAC should be concerned with items that are not budget specific.

Pemberton asked that she receive reports from the subgroup Chairs by December 1. She would then combine these with input from her own notes and a first draft of the minutes and try to have a final report by December 15, 2003.

Hellman noted that the demographic data principal investigators provide in final reports are not accessible to program directors or to the MPSAC. Pemberton felt that NSF should have all nuggets developed by NSF readily accessible as this would allow metrics to be developed that would measure the effectiveness of MPS efforts. Hellman added that the operational cost of facilities needed to be discussed, particularly with respect to the utilization of MREFC funds within MPS divisions. She asked whether a collection of instruments would reach the MREFC threshold, and Turner responded that this was not within the spirit of the MREFC concept.

Action Items and Future Activities

In concluding the meeting, Pemberton listed the following action items:

1. MPSAC members were to respond with respect to their availability for the next meeting in April 2004 by Monday, November 10. (This was done and the date for the April meeting was set as April 22-23, 2004.)
2. Reports for each of the divisional subgroup sessions should be sent to Pemberton by December 1, 2003.
3. The Joint EHRAC/MPSAC subgroup on undergraduate education would continue its work and discussions.
4. Members were to identify venues of possible communication between members of the MPSAC and their respective scientific communities and send this list to Pemberton. She would compile this list of venues.

Adjournment

The meeting was adjourned at 2:00 p.m.

Appendices

APPENDIX I

ATTENDEES

MPSAC Members

Shenda Baker, Harvey Mudd College
Roger Blandford, California Institute of Technology
Luis Echegoyen, Clemson University
Mostafa El-Sayed, Georgia Institute of Technology
Lucy Fortson, Adler Planetarium and University of Chicago
Jean Futrell, Pacific Northwest National Laboratory
Peter Green, University of Texas-Austin
Frances Hellman, University of California, San Diego
Robert Hilborn, Amherst College
John Huchra, Harvard-Smithsonian Center for Astrophysics
Raymond Johnson, University of Maryland
Jon R. Kettenring, Telcordia Technologies
W. Carl Lineberger, University of Colorado
David Morrison, Duke University
Venkatesh Narayanamurti, Harvard University
Claudia Neuhauser, University of Minnesota
Jeanne Pemberton (Committee Chair), University of Arizona
William Pulleyblank, International Business Machines
Joseph Salah, Massachusetts Institute of Technology
Gary Sanders, California Institute of Technology

MPSAC Members Absent

Thomas Appelquist, Yale University
Janet Conrad, Columbia University

MPS Staff

Morris Aizenman, Senior Science Associate, MPS
Adriaan de Graaf, Senior Advisor, MPS
Laura Bautz, Acting Executive Officer, Division of Physics
Donald Burland, Executive Officer, Division of Chemistry
Henry Blount III, Head, Office of Multidisciplinary Activities
Joseph Dehmer, Director Division of Physics
Arthur Ellis, Director, Division of Chemistry
Eileen Friel, Executive Officer, Division of Astronomical Sciences
Adriaan de Graaf, Executive Officer, MPS
Lance Haworth, Executive Officer, Division of Materials Research
Deborah Lockhart, Acting Executive Officer, Division of Mathematical Sciences
William Rundell, Director, Division of Mathematical Sciences
Judith Sunley, Executive Officer, MPS
Michael Turner, Assistant Director, MPS
G. Wayne van Citters, Jr., Director, Division of Astronomical Sciences
Thomas Weber, Director, Division of Materials Research

Visitors

Joseph Bordogna, Deputy Director, NSF
Rita Colwell, Director, NSF
Lyman Page, Princeton University
Nicholas Turro, Columbia University

APPENDIX II

Education and Human Resources Mathematical and Physical Sciences

Joint Subcommittee of the Advisory Committees on Undergraduate Education in the Mathematical and Physical Sciences Disciplines

Purpose:

EHR and MPS and their Advisory committees are creating this joint subcommittee as one aspect of a broader effort to work together toward common goals. These common goals include: preparing the next generation of MPS professionals; broadening participation in MPS disciplines; and creating pathways to MPS careers.

The joint subcommittee will advise MPS and EHR on how they can cooperate in improving undergraduate education, using as context the development of a coherent vision and approach toward strengthening undergraduate majors in MPS disciplines that emphasizes linking study in a field with its practice.

Charge:

Undergraduate education is a pivotal point both for improving professional education and broadening participation in the disciplines and for enhancing STEM understanding in the broader public. The subcommittee will explore NSF's role in addressing these issues, as well as opportunities and challenges for leverage and synergy in existing investments in the two directorates and in exploration of possible new directions.

Background: The research frontier in MPS disciplines and related interdisciplinary areas is moving rapidly, with both the new knowledge and new approaches to research and education having implications for both nature of professional practice and the preparation of the next generation of researchers and practitioners in these fields. Addressing these implications requires input from the broader research, education, and professional practitioner communities concerned with these areas. Both within the scientific communities and within NSF, it has proven difficult to address the issues in concert. The joint subcommittee will aim for an integration of views from these communities that aims toward an integration of research and education activities.

Charge: On behalf of the EHR and MPS Advisory Committees, the joint subcommittee is charged with

- Examining the ways their communities think about and describe the activities of research, professional practice, and education and how those definitions affect the nature of their activities;
- Exploring the commonalities and differences in approaches to integrating research, professional practice, and education and in defining successful integration; and

- Recommending types of activities that EHR and MPS might undertake, either together or in parallel, that would strengthen the preparation of the next generation of MPS professionals, broaden participation in the MPS disciplines, or create new pathways to MPS careers, either by building on existing programs, expanding them in directions that capitalize on commonalities of approach, or developing new programs that would promote innovative paradigms for the integration of research and education.

The two advisory committees expect preliminary recommendations on new or expanded activities for the directorates at their Spring 2004 meetings.

In the course of this effort, the joint subcommittee may need to look carefully at

- The current state of the undergraduate enterprise in MPS disciplines and how it is changing, with emphasis on integration of research, professional practice, and education;
- NSF activities with impact on undergraduate education and their efficacy in promoting change; and
- Past and current experiments in transcending the EHR/MPS boundaries in carrying out these activities.

The joint subcommittee will report regularly to the parent advisory committees on the status of their response to this charge. The advisory committees and joint subcommittee, in consultation with NSF staff in the two directorates, will determine the best way to convey the results of the review and any recommendations arising from it to the relevant scientific and academic communities.

Composition:

The joint subcommittee will consist of an appropriate number of active members from each advisory committee and any appropriate ad hoc members as determined and appointed by the advisory committee chairs. EHR members will have connections to MPS disciplines, where possible. Chairmanship of the joint subcommittee will alternate between MPS and EHR annually.

Staff:

Staff members from each directorate will work synergistically in support of the work of the subcommittee.

**Education and Human Resources
Mathematical and Physical Sciences**

**Joint Subcommittee of the Advisory Committees
on
Undergraduate Education in the
Mathematical and Physical Sciences Disciplines**

INITIAL WORK PLAN

The Joint Subcommittee on Undergraduate Education in the Mathematical and Physical Sciences Disciplines is charged with

- Examining the ways their communities think about and describe the activities of research, professional practice, and education and how those definitions affect the nature of their activities;
- Exploring the commonalities and differences in approaches to integrating research, professional practice, and education and in defining successful integration; and
- Recommending types of activities that EHR and MPS might undertake, either together or in parallel, that would strengthen the preparation of the next generation of MPS professionals, broaden participation in the MPS disciplines, or create new pathways to MPS careers, either by building on existing programs, expanding them in directions that capitalize on commonalities of approach, or developing new programs that would promote innovative paradigms for the integration of research and education.

