March 6th, 2011

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

Dear Dr. Seidel,

On behalf of the 2011 Committee of Visitors (COV) for the Division of Materials Research (DMR) of the National Science Foundation (NSF), I am submitting the compiled findings of our review on the attached templates. Following is a brief summary of the highlights of our review, with a list of our recommendations.

Overall Findings:

NSF-DMR plays a unique and essential role in the materials enterprise, an enterprise that is critical to national competitiveness. NSF-DMR does an outstanding job in stewarding public funds that support materials research. The outcomes are of wide and deep impact. In 2010 alone, for example, DMR supported the research of 2725 faculty members, trained 763 postdoctoral staff and 2893 graduate students, and provided materials research opportunities for 1712 undergraduates. DMR programs are closely coupled to NSF's mission and OSTP initiatives, and support cutting-edge work at the frontiers of materials research.

The division is a key resource for addressing Congressional and Administration efforts to improve America's Economic Competitiveness. Discoveries include a very large and tunable magneto-resistance in graphene nanoribbons; the emerging and intellectually fascinating field of topological insulators that could lead to new quantum computers; batteries made by genetically-engineered viruses; new block liposome vesicles for nanoscale wires and needles; and ground-breaking hybrid superconducting/resistive magnet technology.

The programs also advance national imperatives to train larger numbers of students and a to create a more diverse STEM workforce, for example the internationally recognized MRSEC program alone hosted 1374 undergraduate participants in summer research, of whom 47% were female and 39% underrepresented minorities. The Nova television documentary series "Making Stuff", and the Materials World Network are powerful examples of broader impacts funded by DMR. The innovative PREM program has clearly demonstrated effectiveness in increasing diversity for materials research and training.

While the division is to be applauded for keeping the proposal success rate at 25%, it is abundantly clear that many outstanding proposals cannot be supported due to inadequate funds. The ARRA funding provided an opportunity to rapidly support some of these outstanding proposals in 2009, and these funds were well invested. Increasing the success rate and increasing the median award size are compelling reasons for increases in DMR's budget.

Instrumentation and Facilities:

DMR supports instrumentation ranging from equipment in a single laboratory up to large National User Facilities. The COV struggled with identifying the right balance between these facility-scaled activities and the support of individual and center research by DMR. At present about 20% of DMR funds go to facilities and instrumentation. We agree with previous COVs that some of the facility operating funds should be contributed by other divisions of NSF who are users of the large facilities, but we do not support the concept of removing the facilities from their program management home in DMR. Especially if larger facilities, such as new light sources, are to be operated by DMR in the future, NSF must develop a model to supplement DMR funding and prevent any erosion of core support for individual investigators, centers, or mid-scale instrumentation.

Within the national facilities and instrumentation program, we are concerned that a very large share of funds during the review period went to National Facilities operation, at the expense of small ($30k-$100k) and mid-scale ($100K – $10M) instrumentation. The IMR program, for example, was suspended for two years with negative impacts on materials research. We recommend that in coming years funding for instrumentation at the mid-scale be restored and increased. We also encourage NSF to develop intrumentation newtworks, as has been done very well by the MRSECs, and to make sure that instrumentation is shared between instiutions as much as reasonably possible, in line with the recommendations of the 2005 NRC report: "Midsize Facilities: The Infrastructure of Materials Research".

Recommendation: DMR should make a larger share of their facilities/instrumentation funds available for instrumentation for all scales from $30K to $10M+. Efforts should be made in program solicitations and review to see that large instruments are appropriately shared.

While we support the efforts to engage in new light source R&D, proposed by NSF's Photon Sciences panel, we are concerned that the stewardship role for light sources has been confused somewhat with R&D.

Recommendation*: Especially in these expected challenging budget times*, NSF should develop a facilities stewardship strategy with the materials community in the context of its mission and the role of other agencies.

DMR Response to the 2008 COV Recommendations:

In general DMR has been responsive to the recommendations of the previous COV. Nonetheless, there are systemic problems that recur. For example, the problem of fair assessment of broader impacts remains a challenge (this was identified in the 2005 COV report), but the problem appears to be an NSF-wide and not a DMR-specific one. In response to the questions in part C, and the comments of Subra Suresh, NSF's director, in a recent Science article, we note:

- The COV is concerned that broader impacts are not consistently reviewed or assessed.
- We **recommend** that the NSF develop clearer guidelines for both reviewers and proposers, with emphasis on effectiveness
- **We do not recommend** to take the responsibility from the individual (even new) PI, but we encourage institutions and centers to provide support to outreach activities and assessment

DMR should continue to support activities devoted to materials education and outreach.