Initial Membership

Jeanne Pemberton, MPS (Chair)
Robert Devaney, EHR
Robert Hilborn, MPS
Yolanda Moses, EHR
Claudia Neuhauser, MPS
Thomas Taylor, EHR

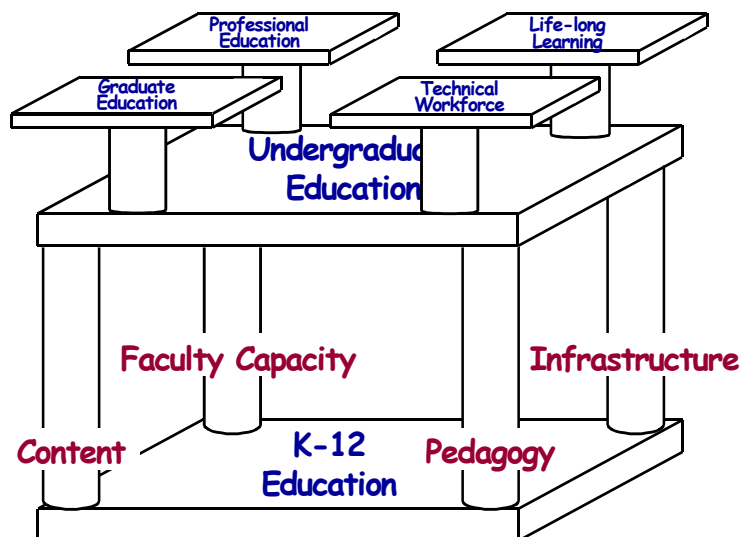
Plan for Responding to the Charge

In carrying out its charge, the joint subcommittee will look carefully at

- The current interplay of research, professional practice, and education in the undergraduate enterprise in MPS disciplines and how it is changing;
- EHR and MPS activities with impact on undergraduate education and their efficacy in promoting integration of research, professional practice, and education; and
- Past and current experiments in transcending the EHR/MPS boundaries in carrying out these activities.

It will use the “Four Pillar” approach developed by its chair, Dr. Pemberton, for discussion with the EHR Advisory Committee as illustrated in the graphic below in addressing these issues.

The Four Pillars of Undergraduate Education in the Mathematical and Physical Sciences



Within each of the categories represented by the four pillars – content, pedagogy, faculty capacity, and infrastructure – the subcommittee members will develop, refine, and respond to a set of key questions that will form the basis for speaking to their charge. The questions will elicit information about how different communities understand research, professional practice, education and their interplay; how those understandings are expressed in the undergraduate experience and in plans to change the experience in MPS disciplines; and the role of the research, education, and professional practitioner communities in the change process. The subcommittee will explore in parallel fashion how MPS and EHR approach their responsibilities for improvement of undergraduate education in MPS disciplines, how these approaches have evolved over time, and how they might be more effective.

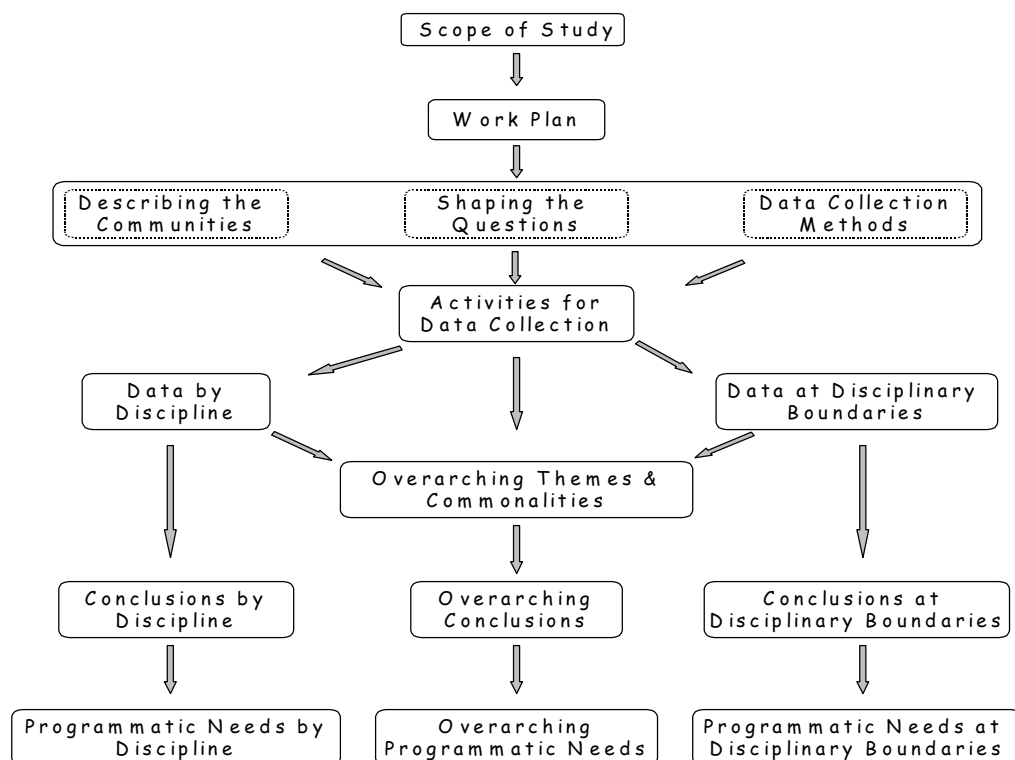
In carrying out its work, the joint subcommittee will focus on elements that

- Reflect the changing nature of science (including emerging interdisciplinary areas) in MPS disciplines in the preparation of MPS professionals;
- Help define the integration of research and education in the preparation of MPS professionals;
- Connect out-of-class research experiences for undergraduates or related opportunities such as internships or community service with academic programs;
- Enhance the research base on learning in MPS disciplines; and
- Increase the capacity for change.

Activity Work Flow

The joint subcommittee held its first meeting in September 2003 to refine its plan of action. It agreed to use the following flow of work.

**EHR/MPS Joint Subcommittee on Undergraduate Education
in the Mathematical & Physical Sciences Disciplines:
Activity Flowchart**



Timing

To initiate the phase of describing communities, shaping questions, and determining methods, the joint subcommittee formed three subgroups. The first subgroup consists of members who will focus on the three disciplinary communities – math, chemistry, and physics, developing appropriate sets of contacts and questions. The second will focus on the broad range of improvement efforts in the undergraduate education arena. The third will focus on the intersection of undergraduate education and the community of professional practitioners (e.g., employers).

This stage of activity will take place during October 2003. Following a discussion with the parent advisory committees in November 2003, the joint subcommittee will implement its plan through FY 2004. The current plan is to complete data collection by the end of January 2004. The parent advisory committees expect a report on preliminary findings and recommendations in spring 2004. They will use these preliminary materials to advise the directorates on initiating new or expanding existing cooperative efforts in FY 2005.

The joint subcommittee will complete a draft report for the advisory committees for the November 2004 meetings. Over the following winter, the subcommittee will finalize their product for submission to the advisory committees and the Assistant Directors for EHR and MPS in the spring of 2005.

In the process of implementing its plan, the joint subcommittee will ask for significant input from relevant communities. The relevant divisions within both MPS and EHR, professional societies, employers of MPS baccalaureates, graduate and professional programs to which MPS baccalaureates might go, and others, including students themselves, will have the opportunity to participate in the effort. To facilitate the actions of the joint subcommittee, MPS will maintain a web site that contains core information on which the activities will draw.