We were glad to see that the very successful seed funding and shared instrumentation components of the MRSEC progam were proportionately increased in response to the 2008 COV recommendations. The opening of MRSEC facilities to outside users, and the creation of a national network (MRFN) were very positive steps and should be expanded into the instrumentation and national facilities programs.

DMR and the Structure of NSF:

The COV was asked to consider possible reorganization of NSF to better support the materials research mission. Our **recommendation** follows: The COV endorses the creation of a Materials Directorate within NSF, provided that proper attention is given to seamless connections with areas of materials research within other directorates or divisions. Any reorganization must be consistent with the long-term research horizons and the full breadth of DMR. The current internal structure of DMR was considered to be well-matched to its mission.

DMR Budget:

The COV saw evidence that DMR is chronically understaffed, even by NSF standards. DMR's mission is complex, including centers, individual investigators, large facilities and many inter-divisional activities. Specific suggestions and recommendations for added staff are covered in the templates. **Recommendation**: Staffing in DMR should be increased to reflect its budget and responsibilities.

We believe that the highly successful Materials Research Centers and Teams programs deserve a budget increase, together with individual investigator programs. We note the observation in the CMMP 2010 report that in the last 5 years grant sizes have gone up 15% while the cost of graduate students has gone up 25%.

Balance (individual investigator, groups, centers, facilities):

In general we find that the balance is stable and reasonable among these groups, although we expressed concern about the balance within facilities and instrumentation, where instrumentation is underweighted. Instrumentation should grow at the expense of facilities stewardship, unless support from outside DMR can be increased for national facilities. We reiterate the guidance from the two previous COV reports that funding for single investigators and small groups must not be diminished, given the foundational role that these efforts play in the overall research enterprise.

Award Size, Duration and Proposal Success Rate:

We find that the current funding rate and award size are a reasonable compromises in view of the pressures facing DMR. However, many outstanding proposals are unfunded and award value is dropping. This should be a compelling argument to increase funding.

Best Practices from DMR:

The Committee of Visitors were impressed by the thoughtfulness and transparency of program decisions and the sincere efforts to balance the NSF's goals. In general, our perception was that careful thought has gone on regarding the choice of referees, methods of refereeing and the interpretation of referee reports to ensure that funds are allocated to the most deserving projects. The program director's review analysis, which is not seen by the proposers, in general provides excellent analysis supporting the decision making. We encourage the practice of letting declined PI's know that the program manager is able to discuss the decision by telephone in more detail. We were delighted to see the emphasis on new CAREER awards to PIs in all of DMR's programs.

Conclusion:

The committee is grateful for the openness of all program directors and NSF management, and the support of NSF staff for our efforts. We believe that the COV is a good and fair process for performance review and community guidance. The committee unanimously endorses the very high effectiveness of DMR over the past three-year review period.

Sincerely

J. Murray Gibson
Dean, College of Science
Northeastern University
360 Huntington Avenue
Boston, MA 02115

CORE QUESTIONS and REPORT TEMPLATE

for

FY 2010 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in two primary areas: (A) the integrity and efficiency of the ***processes*** related to proposal review; and (B) the quality of the ***results*** of NSF's investments that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order to determine the likelihood that the portfolio will lead to the desired results in the future. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. *COV reports should not contain confidential material or specific information about declined proposals.* Discussions leading to answers for Part B of the Core Questions will involve study of non-confidential material such as results of NSF-funded projects. Suggested sources of information for COVs to consider are provided for each item. The reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements, and are made available to the public. Since material from COV reports is used in NSF performance reports, the COV report may be subject to an audit.

ARRA Addendum: Awards funded by the American Recovery and Reinvestment Act (ARRA) were made during the period of time under review by the COV. We have included questions on the template that deal explicitly with this subset of the overall portfolio and the extent to which it met the objectives of the Act and the priorities articulated by the NSF Director. Key information regarding ARRA and NSF priorities as well as optional program-specific priorities will be provided to you.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions. For past COV reports, please see http://www.nsf.gov/od/oia/activities/cov/covs.jsp.

Biomaterials, Polymers and Solid State and Materials Chemistry Cluster Review (Parts A and B)

FY 2010 REPORT TEMPLATE FOR

NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: *February 9-11, 2011*

Program/Cluster/Section: BMAT/POL/SSMC

Division: Division of Materials Research

Directorate: Mathematical & Physical Sciences

Number of actions reviewed:

Status	2008	2009	2010
Awards	9	23	17
Declines	4	11	16
Other			

Total number of actions within Program/Cluster/Division during period under review:

Status	2008	2009	2010
Awards	88	131	112

Declines	300	333	363
Other			

Manner in which reviewed actions were selected:

15 Proposals from Each Program

- 5 Clear Awards/Declinations
  - 2 Awards
  - 2 Declinations (including one renewal)
  - 1 Creativity Extension

- 5 Awards in the Decision Interval
  - 1 Renewal
  - 1 New proposal
  - 1 RUI
  - 2 Other

- 5 Declines in the Decision Interval
  - 2 Declined Renewals
  - 2 Declined New (young and established)
  - 1 Other

10 Proposals culled from the different programs in each breakout

- 2 Specialty proposals in Each Breakout (1 award and 1 declination from each solicitation)
  - SciArt

Solar

SI2

CDI

Etc.

Co-reviewed Proposals (1 award and 1 declination)

Between Programs

Between Divisions

Between Directorates

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. **Provide comments in the space below the question**. **Discuss areas of concern in the space provided.**

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: There was a consensus from the COV members that the individual review methods (ad hoc and panels) and even combinations of them were appropriate for each program to foster timely, efficient and effective decisions. It was also noted that the panel reviews appear to be more effective for multi-disciplinary and newer programs when there is a grouping of subject areas (BMAT, SSMC) and a critical mass is achieved. Source: Jackets and Program Director Presentations.	YES
2. Are both merit review criteria addressed a) In individual reviews? Both merit review criteria were addressed. In the case of reviewing the *broader impact* of the proposals, the reviews were often too general or vague. This issue needs to be better addressed with more specific comments by the majority of the reviewers. Possibly more detailed questions/templates should be provided to the reviewers in order to get them to adequately assess the *broader impact* of the proposals. The *intellectual merit* sections had much more detailed analysis than the	YES

[1] If "Not Applicable" please explain why in the "Comments" section.

broader impact section. Although misplaced, several reviews included comments on broader educational aspects in these IM sections. b) In panel summaries? Both merit criteria were adequately addressed. c) In Program Officer review analyses? The review analyses were very comprehensive and explained the summary of the reviewers as well as the funding decision and the follow-up actions to be taken. Both merit criteria were discussed and articulated in detail. Source: Jackets	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments In most cases the reviewer comments provided substantive commentary in analyzing strengths and weaknesses of the proposals. In some jackets there are one or two reviews that are not very substantive, but when the reviews are taken as a whole, there is a thorough examination of the proposal. Source: Jackets	YES
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The panel summaries are concise and contain an accurate distillation of reviewer comments and panel discussion. Each panel summary was also very clear about their funding recommendations or declinations Source: Jackets	YES

5. Does the documentation in the jacket provide the rationale for the award/decline decision? The documentation for the jackets was excellent. The Program Directors documented all communications (with PI and reviewers), summaries, diary notes and action items. The review analysis documents were highly informative and contained comprehensive summaries of the review process. These analyses discussed in great detail the decision process and action items taken (including constructive suggestions for the PI and for borderline cases). (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? Yes, for example a reversal of a CAREER award was clearly supported by the quality of the proposal and supported by the prioritization of the panel (rated as "Fund if Possible"). *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Yes. The reversal cases contained a descriptive revised review analysis listing the reasons for the decision to support the awards. The decision was based on strong reviews, panel evaluation of the intellectual merit and broader impacts of the CAREER proposal. Source: Jackets	YES

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a	YES

declination.) Comments: Correspondence with PIs is well documented through diary entries, and review analysis and summaries. If declined, the PI receives an email from the Division Director with instructions to call the Program Director if additional information about the decline decision is required. Some Program Directors directly contact the PIs. The reviews are available to the PI by Fastlane. Upon request, the Program Director will explain the reasons for rejection and offer constructive suggestions for improving. The majority of these discussions are handled by telephone and in some cases face to face meetings. In some cases, awards were made with the request that the PI make adjustments of budgets. A context statement is also provided to the PIs. Source: Jackets	
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The Program Directors have consistently kept the time to decision short (< 6 months) which was viewed as an outstanding achievement given the heavy workload sustained by the Program Officers. The panel is concerned that the review process workload for the Program Officers is unreasonable and the current level of performance is likely unsustainable. Additional resources are warranted. Source: Jackets and Data available on Website.	YES
8. Additional Comments a) Additional comments on the quality and effectiveness of the program's use of merit review process. The intellectual merit review process was considered to be excellent and effective. The broader impacts effectiveness was less clear, as discussed in other sections of the COV report. b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? The use of ARRA funding was well-justified and clearly followed the guidelines for such grants.	