Meta-Level Questions for the Review

In the course of addressing the specifics of its charge, the joint subcommittee may want to explore some of the following questions.

- To what extent does undergraduate MPS education reflect or emphasize the *current body of knowledge* within a discipline? The most recent additions to that body of knowledge?
- To what extent does undergraduate MPS education reflect “*current practice*” and/or employer needs of disciplines?
- To what extent is undergraduate MPS education receptive to *variable and diverse pathways to STEM careers*? To what extent does it facilitate the progress of those who need such pathways?
- What are *essential elements of “highly successful” models* of undergraduate MPS education in the context of integration of research and education.
- What *essential elements* of undergraduate MPS education are not addressed by current NSF activities?
- What are *anticipated essential elements* of undergraduate MPS education that should be addressed by future NSF activities?
- What are *essential elements of “highly successful” joint MPS/EHR activities* in undergraduate MPS education?

**Education and Human Resources
Mathematical and Physical Sciences**

**Joint Subcommittee of the Advisory Committees
on
Undergraduate Education in the
Mathematical and Physical Sciences Disciplines**

**Summary Information and Assignments
Meeting of September 29, 2003**

At its meeting of September 29, 2004, the joint subcommittee provided the following simplified version of its work stages.

1. Frame the issues.
2. Examine the current situation.
3. Explore and select recommendations for opportunities.
4. Review the joint subcommittee experience.
 - a. Explore what we learned in considering the next phase of this subcommittee.
 - b. Explore implementation of the recommendations.

The joint subcommittee used the September 29 meeting to frame the issues and establish the process for examining the current situation.

The EHR and MPS Advisory Committees have charged the joint subcommittee to address issues around

- Capturing the interest of students and retaining them in science; and
- Determining what elements are necessary and/or beneficial in an undergraduate experience in these disciplines to prepare students for the 21st century (also known as contemporary practice).

The scope of the task includes

- Chemistry, Physics, and Mathematics undergraduate majors
- In the context of the on-going discussion of the purpose of undergraduate education
- And the outcomes of undergraduate education
 - Gateway to the professions in government and industry
 - Preparation for advanced study and entry into the research community in academia, government, and industry.
 - Secondary teaching

Tom Brady, Chair of the BIO Advisory Committee's Committee on Education, and Ron Williams, Chair of the EHR Advisory Committee, participated in the September 29 meeting and have agreed to serve as adjunct members of the joint subcommittee. Members recognize the critical interface in undergraduate education between the core MPS disciplines and Biology. All agreed that interaction with the BIO Advisory Committee would be valuable as a mechanism to explore this interface.

In examining the current situation, three elements provide the context.

- Changes in the disciplines
- Lessons from recent work on undergraduate education
- Changes in demands of the STEM workforce
 - Employers' viewpoint
 - Employees' viewpoint

Once the joint subcommittee understands the current situation, the members will develop principles for selecting options for future activities and make recommendations. Immediate assignments involve establishing the framework for examining the current situation.

- Changes in the disciplines: Bob Devaney, Bob Hilborn, Claudia Neuhauser, Jeanne Pemberton
- Lessons from undergraduate reforms: Tom Taylor, Yolanda Moses
- Demands of the STEM workforce: Tom Brady, Ron Williams

Members of the joint subcommittee have agreed to provide (1) a list of questions and (2) a list of groups/individuals of whom the questions should be asked to NSF staff (Judy Sunley in MPS, Jim Lightbourne in EHR) by October 10. NSF staff will take the multiple lists and, in consultation with the chair of the joint subcommittee provide to the full subcommittee a list of proposed questions, approaches, and contacts for the data collection phase by October 24. The joint subcommittee is aiming for a January 31, 2004, completion of the data collection phase, with an early March meeting to consider the data and principles for generating recommendations.

In addition, the following assignments were made during the meeting in the discussion of background sources.

- Place a URL or a copy on the subcommittee web site of
 - The study by Elaine Seymour on why people leave science and engineering, as well as her presentation of preliminary data on assessment of undergraduate research participation;
 - The study of REU programs from the early 90s;
 - Any preliminary information available on the current REU study;
 - Material from the Reinvention Center (Stony Brook) conference on undergraduate research participation;
 - Preliminary data on the CSEMS program;
 - Data as per the material under tab 9 of the agenda book.
- Make appropriate contacts with the NRC Committee on Undergraduate Science Education and Mathematical Sciences Education Board.
- Give all members access to the extended *Shaping the Future* document.
- Finalize the charge and initial work plan in light of this discussion.

APPENDIX III

MPS Advisory Committee Meeting November 5 - 7, 2003 National Science Foundation

Questions for Meetings with Divisions

The focus for the meeting of Advisory Committee members with the divisions is obtaining the divisional perspective on long range planning. In the time available, address the following to the extent possible.

1. Identify scientific¹ issues or areas of critical importance for the division that need future emphasis. What is the division's role in these areas?
2. What is the division's role in potential areas of future importance discussed in the MPS White Papers presented at the May 2003 meeting?
3. What is the division's role in two additional MPS emphasis areas included in the FY 2004 budget request, namely: mid-scale instrumentation; quantum science and technology?
4. What is the division's role in current (FY 2004) NSF priority areas: Information Technology Research; Nanoscale Science and Engineering; Biocomplexity and the Environment; Mathematical Sciences Priority Area; Human and Social Dynamics; and Workforce for the 21st Century?
5. Are there areas that you recommend the division and/or MPS as a whole develop more fully for discussion at the May meeting? How might that best be done?
6. How does the division approach setting priorities among these areas? Are there alternative approaches you might recommend?

¹ In this document, the terms "science" and "scientific" are inclusive terms, meaning approaches to developing the People, Ideas and Tools of the MPS fields.

Minutes of the MPSAC Meeting of November 6-7, 2003

DIVISIONAL ASSIGNMENTS FOR MPSAC MEMBERS					
	AST	PHY	CHE	DMR	DMS
APPELQUIST (Absent)					
BLANDFORD	X				
HILBORN		X			
PEMBERTON			X		
PULLEYBLANK					R
SALAH	R				
BAKER				R	
GREEN				X	
FUTRELL			R		
MORRISON		X			
NEUHAUSER					X
SANDERS		R			
CONRAD (Absent)					
ECHEGOYEN			X		
EL-SAYED				X	
FORTSON	X				
HELLMAN				X	
HUCHRA	X				
JOHNSON					X
KETTENRING					X
LINEBERGER			X		
NARAYANAMURTI				X	

X,R MPSAC members attending Divisional Subgroup Meetings on 11/06/03

R Subgroup CHAIR, MPSAC member who will summarize Divisional meetings activities to MPSAC



Jeanne E. Pemberton
John and Helen Schaefer
Professor of Chemistry
Department of Chemistry
1306 East University Boulevard
Tucson, AZ 85721

Phone: (520) 621-8245
FAX: (520) 621-8248
email: pembertn@u.arizona.edu

November 20, 2003

Dr. Michael S. Turner, Assistant Director
Directorate for Mathematical and Physical Sciences
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Turner:

I am pleased to inform you of the formal acceptance of the Report of the Committee of Visitors (COV) for the Office of Multidisciplinary Activities (OMA). Dr. Nicholas J. Turro, Chair of the COV, presented the Report to the MPS Advisory Committee (MPSAC) at its November 7-8, 2003 meeting. The Report was very laudatory regarding OMA's effectiveness in facilitating the integration of research and education, in enhancing diversity, in enabling multidisciplinary efforts in MPS disciplines, and in resource management.