Source: document “American Recovery and Reinvestment Act (ARRA) in DMR”

A.2 Questions concerning the selection of reviewers. **Provide comments in the space below the question. Discuss areas of concern in the space provided.**

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The Program Directors go to great lengths to ensure that each proposal is reviewed by qualified professionals in the field. In addition to internal databases of reviewers, the PDs use PI suggestions when appropriate. The reviewers suggested by the PIs are also entered into the database to help PDs with finding reviewers for other proposals. PDs also made efforts to reach out to the broader communities by attending NSF-sponsored workshops and other professional meetings to increase the reviewer base. The reviewer base comes from all sectors and include international experts. Source: Jackets	**YES**
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: Every effort is made by PDs to include reviewers from across all states (even international reviewers in many cases) and from undergraduate-only institutions. These reviewers include both female and underrepresented groups, and the balance is only limited by availability. Source: Jackets.	**YES**
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments:	**YES**

[2] If "Not Applicable" please explain why in the "Comments" section.

Yes, these are documented in the diary notes by the PD. Source: Jackets and Program Director Presentations	

4. Additional comments on reviewer selection: Reviewers have been carefully selected to match their expertise with particular proposals. PDs have made the best efforts to ensure diversity in representation from geographic regions, types of institutions, gender and URGs.

A.3 Questions concerning the resulting portfolio of awards under review. **Provide comments in the space below the question. Discuss areas of concern in the space provided.**

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The quality of the supported research and educational projects is excellent. Highlights and Program Director presentations for the BMAT/POL/SSMC cluster offer multiple examples of high-impact publications and also evidence of creative and highly effective integrated education and outreach efforts. The breakout group also notes a number of high profile researchers including several Nobel Laureates among the grant awardees. Source: Highlights and Program Director Presentations.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: BMAT/POL/SSMC do an excellent job in promoting the integration of research and educational efforts. As stated in A.3.1, there are numerous examples of such integration, which include the REU Site at Tufts University focused on engaging Deaf Students in polymeric materials research and the Summer Program in Solid State Chemistry for Undergraduate Students and College Faculty.	Appropriate

[3] If "Not Appropriate" please explain why in the "Comments" section.

Source: Program Director Presentations.	
3. Are awards appropriate in size and duration for the scope of the projects? Comments: Given the funds available, the award size and duration are appropriate. If more funding is available, the scope of projects could be increased and PIs should be encouraged to submit longer duration proposals, as appropriate. However, the COV breakout group is concerned about the rising costs of graduate students/postdocs, which is adversely affecting the effectiveness of an award at the current funding level. Source: Jackets and Data available on website.	Appropriate
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? **Yes** Comments: The breakout group noticed that it is often difficult to identify potentially transformative projects. Having said that, the breakout group believes that Program Directors of BMAT/POL/SSMC did an excellent job selecting the most exciting and promising projects for funding, and it appears that appropriate balance of projects is maintained. In retrospect, several such projects turned out to be transformative of the field. A significant portion of ARRA funds were used to support CAREER and new investigator grants. Source: Highlights and Program Director Presentations.	Appropriate
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: (can combine with question 10 on p. 12)	Appropriate

BMAT/POL/SSMC have maintained a good balance of inter- and multi-disciplinary projects. The PDs have done an excellent job in funding cross-directorate, inter-division, and intra-division projects. Source: Jackets, program information, and data e.g. on jointly funded projects.	

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The BMAT/POL/SSCM cluster has a diverse portfolio of awards with an appropriate balance between CAREER, individual and multiple investigator grants. However, our 2011 COV panel reiterates what was stated in the 2008 COV, that the relative proportion of individual awards needs to be monitored to insure it stays at current levels or even increased if the opportunity arises. Source: Program Director Presentations.	Appropriate
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: BMAT/POL/SSMC have been very supportive of new investigators, especially through the CAREER program. ARRA funds were used appropriately to bolster the balance of awards to new investigators. Source: Program Director Presentations.	Appropriate
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The BMAT/POL/SSCM programs make funding decisions according to the quality of the proposals received. Some regions submit more proposals and thus receive more grants than others. EPSCOR and other NSF policies help mitigate disparities. Source: Data available on website.	Appropriate