The COV report noted several important issues and opportunities that the MPSAC believes should receive increased attention.

Specifically, given the increasingly prominent role of OMA in facilitating the NSF mission in PEOPLE within MPS, concern was expressed that the continued flat OMA budget would lessen the effectiveness of the Office in facilitating unique and/or emerging multidisciplinary research opportunities over time. The COV also recommended attention to the balance of OMA co-investment among MPS Divisions.

The MPSAC is pleased to see the increasing interactions between MPS and EHR and encourages MPS to consider mechanisms for further formalizing these interactions using the OMA as an appropriate bridge. Mechanisms for enhanced interaction between MPS and EHR should be explored in the context of cooperative support for educational activities.

Finally, the MPSAC endorses the COV suggestion of a yearly "State of the OMA" address to the Divisions as an excellent mechanism for continuing the effectiveness of the OMA in facilitating multidisciplinary activities in research and education.

We are grateful to the COV and its Chair for the excellent, in-depth review of OMA, and to the OMA Head for his thorough preparations for this COV review and for his commendable work.

Sincerely,

A handwritten signature in black ink that reads "Jeanne E. Pemberton". The signature is written in a cursive style with a large initial 'J'.

Jeanne E. Pemberton
Chair, MPS Advisory Committee

cc: N.J. Turro, H. N. Blount, M. Aizenman

APPENDIX V

MPS Advisory Committee Follow-up to Recommendations from the April 2003 Meeting

At the meeting of the MPSAC at NSF on April 3-4, 2003, various initiatives were presented by the MPS Directorate and its Divisions and were discussed as part of the long-range planning activity for MPS. This document provides initial follow-up information.

Planning Process

The MPSAC strongly endorsed the newly-proposed strategic planning and prioritization process for MPS, as outlined in the presentation on April 4 by the special MPSAC subcommittee chaired by W. Pulleyblank.

MPS is revising the draft document to ensure that the MPS planning and budget processes are appropriately situated in the NSF-wide context and to clarify the role that the MPSAC might play. We are sharing the current draft with the MPSAC at the November meeting and are preparing to implement the process it lays out, with appropriate modifications as needed, following the meeting.

Furthermore, MPSAC recommends that, in the future, white papers be prepared in a uniform format by the various MPS Divisions for both disciplinary and interdisciplinary initiatives and presented at the annual Fall meeting for review and discussion. The papers should provide the science background, projected impact, proposed goals, and the rationale for recommended actions, with authors identified. MPSAC would then provide its feedback and input, and propose additional initiatives for consideration.

MPS is still considering the best mechanisms for collecting input and creating white papers for MPSAC consideration. The current draft of the planning document lays out an alternative. We agree that a uniform format is desirable.

II. MPSAC Recommendations for Areas of Emphasis

- (1) *A re-investment in the nation's future by increasing the financial support of the MPS core research program.*

One of the highest priorities for MPS and NSF is intensifying investment in core programs – increasing award size, extending duration of awards, and, to the extent possible, increasing the number of awards. This is evident in all MPS planning and budgeting activities and is clearly articulated in the most recent NSF Strategic Plan.

- (2) *Establishment of Computational Science as a priority area within MPS.*
- (3) *Development of an initiative that enables the processing of high-dimensional massive data.*

- (4) *Consideration be given to the establishment of a special subcommittee consisting of MPSAC members, MPS Division staff, and possibly experts from the broader community, in order to outline the preparations needed for MPS to take full advantage of the NSF-wide Cyberinfrastructure initiative.*

As suggested by the MPSAC approach to these three areas, MPS planning in these three areas takes place in a coordinated environment and in conjunction with related planning across NSF. MPS has a working group of program officers who meet regularly to address what we are now terming *Cyberscience*. The group includes the program officers who serve as MPS representatives on the NSF-wide working groups addressing the Information Technology Research (ITR) priority area and Cyberinfrastructure. Over the past six months, much of their work has been aimed at ensuring that the formulation of the FY 2004 ITR solicitation and NSF plans for cyberinfrastructure provide appropriate roles for MPS. FY 2004 is the final year of the ITR priority area, and smoothing the transition to cyberinfrastructure is important for maintaining a continuity of effort in cyberscience. The Mathematical Sciences Priority Area also has some intersection with these areas. The next step for the working group is developing an MPS plan for cyberscience. We will encourage members of the working group to participate in the November meeting of the MPSAC to hear any further discussion of this topic, and we expect to be able to share MPS planning for cyberscience with the MPSAC at the spring meeting.

- (5) *Implementation of programs and facilities that respond to the challenges posed by the NAS study "Connecting Quarks with the Cosmos". MPSAC endorses the approach that has been instituted to coordinate a joint NSF-NASA-DOE research plan for this initiative under OSTP leadership.*

Members of the Divisions of Astronomical Sciences and Physics and the Office of Polar Programs have participated in meetings of the Interagency Working Group charged by the National Science and Technology Council with addressing the recommendations of the NAS report "Connecting Quarks with the Cosmos." The report from this working group is undergoing final editing. NSF has already begun acting on several of its recommendations. The Astronomy Division, for NSF, is leading an interagency working group to organize the development of a roadmap for measurements of CMB polarization. The Physics Division is taking the lead in an interagency group to organize a roadmapping activity for a national high energy density physics program. Particle and nuclear astrophysics is emphasized in the FY2004 NSF budget and the Physics Division plans to continue this emphasis in future years.

Progress toward meeting the NAS recommendation of realizing the Large Synoptic Survey Telescope (LSST) is proceeding through the activities of the NOAO LSST Science Working Group created under the auspices of AST. The community is actively preparing proposals for funding, and initial work on the design of a large-format, wide-field imager, which is in the critical path for the LSST, has been funded by AST. In addition, MPS continues discussion with the scientific community on possibilities for an underground laboratory.

- (6) *Development of the Molecular Science and Technology (MOST) initiative to help launch the 'molecular age'.*

The MOST white paper has been discussed within NSF by the MPS (CHE, DMR, PHY), ENG (CTS, BES), and BIO (MCB) directorates. There is shared recognition that collective/cooperative molecular interactions represent an important frontier for molecular science. A specific example of significant investment identified by the three directorates is the general area of membranes, which embraces a broad spectrum of experimental, theoretical and computational activities, ranging from single-molecule detection to self-assembly to engineering applications involving transport, sensing, and purification. The three directorates are discussing mechanisms for collaborating on an initiative centered on natural and artificial membranes, such as a joint program announcement.

In response to MOST and to the recent NRC document, "Beyond the Molecular Frontier," CHE has created a new program announcement (03-606) called Chemical Bonding Centers (CBCs). CBCs are intended to promote high-risk, high-impact projects of long duration that could address such issues as cooperative interactions and emergent behavior in molecular systems. Discussions are also taking place with DOE, NIH, and OSTP on these themes. Several workshops have occurred or are in planning stages to raise community awareness of tools that may be relevant to MOST: 1) a pair of DMR/CHE neutron scattering workshops; 2) a CHE/CTS nanoscale catalysis workshop; and 3) a DOE/NSF (MPS/BIO)/NIH terahertz spectroscopy workshop.

(7) *Promotion of an initiative to address Mathematical and Physical Sciences at the Biological Interface.*

An MPS-BIO Working Group has been in existence for about three years. It has identified three different types of activities that could strengthen the interaction between MPS and BIO and help foster growth at the intersection between the disciplines. These are: a cross-disciplinary postdoctoral program; a program for mid-career scholars establishing cross-disciplinary research collaborations; and development of a more coherent approach to evaluating proposals that cross the MPS/BIO boundary. The post-doctoral and mid-career efforts were developed in response to numerous comments from both the MPS and BIO communities that cross-disciplinary education and training are key to bridging the gap between the different cultures characterizing the two fields.

In FY03, as a first step in creating a joint effort, we expanded the final year of the existing BIO Postdoctoral program in Informatics, creating the *Postdoctoral Research Fellowships in Interdisciplinary Informatics*. We reviewed 85 applications and made 35 awards. A draft solicitation for a full, expanded program, *MPS-BIO Cross-Disciplinary Postdoctoral Research Fellowships*, is presently under consideration in both the BIO and MPS Directorates. This new, expanded program would no longer be restricted to informatics but would include all areas of biology and the MPS disciplines, both theoretical and experimental aspects. A draft solicitation for the mid-career activity is also under development.

In FY04, we issued a special "Dear Colleague" letter, NSF 03-045, informing the community that MPS and the Division of Molecular and Cellular Biosciences (MCB) would be holding a special review panel to review CAREER and young investigator proposals addressing the interface between MPS and MCB. Program Directors in MPS were asked to submit to this panel any proposals that they would like to have reviewed from the perspective of both MPS and MCB. We consider this as an experiment in a more organized co-review, without the need for a special solicitation, and, if it is successful, our intention is to extend it to more than just CAREER and young investigator proposals.

- (8) *Execution of a clear and visible step to address the need for planning for life cycle costs of major projects. MPSAC endorses the proposed Facility Stewardship Initiative as presented to the AC at its April 2003 meeting.*
- (9) *Development of a funding path for projects at the mid-size scale (between MRI and MREFC). In particular, MPSAC recommends the start of a planning process within MPS where each Division prepares a plan for its needs for projects that fall within mid-size infrastructure guidelines, so that an overall timeline and prioritization process based on readiness and funding allocation can be developed.*

While these two recommendations are quite different in character, we are responding to them together because MPS progress in addressing them is influenced by actions underway across the NSF. A recent National Science Board (NSB) study entitled *Science and Engineering Infrastructure for the 21st Century: The Role of the National Science Foundation* () analyzed and identified requirements for investment in future infrastructure capability. The report recommended that special emphasis be made in four categories of infrastructure needs, including addressing the increased need for midsize infrastructure. It also recommended that NSF strengthen the infrastructure planning and budgeting process through actions including development of budgets for projects that include the total costs to be incurred over the entire life cycle of the project.

At the August NSB meeting, the Committee on Strategy and Budget discussed a report mandated by Section 22 of the NSF Authorization Act enacted in mid December 2002. This legislation calls for the Board to “prepare a report to address and examine the Foundation’s budgetary and programmatic growth provided for by the Act.” The Board discussed five issues Congress identified for special attention in the report, one of which is the science and engineering research infrastructure.

NSF continues its efforts to improve management and oversight of its large facility projects, and MPS staff have played a key role in this process. In June 2003, a new Deputy Director for Large Facility Projects (LFP) came onboard to strengthen NSF’s ability to effectively manage large facility projects. On July 31, 2003, the *Facilities Management & Oversight Guide* was released. The Guide is meant to be a living document – to be updated over time to reflect policy changes and lessons learned as the Foundation continues to create and operate facilities at the research frontiers. The Guide states clearly the policies, procedures and requirements that come into play at each stage of the facility project, including description of each stage of the life cycle. The Guide is available on the Web at <http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf03049>.

In the past, NSF has provided detailed information about project costs through special reports to Congress (February 2002, July 2002). Beginning in February 2003, such information will routinely be included in NSF’s annual budget request to Congress. MPS will continue to work with the Deputy Director for LFP and the MREFC Panel Committee to ensure that there is consistent planning and budgeting provided for the full life cycle costs of facility projects. MPS has an infrastructure working group that will undertake the development of a planning process for the directorate that will address these life cycle questions. MPS divisions are already beginning to fold life cycle cost issues into their development of roadmaps for such pending large-scale activities as an underground laboratory and a giant segmented mirror telescope.

With respect to mid-scale infrastructure, all MPS divisions have programs that can and do support development and/or acquisition of instrumentation, but the needs in most fields have outstripped the resources available. In addition to these disciplinary programs, if the instrument cost is less than \$2 million, then researchers can apply to the Major Research Instrumentation Program for funding. If the

instrument construction costs are greater than 10% of a Directorate's annual budget (>\$100 M for MPS), then the Major Research Equipment and Facilities Construction account can be used to fund such projects.

The gap between the existing funding mechanisms is significant. For example, an instrument costing \$20 M would take up approximately 10% of a division's budget and cause a significant distortion of the research portfolio. Examples of such instruments include synchrotron and neutron beam lines, the Energy Recovery Linac, petawatt lasers, VERITAS, the Auger project, solar and other neutrino experiments, etc. AST, CHE, DMR, and PHY see the need to support instrumentation at this level.

DMR has initiated a new activity in FY 2004, the Instrumentation for Materials Research – Mid-scale Instrumentation Program (NSF 03-604) at a planned level of \$4.5M. DMR envisions that the program budget will grow to approximately \$25 - \$30 M annually by FY 2008, which would allow funding for one to two synchrotron or neutron beam lines (\$8 M to \$15 M each). AST has developed a plan and funding profile that would allow the realization of community recommendations for high priority mid-sized instrumentation and the design and development phases for future recommended major (MREFC-scale) facilities. Initial effort toward meeting some of these goals began in FY2003 with a \$3M program, managed through NOAO, for the development of adaptive optics systems necessary for the next generation of large telescopes. This program is planned to continue in FY2004 and opportunities for such support expanded in FY2005. CHE and PHY anticipate starting similar activities in FY 2005.

(10) Continued support of basic research that benefits the Nation's security, in collaboration with other Federal agencies. Review mechanisms, allocation of resources, and the role of the national laboratories should be examined.

The recent partnership of the U. S. Intelligence Community (IC) and the NSF Mathematical and Physical Sciences Directorate began November 2002 at a joint workshop. The gathering of 100 scientists focused on five key areas where breakthroughs in fundamental science might lead to IC applications – which would increase our ability to predict, and possibly prevent, acts of terrorism. The workshop report contains recommendations for many research projects that span the frontiers of basic mathematical and physical sciences and have clear connections for developing technology for intelligence use. (url available in a day or so)

The “Approaches to Combat Terrorism” (ACT) competition that resulted called for high risk, high impact proposals, and relatively small grants of ~\$100,000 each so that many projects could get off the ground quickly. MPS made \$2.5M available, producing a total of \$3.5M with \$1M from the IC. Five panels of NSF and IC scientists conducted an internal review of the 157 proposals, resulting in 39 awards. The largest numbers of proposals were received in the sensor area, followed by mathematical methods, spectroscopy, power sources and imaging. The success rate was 27%, with the highest success rate in the power category, which the IC regarded as a high priority. Another goal was cross-fertilization of the NSF academic community and the IC. This process began at the workshop, continued with the competition, and will continue at the awardees meeting next spring. MPS staff are currently working on development of the second round of ACT, which will move toward longer-term projects.

NSF has a long-standing record of cooperation with other agencies. The newest of the agencies addressing national security is the Department of Homeland Security. As its R&D programs are evolving, NSF is exploring mechanisms for cooperation. MPS remains open to possibilities for collaborative efforts, but can not yet describe exactly how they might take place.