9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: NSF as a whole and DMR programs likewise have many programs to help all institutions (research universities, PUI, HBCU, etc) competing for grants. The portfolio for the BMAT/POL/SSMC cluster is well-balanced with regard to institutional types. Source: Data available on website.	Appropriate
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: See COV panel comments made in the related question A2.Q.5 Source: Jackets and program information	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: The panel was split on this question with one group feeling the answer is "Appropriate" and the other disagreeing and feeling the answer is "Not Appropriate". We offer a summary of these two differing responses below: 1. Appropriate: Considering the number of proposals coming from the underrepresented groups, the program has an appropriate portfolio. 2. Not Appropriate: The program portfolio did not have appropriate participation of under-represented minorities that was commensurate with the national U.S. demographics. The COV was provided with data on the top 50 US Institutions in the relevant disciplines that showed an approximately equivalent pool of applicants relative to percentage of participants in DMR. It should be noted that many eligible URM candidates can be found outside of the top 50 Institutions and increased efforts in targeted outreach may diversify the pool of applicants further. The Program Directors have made great efforts in the area of under-represented groups. However, continued and increased commitment to broadening participation and increasing diversity nationally is essential. Alternatively, had the question had been, "Are the Program Directors of BMAT/POL/SSMC putting forth an appropriate level of effort to maintain and increase participation of underrepresented groups?", the panel would have been in agreement. However, this is not the way the question was	PANEL SPLIT

worded. Source: Data available on Web and Program Director Presentations.	
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: During the review period there have been a number of timely initiatives which guided the programming within the clusters (e.g. NSF NCI joint initiatives on physical science of oncology, SOLAR, EFRI, SCIART, MWN). BMAT/POL/SSMC have also been informed by activities and reports such as the report from the workshop on Interdisciplinary Globally-Leading Macromolecular Science and Engineering, the NRC report "Inspired by Biology (2007)", and a 2009 NRC report, "Frontiers in Crystalline Materials: From Discovery to Technology", and a 2010 NAS Report on Research at the Interface of Physical and Life Sciences. The program clusters place a high value on national priorities and issues in education, national competitiveness and diversity and uses this information to shape the development of the research portfolio. Source: Program Director Presentations and information on DMR COV website under public attachments.	Yes
13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards). The panel found there is an appropriate number of IIA vs CAREER awards. Panel feels that the dollar amount allocated to IIA grants should not decrease relative to other funding areas within DMR. ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?	

A.4 Management of the program under review. **Please comment on:**

1. Management of the program. Comments: BMAT/POL/SSMC are very well managed with clearly articulated goals, objectives, and metrics. Getting more proposals processed and funded despite reduced staff is a monumental tribute to their resourcefulness. The Program Officers have done an excellent job in the daunting task of managing recruitment of qualified reviewers. Each program has used a combination of ad hoc and panel reviews appropriately. The programs have been historically technically diverse and are still evolving and the Program Officers effectively manage this portfolio. While the programs have been extremely effective, the panel recognizes that the Program Directors are carrying a large workload and in order to continue the level of excellence going forward, additional resources in terms of staff would be helpful.
2. Responsiveness of the program to emerging research and education opportunities. Comments: During the review period there have been a number of timely initiatives to which the program cluster have contributed (e.g. NSF NCI joint initiatives on physical science of oncology, SOLAR, EFRI, SCIART, MWN). BMAT/POL/SSMC have also been informed by activities and reports such as the report from the workshop on Interdisciplinary Globally-Leading Macromolecular Science and Engineering, the NRC report "Inspired by Biology (2007)", and a 2009 NRC report, "Frontiers in Crystalline Materials: From Discovery to Technology", and a 2010 NAS Report on Research at the Interface of Physical and Life Sciences. The program clusters place a high importance on how national priorities and issues in education, national competitiveness and diversity shape the development of the research portfolio.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

As discussed above, program planning is driven by external scientific and national priorities, informed by workshops, academy reports, etc. Prioritization of funding is driven primarily by reviews (ad hoc and panels). Priority was given to new and young investigators for funding at the boundary. ARRA funds were also used to support funding of new and young investigators.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

The Program Officers reported changes made in response to the previous COV and they are clearly responsive to external suggestions and advice. The BMAT/POL/SSMC cluster has improved review responsiveness to the Broader Impacts criteria. For example, in panel reviews, the Program Officers are able to extract meaningful evaluation of broader impacts from the reviewers. In the case of ad hoc and mail reviews, more effective communication to reviewers on how to evaluate broader impacts is recommended. The COV breakout group recognizes that this is not an issue isolated to this cluster but a NSF-wide problem. Strategically, the Program Officers increased the size and duration of awards by improved management of their budget mortgages.

5. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*"

This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:
Research from the BMAT/POL/SSMC cluster contains exciting and transformative research. The panel has highlighted several informative examples.

DMR-0704192 (POL), "Discovery of New Phase in Diblock Copolymer Melts." PI: Frank S. Bates (University of Minnesota). Bates reports the discovery of a new polymeric ordered morphology corresponding to a crystal structure known as the sigma-phase, first described by Frank and Kasper more than 50 years ago. Diblock copolymers, the simplest form of this versatile class of macromolecules, have previously been known to self-assemble into four types of ordered structures: spheres arranged on a BCC lattice, cylinders, lamellae and the bicontinuous gyroid. This recent discovery has identified a new packing arrangement for sphere forming block copolymer melts, characterized by tetragonal symmetry with 30 spheres per lattice point. This work was published in Science (2010, 330, p. 349) and picked up by popular media outlets (NPR October 2010).

DMR-0512156 (POL), "Materials from Nature: Spider Silk as an Artificial Muscle." PI: Ali Dhinojwala (U. of Akron). The research group of Prof. Dhinojwala (U, Akron) have discovered new ways to stimulate artificial muscles by studying the behavior of natural silk fibers as a function of the environment (e.g. humidity). This is a transformative discovery the learning of which could be applied to artificial bio- and non-mechanical systems to carry repetitive and heavy workloads to benefit individuals and the society. The work was published in the Journal of Experimental Biology, which is also added a Perspective, received coverage in the popular press, e.g. in Cleveland and was the subject of a U. of Akron press release.

DMR-0803103 (BMAT): "New Block Liposome Vesicles Discovered" PI: Cyrus Safinya (UCSB). This research falls under the category of new materials discovery and produced novel self-assembled anisotropic rod-like hybrid block liposomes with high stiffness that may have practical applications as templates for nanoscale wires and needles for use in nanoscale circuitry or nanodevices and targeted therapeutic transport of drugs and genetic material.

DMR – 0745786 (BMAT): "Biological Membrane Mimics Respond to Light", PI: Linda Hirst. This unique research studies interesting light-induced phenomena in a membrane model of the living cell membranes. The researchers have demonstrated that long, uniform cylindical membrane tubules respond to illumination by reorganizing into a shape resembling a string of beads. The new and interesting results provide an unusual glimpse into how cell membranes respond to the stress placed on it by external stimuli. The phenomena observed provide an additional mechanism by which processes in living cells may actually occur.

The SSMC program is highly multidisciplinary and consists of a very broad portfolio of awards. The program has been responsive to emerging discoveries and societal needs, through co-funding with other programs and being actively involved in multidisciplinary solicitations such as SOLAR, EFRI, and SCIART. In doing so, the Program Directors foster cutting-edge research that will advance and maintain the position of the U.S. science as a global leader. A number of projects funded by the SSCM program have already resulted in major advances and changed the directions of the field; in some cases, potentially transformative research has resulted. Examples of these accomplishments include the discovery of inorganic Zintl compound thermoelectric materials (Susan Kauzlarich, DMR-0600742) and development of improved methods for graphene functionalization (Jiaxing Huang, DMR-0955612).

B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

The BMAT/POL/SSMC cluster supports awards that are cutting edge in fostering education and inclusivity. The panel has highlighted several representative examples.

DMR-00645586 (POL): "Inspiring Mentoring Leads to the Next Generation of Role Models." PI: Thomas Epps III (University of Delaware). Epps, a young investigator supported by a CAREER award, has developed a very dedicated and multifaceted set of outreach activities focused on underrepresented-minority students. He is assisting Delaware State University (DSU), which is one of America's first land-grant and Historically Black institutions of higher learning in evolve into a fully accredited and diverse university. Working with the Chemistry Department at DSU, they have developed a web-based polymer science course, which is planned to be a critical component of a future Polymers Concentration at DSU. He is also providing lecture notes for a polymers course and consulting on developing laboratory facilities and exciting polymer experiments at DSU.

DMR-0906455 (POL): "An Internship Opportunity for Deaf and Hard of Hearing Students in Polymer Blends." PI: Peggy Cebe (Tufts University). Prof. Cebe (Tufts U), through her proton exchange membrane (PEM) hydrogen fuel cell work, provides a unique opportunity for deaf and hard of hearing students to participate in an exciting research program in the renewable energy field, which is critically important to the nation.

DMR-0706431 (BMAT): "Viruses Fall into Line: Synthesis of Composite Nanofibers by Controlled Self-assembly of Tobacco Mosaic Virus." PI: Qian Wang (University of South Carolina). The PI has developed a program "Adventures of BioNanotechnology" for High School Students where more than 120 high school students from South Carolina, North Carolina, Georgia, and Florida attended this program since 2004. The program includes lectures, experiments, field trips and discussion related to the PIs research.

DMR – 0846363 (BMAT); "Adaptable biomaterials that enable cell-induced remodeling and drug delivery", PI: Sarah Heilshorn. This researcher's laboratory hosted two high school students from under-represented minority. With the guidance of a graduate student mentor, the high school students performed independent research projects and prepared posters describing their results. Both students are interested in pursuing science or engineering and would be the first of their families to attend college. Through DMR support, graduate student Nicole Romano was selected as a US representative to attend a meeting of Nobel Laureates in Lindau, Germany and she presented highlights of her inspiring trip to other students after returning.

DMR (SSMC); The SSMC program has a long tradition of promoting the integration of research and education, for example, by supporting the Summer Program in Solid State Chemistry for Undergraduate Students and College Faculty (DMR-0804648). A number of participants of these programs have gone on to pursue careers in science and engineering in academia and industry. The SSMC program places a strong emphasis on encouraging active participation from students at all career stages (K-12, undergraduate, graduate, and postdoctoral fellows) and from the underrepresented groups. An example of such activities is exposing students to international experience by participating in I-CAMP summer schools in China and Argentina that were organized by a SSMC PECASE/CAREER awardee (DMR-0847782).

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

This category includes facilities, research instrumentation, and cyberinfrastructure.

Comments:

While generally, the programs managed by the BMAT/POL/SSMC cluster do not concentrate solely on research infrastructure, notable examples can be found in the programs where there is a high impact upon the national facilities and advanced instrumentation. For example, DMR-Polymers manages a Science and Technology Center (STC). DMR-0423914 (POL), "Center for Layered Polymeric Systems (CLiPS)", PIs: Eric Baer and Anne Hiltner (Case Western Reserve and affiliated partners). The PIs have constructed a unique technological center (STC), CLiPS which focuses on a powerful set of technologies concerning "forced assembly", or the multilayering of two polymers using layer multiplication coextrusion techniques. Their processing capabilities and tools are one of a kind in the world. They have recently reported the confined crystallization of polyethylene oxide in nanolayer assemblies. They discovered a morphology that emerges as confined polyethylene oxide (PEO) layers are made progressively thinner. When the thickness is confined to 20 nanometers, the PEO crystallizes as single, high-aspect-ratio lamellae that resemble single crystals. Unexpectedly, the crystallization habit imparts two orders of magnitude reduction in the gas permeability. This work was published in *Science* (**2009**, *323*, p. 757-760).

CERAMICS, ELECTRONIC AND PHOTONIC MATERIALS, AND METALS AND METALLIC NANOSTRUCTURES CLUSTER REVIEW (PARTS A and B)

Date of COV: *February 9-11, 2011*

Program/Cluster/Section: CER/EPM/MMN

Division: Division of Materials Research

Directorate: Mathematical & Physical Sciences

Number of actions reviewed:

Status	2008	2009	2010
Awards	8	24	22
Declines	11	16	8
Other			

Total number of actions within Program/Cluster/Division during period under review:

Status	2008	2009	2010
Awards	70	119	91
Declines	325	271	296
Other			

Manner in which reviewed actions were selected:

15 Proposals from Each Program

- 5 Clear Awards/Declinations
  - 2 Awards
  - 2 Declinations (including one renewal)
  - 1 Creativity Extension

- 5 Awards in the Decision Interval
  - 1 Renewal
  - 1 New proposal
  - 1 RUI
  - 2 Other

- 5 Declines in the Decision Interval
  - 2 Declined Renewals
  - 2 Declined New (young and established)
  - 1 Other

10 Proposals culled from the different programs in each breakout

- 2 Specialty proposals in Each Breakout (1 award and 1 declination from each solicitation)
  - SciArt
  - Solar
  - SI2
  - CDI
  - Etc.
- Co-reviewed Proposals (1 award and 1 declination)
  - Between Programs