(11) Support of pilot programs for science partnerships with developing countries tailored for specific region of the world. These programs can then provide the basis for the development of models for future collaborations in the region.

Building on a series of meetings dating back to FY 2000, DMR has worked closely with African nations to build networks in materials research. A third US-Africa implementation meeting will be held at NSF on October 27-28 2003; delegates from 18 African nations are expected to participate. This meeting is co-organized by the U.S./Africa Materials Institute at Princeton University, one of three International Materials Institutes established by NSF in FY 2003.

A planning meeting for a US-India materials workshop (upcoming in 2004) was held in New Delhi on June 14-15 2003. Delegates from the Department of Science and Technology in India and from the Chinese National Science Foundation will attend a US-Asia materials implementation meeting to be held November 13-14, 2003 in Hawaii.

CHE is supporting a project from the American Chemical Society, "Symposium on Frontiers of Chemical Sciences: Research and Education in the Middle East," that will be held in Malta, Dec. 6-11, 2003. The Middle Eastern countries represented include Egypt, Israel, Iran, Jordan, Kuwait, Lebanon, the Palestinian Authority, Saudi Arabia and Syria. Seven Nobel laureates will deliver keynote lectures on topics including the chemistry of water in an arid land, preservation of antiquities, natural products chemistry of the desert, and public understanding of science. It is anticipated that the meeting will increase social understanding among the individuals and subsequently their communities. CHE has a new program announcement, Discovery Corps Postdoctoral and Senior Fellowships (03-596), that encourages partnerships with scientists in developing countries as one class of possible projects: Fellows will draw upon their research expertise to provide professional service to these countries through projects that can enhance the quality of life in the country and lead to future collaborations.

APPENDIX VI

MPS Planning and Budget Formulation Guidelines

Overview

Planning is an on-going activity within MPS that varies in intensity and immediacy throughout the year. It is tied both to NSF and federal planning and budget cycles. Thus, at key points during the year, MPS produces a “snapshot” of its planning that meets the requirements of agency, administration, and congressional decision-makers.

In MPS, the planning process is about “science”² first and dollars second. It is a continuous activity that largely draws its energy from a “bottoms up” approach, with the external scientific community acting as the major source of information and ideas. Ongoing dialogue with individuals, Advisory Committees, and professional societies, as well as focused opportunities for dialogue through activities such as workshops, all contribute to the development of MPS long-range plans and goals.

However, to be effective, MPS cannot limit its planning processes to understanding what the community desires. Planning must take account of the broader environment in which MPS sits. It must provide input to establishing NSF-wide directions at the same time it aligns with the underlying NSF strategic plan. Planning requires an understanding of what is happening at other agencies and in international arenas. Ultimately, planning must take into account the realities of the budget, producing priorities for action that allow MPS to meet the needs of both the science and the decision-makers.

This set of guidelines is intended to provide a brief overview of the planning structure within MPS, both as it exists and as it might be, as well as an explanation of the roles played by different groups and the timing of the annual budget formulation process.

MPS Planning

MPS planning occurs in the context of the NSF Strategic Plan. The Government Performance and Results Act (GPRA) of 1993 mandates that Federal agencies account for program results through the integration of strategic planning, budgeting and performance measurement. At the core of this is the strategic plan, a document covering a five-year period that is updated every three years.

The updating process took place in 2003, with the active involvement of NSF staff and the National Science Board. Goals in the updated plan extend those of the plan developed in 2000. They have to do with developing People, Ideas, Tools, and Organizational Excellence to advance NSF’s mission.

At the directorate level, MPS is beginning to develop a long-range plan that looks out at least 5 years in the context of addressing the goals of the NSF strategic plan. The frontiers of science, engineering, and mathematics are constantly evolving; the capabilities provided by instrumentation and facilities open new avenues of investigation; and bringing new generations of people to these fields requires constant attention to how the fields are evolving. Stimulating progress requires that we look to the future and anticipate what will best serve MPS fields. MPS will assess progress and revise this plan annually and, in its budget formulation process, will address the alignment among the NSF strategic plan, the present and future scientific goals, and the likely funding trajectory.

To assist in this process, MPS has a number of internal working groups (currently, education, science, and infrastructure working groups) that are loosely aligned to the NSF strategic goals for People, Ideas, and Tools. The existing groups are chaired by senior staff in the Office of the Assistant Director (the Head of the Office of

² In this document, the terms “science” and “scientific” are inclusive terms, meaning approaches to developing the People, Ideas and Tools of the MPS fields.

Multidisciplinary Activities, the Executive Officer, and the Senior Advisor, respectively), with participation from all divisions. As the long-range planning process evolves, the groups will evolve to become more strategic in their approaches and better connected to the annual cycle of planning and budget formulation. We will add a working group related to Organizational Excellence and improve integration across all the planning groups.

Generally speaking, emerging opportunities are targeted for inclusion in the budget two to three years after their identification in the planning process. MPS encourages more immediate “experimentation” with activities incorporating these opportunities in order to establish the need for a scale of visibility and/or funding that would require explicit mention in future budgets. Such experiments are frequently co-funded through the Office of Multidisciplinary Activities.

As MPS explores inclusion of new opportunities in future budgets, scientific readiness, technical feasibility, response to national needs, and balance with existing programs are some of the considerations to be taken into account. Affordability also becomes a consideration, particularly in the plans for staging large-scale activities.

As it initiates this explicit form of long-range planning, MPS will work with the MPSAC to ensure that the process has an approach that is appropriately broad and deep to capture the many facets of MPS activity effectively. We hope to have at least an outline of this plan at the April 2004 meeting.

Budget Formulation

The federal budget cycle consists of three major phases: Budget Execution; Congressional Authorization and Appropriation; and Budget Formulation. As a result, Federal agencies spend most of a calendar year dealing simultaneously with three separate fiscal year budgets: 1) the current year budget; 2) the requested budget being considered by the Congress for the upcoming fiscal year; and 3) the preparation of the budget for submission to the Congress for the following fiscal year.

Although Congressional authorization and appropriation and budget execution are of significant importance, the *MPS Planning and Budget Formulation Guidelines* will address the budget formulation phase. The endpoint of budget formulation is submission of the budget to Congress in February of each year. The operational year runs from October 1 to September 30 each year, and MPS uses the fiscal year as the basis for the annual planning and budget formulation cycle. (See below.)

Budget Planning Phase

The rough outline of the MPS planning process that follows begins approximately two years before the formal results will be seen in the context of an appropriation upon which MPS acts. It takes place at the same time as work on the Congressional request for the following fiscal year and the execution of the current fiscal year’s budget. Because these three activities are interdependent, MPS needs to be free to adapt the timing to accommodate the particulars of a given fiscal year.

Generating Ideas – Within MPS

(In FY 2004, absent an existing long-range plan and anticipating a change of leadership, these idea generation activities have not yet taken place. They will grow out of the November 2003 MPSAC meeting.)

Early in the fiscal year, the MPS OAD will issue a memorandum to MPS Program Officers calling on them to identify emerging scientific areas not previously addressed (as well as areas demanding more attention than they are getting) for consideration in the planning process. They will be asked to develop a paper of one to two pages

that explores opportunities in advancing the Foundation's People, Ideas and/or Tools goals following a common template. Where appropriate, they should highlight reports from the scientific community that address the potential impact of acting on the opportunity. The Division Director and Executive Officer will review the science papers, combine opportunities as appropriate, and share them for discussion within MPS working groups before discussing them with the MPSAC in November.

On a parallel track, the MPS senior management team will revisit the MPS long-range plan, comparing its directions and priorities with progress in budget development. They will update the framework for the plan preparatory for future priority discussions, examining the way the Foundation's plans align with MPS plans and taking into account previous MPSAC recommendations.

Generating Ideas – MPS Advisory Committee

The November meeting of the Advisory Committee will include a status report on the directorate, a briefing on the developing five-year plan, and an update on the planning discussions at the previous May meeting at a depth consistent with the confidential stage of the budget formulation process for the following fiscal year. AC members will meet in subgroups with the five MPS divisions, focusing on emerging opportunities from the viewpoint of the divisions and their relationship to each other and to on-going activities at the division, directorate, NSF, interagency, and international level.

The AC, the Assistant Director for MPS, and relevant MPS staff will engage in a discussion that will identify items to be highlighted for further attention in the planning process and will make suggestions for how to obtain the input needed for effective consideration of options. For example, the AC may decide to prepare some white papers in these areas, may suggest that NSF staff do so, might appoint a subcommittee to address the issues, or might suggest developing a workshop. AC members may also wish to suggest additional items for consideration and provide input to MPS on the completeness of its processes for identifying emerging opportunities.

Refining Ideas

In January and February, each division meets with MPS Senior Management to present the new science opportunities and needs that they feel should become elements of the MPS long-range plan and priorities for upcoming budgets. Where appropriate, they will also provide information coming from the MPSAC. The presentation by the divisions will address questions such as:

- How does the new opportunity advance science in a unique way over what NSF is presently supporting?
- How does the new opportunity meet the goals and the objectives of both the NSF strategic plan and the MPS long-range plan?
- What is the readiness of the community to respond?
- What impact will the new opportunity have on the science community and NSF?
- What are the broader impacts of this opportunity?
- How is the new opportunity connected to a national need?
- What is the anticipated role for NSF?
- How is the new opportunity positioned with respect to partnerships within NSF, with other agencies, international communities, private industry, and/or state and local governments?

After reviewing science papers, presentations and discussions in the budget planning stage, MPS senior management meets in a 2-3 day retreat in February or March to discuss and update the long-range plan and begin to identify key elements for the upcoming OMB budget submission.

Priority Setting

The NSF priorities develop through an iterative process that reflects both opportunities "bubbling up" from the directorates and the federal science and technology policy environment. The MPS process for setting priorities takes NSF priorities into account, ensuring that what the directorate proposes is consistent with the agency's long-term directions.

MPS Advisory Committee

In April, the MPS Advisory Committee (AC) meets for a second time. At this meeting, presentations by MPS staff members will:

- Describe how AC input from previous years influenced the congressional budget request for the upcoming fiscal year.
- Present the revised MPS Long-range Plan for discussion. (*In April 2004, this will be the preliminary version of the first long-range plan.*)
- Describe how the emerging opportunities discussed in November were incorporated in the planning.
- Suggest a framework for establishing priorities in developing the next OMB and congressional requests.

The AC revisits the process for input described in November, examines progress to date, and determines whether further input is necessary. It will provide comments on the MPS Long-range Plan and the suggested framework for priority setting.

MPS Priority Setting

Following the MPSAC meeting, MPS will engage staff members in developing a coherent argument for including identified areas as priorities in the upcoming budget process through the planning groups described above and, where appropriate, topically-oriented subgroups. They will develop one to two page documents to make the case for immediate attention to these opportunities. In addition to opportunities identified through the MPS process, the planning groups will examine the MPS role in the NSF priority area funding opportunities and how funding for the MPS core areas might be enhanced.

These documents will be shared with potential partners in other directorates and used in developing the OMB submission. They will include information on:

- Science need, importance, impact and possible outcomes
- Five year annual funding profile and performance plan
- Internal NSF management plan
- Partnerships

The Assistant Director for MPS, working with the division directors and other key staff members, will test the items against the priority framework and determine the extent to which the items are likely to rise to the top in subsequent budget exercises.

Priority setting is a key element of planning, taking general goals and directions and placing them in the context of action under constrained resources. OMB Circular A-11 has specific instructions to Federal agencies, "the strategic plan is a tool to be used in setting priorities and allocating resources consistent with those priorities." Thus, careful deliberations to determine "overlapping" scientific themes, scientific readiness, and flexibility need to be examined by senior management and integrated with information about on-going cross-directorate programs, NSF priority areas, and interagency partnerships in the context of the strategic plan.

Preparing the OMB Budget Request

The budget request to Congress is a key tool for developing and realizing Administration policy. Thus, the budget preparation process takes place under constraints of confidentiality to which the broader planning processes are not subject. Planning is a collaborative effort with the scientific community. Preparing the budget is an internal government process.

The budget process begins with a Budget Call that is issued in June from the Budget Division. The Budget Call incorporates the guidance from the Office of Management and Budget (OMB) and the Office of Science and Technology Policy (OSTP) and provides the instructions and schedule for preparing the budget materials. The guidance provided includes the President's policy priorities, instructs agencies on what programs to develop, emphasize, reduce or eliminate, and provides the overall policy direction for the budget year. OMB also provides technical guidance on preparing strategic plans and budget request submissions, and integrates the requirements of the laws and regulations applicable to the budget process. This guidance is issued as Circular A-11, which is revised every year.

The OMB submission is due the first Monday in September. While the MPS directorate-level budget process begins with budget materials produced at the division-level, the OMB submission is a directorate level document. The MPS Budget Liaison Working Group (BLWG) meets regularly throughout the summer months to develop the budget materials. The BLWG is comprised of the MPS Executive Officer (EO), Senior Advisor (SA), MPS Budget and Planning Officer (BPO), Executive Officers (EOs) from each division, Head of the Office of Multidisciplinary Activities (OMA), the MPS GPRA Officer, and the MPS Priority Area Coordinators. The MPS divisions use the material developed in the MPS planning and priority setting processes as the foundation for developing the OMB budget submission.

From the OMB Submission to the Congressional Submission

During the fall, OMB reviews agency budget submissions and refines target estimates across the government. NSF and the OMB examiner maintain continuous contact during this period. OMB conducts hearings with the Directorates to discuss and question their budget submission. In late October/November, the OMB Director Review takes place. The OMB Branch Chief presents the NSF budget to the OMB Director.

In late November, OMB issues the "passback" to NSF. The passback represents the OMB recommendation and the President's initial decision on the allocation of money that NSF can request from Congress. There is usually a period of time in which the agency can appeal to OMB for additional funds. If the NSF Director decides to appeal the passback, additional materials may be required. At the end of the appeal process, the NSF Director, taking into account guidance from OMB on the structure of the NSF budget request, makes the final allocation of amounts to all Directorates.

In a parallel process, MPS BLWG meets to prepare for the OMB hearing, creates options for moving forward with the congressional request depending on passback and internal NSF allocations, and initiates the next cycle of budget formulation. The new fiscal year has begun and preliminary operating plans are put in place while awaiting an appropriation. After the President signs the Appropriation, the Budget Division provides allocation of the funds by Budget Account and Directorate. This is based on Appropriation and Conference Report language.

In late December/early January, Directorates receive their allocation for the congressional request. The MPS Assistant Director (AD), EO and BPO determine the allocation to be made to the MPS Divisions. The Budget Division issues the Budget Call for the *justification materials* for the President's request to Congress. The budget call provides the instructions and schedule for preparing the budget materials. MPS BLWG meetings occur weekly or more frequently. Assignments are made for materials to be provided. Deadlines are usually short and the MPS BPO maintains continuous contact with the Budget Division. This is a time in the process when last-minute developments in the budget request may result from several sources ranging from substantive programmatic issues, through politically sensitive issues, to technical matters. Because the process is at its most

Minutes of the MPSAC Meeting of November 6-7, 2003

confidential at this point, MPS can react most effectively when we have a strong base of previous input from the community to draw on in responding.

The Budget and Planning Officer keeps the MPS Assistant Director and Executive Officer informed daily on the status of the budget request and seeks advice and recommendations on all major issues. The NSF Budget Request goes to the Congress on the first Monday in February.

APPENDIX 1

Parties to the Budget Process

OMB is responsible for overseeing the development and execution of the President's budget. To assist in the formulation of the President's spending plans, OMB assesses the effectiveness of all agency programs, policies, and procedures, evaluates competing funding demands among agencies, and sets the Administration's funding priorities. In addition, OMB is involved in the development and resolution of all legislative, regulatory, procurement, and management issues on behalf of the President. This includes ensuring that all reports, rules, testimony, and proposed legislation are consistent with the President's budget and with Administration policies.

OSTP was established in 1976 to provide the President with timely scientific policy advice and to coordinate the science and technology investment. OSTP plays a prominent role in advancing the Administration's science and technology agenda. OSTP and the National Science and Technology Council (NSTC) play a prominent role in developing the annual science and technology budget agenda for the Administration, which involves broad interagency funding. President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This cabinet-level council is the principal means for the President to coordinate science, space, and technology policies across the Federal Government. NSTC acts as a "virtual" agency for science and technology to coordinate the diverse parts of the Federal research and development enterprise.

OSTP and OMB issue a joint memorandum of guidance each June detailing the Administration's priorities for R&D funding.

The Congress appropriates the funds for NSF in the VA, HUD and Independent Agencies Appropriation and passes legislation. Through hearings, deliberations, and appropriated funding, the decisions and intentions for the role and investment for science and technology are made known by Congress.

The Administration sets policy in the government through the annual submission of the budget request. The budget request submitted by NSF is the policy of NSF. Since the President's budget is only a request to Congress; Congress is not required to adopt the Administration's recommendations. Nevertheless, the power to formulate and submit a budget is a critical tool in setting national policy.

APPENDIX 2

Budget Development Process

Below is the budget process in a ‘nutshell’. This by no means provides the detail of the process that goes on but outlines the roles, meetings and time line associated with the process.

I. OMB Request (June-September)

In June, the OMB request begins with the issuance of the first Budget Call by the Budget Division. There are usually at least three to four subsequent budget calls issued throughout the process during the summer months.

- NSF BPLG meeting to discuss the Budget Call is attended by MPS EO and BPO.
- MPS BPO schedules a meeting with MPS BLWG as soon as Budget Call is received, assesses the work to be accomplished and the schedule.
- MPS BPO provides the MPS AD and EO with scenarios for the budget based on the instructions provided in the Budget Call.
- MPS BPO drafts an MPS schedule for meeting the Budget Call deadlines and an agenda for the BLWG meeting.
- MPS BPO and MPS EO discuss the workload allocations and provide a list at the BLWG meeting.
- Working Group/Priority Area Coordinators meet on assigned areas.
- Division EOs prepare Budget Call documents, based on allocations and decisions made during the priority setting phase, for the Division.
- BPO incorporates input from the Divisions into a draft Directorate response.
- EO & BPO analyze for consistency with MPS Long-range Plan.
- Final documents are presented to MPS AD for comment.
- Document is revised as necessary before final submission.

II. Continuing Budget Process (July-December)

During the early stages of the OMB request, the MPS program staff are busy spending the money allocated in their programs for the current fiscal year. Throughout the fall, MPS senior staff continue to work on the MPS Long-range Plan, have working group meetings to prepare for MPS AC meeting in November, and begin new fiscal year funding with clearance of program announcements/solicitations, panel meetings and site visits.

- BPO monitors spend-out process in the Divisions.
- BPO notifies Budget Division of any reprogramming problems.
- Planning working groups and BLWG continue to work on MPS Long-range Plan and to plan for MPS AC meeting in November.
- Present latest MPS Long-range Plan to MPS AC meeting for continued discussion.
- BPO provides divisions with preliminary allocations for fiscal year Oct 1st.
- BLWG prepares for OMB budget hearings.
- When the Appropriation is passed and signed by President:
 - Scenarios developed by BPO for Division allocations to be reviewed and approved by MPS AD and EO.
 - Current Plan letter input to Budget Division.
- MPS AD issues call for Science Papers from all MPS Program Officers.

III. Congressional Budget Process (November-May)

In late November, around Thanksgiving, OMB issues the agency “passback”. The NSF Director has a limited time in which to appeal. Once the appeal process is complete, NSF receives its allocation for preparing the *justification materials* for the President’s request to Congress. There is usually about four weeks for Directorates

Minutes of the MPSAC Meeting of November 6-7, 2003

to provide all needed material. Deadlines are short and the Budget Division is in constant communication with OMB and MPS BPO. Changes are often made at the very last minute.

- Review NSF passback and provide comment to Director.
- Provide input for appeal process.
- NSF BPLG meeting to discuss the Budget Call is attended by MPS EO and BPO.
- MPS BPO schedules a meeting with MPS BLWG as soon as Budget Call is received, assesses the work to be accomplished and the schedule.
- MPS BPO provides the MPS AD and EO with allocation scenarios for the division budgets based on the instructions provided in the Budget Call.
- MPS BPO drafts an MPS schedule for meeting the Budget Call deadlines and an agenda for the BLWG meeting.
- MPS BPO and MPS EO discuss the workload allocations and provide a list at the BLWG meeting.
- Working Group/Priority Area Coordinators meet on assigned areas.
- Division EOs prepare Budget Call documents, based on allocations and decisions made for the Division.
- Draft MPS budget is composed and reviewed by BPO for funding correctness.
- EO & BPO analyze for consistency with MPS Long-range Plan.
- MPS comments on NSF-wide documents.
- Final documents are presented to MPS AD for comment.
- Revise document as necessary before final submission.
- BPO prepares slides and briefing materials for MPS budget roll out presentation given by MPS AD.
- BPO sends out a call for the Directors Back Up Book and for the MPS AD's Back Up Book.
- BPO edits Back up Book materials and prepares MPS AD Back up Book for Congressional Hearing.
- BPO attends hearings with MPS AD.
- Budget Division provides Q&As from hearings and BPO coordinates MPS response to Congress.

APPENDIX VII

Certification of Accuracy of Minutes of November 2003 MPSAC Meeting



Jeanne E. Pemberton
John and Helen Schaefer
Professor of Chemistry
Department of Chemistry
1306 East University Boulevard
Tucson, AZ 85721

Phone: (520) 621-8245
FAX: (520) 621-8248
email: pembertn@u.arizona.edu

January 27, 2004

Dr. Michael S. Turner, Assistant Director
Directorate for Mathematical and Physical Sciences
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Michael:

I have reviewed the final version of the minutes of the Directorate for Mathematical and Physical Sciences Advisory Committee meeting that was held on November 5-7, 2003 (attached), and am pleased to certify the accuracy of these minutes. I appreciate the efforts of Morris Aizenman and other staff within MPS in getting these minutes prepared and in accommodating changes suggested by the Advisory Committee.

With best wishes,

Sincerely,

A handwritten signature in black ink that reads "Jeanne E. Pemberton". The signature is written in a cursive style with a large initial "J".

Jeanne E. Pemberton
Chair, MPS Advisory Committee

xc: M. Aizenman