Between Divisions

Between Directorates

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE**[4]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The use of panel and ad hoc review methods are appropriate and sufficient (site visits are not used for reviews in CER/EPM/MMN). Also reviews are carried out by Program Directors in certain special cases (e.g. RAPID). Co-reviews are performed between programs in cases of potential overlap and are valuable for both identifying proposals submitted to multiple programs and for enhancing the quality of the reviews. Co-reviews (e.g. joint panel reviews and ad hoc reviews between electronic materials in DMR and electronic devices in ENG) serve to educate panelists and ad hoc reviewers as to the nature of proposals and research in various sub-disciplines, and to better evaluate proposals that span more than one disciplinary area. Source: Jackets and Program Director Presentations.	YES
3. Are both merit review criteria addressed	
a) In individual reviews?	YES
b) In panel summaries?	YES
c) In Program Officer review analyses?	YES

[4] If "Not Applicable" please explain why in the "Comments" section.

Comments: Yes, individual reviewers and panel summaries highlight relevant issues to varying extents and place different emphases on various strengths and weaknesses of proposals. They address both merit review criteria. Source: Jackets	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: In most cases, the individual reviewers provide substantive comments. When comments are not sufficient or comments are in apparent conflict with the assigned scores or other reviewers, the program officers supplement the reviews with additional reviews and place the reviews in appropriate context in the review analysis. It was noted that ad hoc reviews tend to be more detailed, but panel summaries generally provide consensus about a proposal that may not be achieved via ad hoc review. Source: Jackets	YES
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Panel summaries provide sufficient rationale for the panel consensus. We note that panel consensus is nearly always achieved. In one instance when panel consensus was not achieved in a reasonable time frame, the program officer recruited additional ad hoc mail reviewers after the panel to reach a decision. Source: Jackets	YES

5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) iii) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. iv) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: The jacket presents the complete rationale for the award decision. ARRA funding did not result in reversing any decisions in CER and MMN. Two proposals at the accept/decline boundary in EPM were reversed to acceptance in 2009 as a result of the ARRA stimulus funding. ARRA dollars simply allowed for awards near the funding boundary to be carried over as an actual award. Source: Jackets	YES YES YES

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The PI receives the reviews (and the panel summary if a panel was used). The PI is encouraged to phone the program director for a more detailed analysis since they do not see the program director review analysis.	YES

Most of those who are new to the system or have a proposal that fell just under the threshold of the funding boundary will call the program director to discuss the proposal review results. Some program managers alert the PI (via email or phone) to the fact that a decision has been made and encourage a discussion. We consider this alerting the PI of the possibility to discuss results by phone to be a valuable practice, particularly for new proposers. Source: Jackets	
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The NSF goal is that decisions should be reached for 70% of proposals within 6 months of submission, and this goal has been exceeded during the majority of the three year period under review. Data for the technical sections are given below: Area (FY08 and FY10) CER 83% and 97% EPM 97% and 93% MMN 88% and 69% Data is not reported for 2009 due to the ARRA funds infusion which distorts the data. Source: Jackets and Data available on Website.	YES

8. Additional Comments

c) Additional comments on the quality and effectiveness of the program's use of merit review process.

d) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

NSF was required to place a statement regarding the use of ARRA monies in the review analysis and at the top of each abstract. This documentation was carried out in these programs and provided this rationale.

Source: document "American Recovery and Reinvestment Act (ARRA) in DMR"

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[5]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: A wide spectrum of reviewers was used and in general proposals received reviews from clear experts in the field. Source: Jackets	YES
3. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: The reviews reflected a good distribution of geographic area and institutional type. Underrepresented groups were also included in the distribution of reviewers. Choosing reviewers from undergraduate institutions was felt to be an important component of this overall mix because this assists faculty members at these institutions in keeping current in their fields, exposes them to the proposal process, and encourages them to consider submitting proposals to the RUI program. Source: Jackets.	YES
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments:	YES

[5] If "Not Applicable" please explain why in the "Comments" section.

No conflicts of interests were evident in the choice of reviewers. Also, the lack of self-reported COI by reviewers suggests that the Program Directors do an excellent job in identifying such conflicts. Source: Jackets and Program Director Presentations	

4. Additional comments on reviewer selection:

The quality of the reviews received depends entirely on the expertise, effort, and communication skills of the reviewers. Reviewer selection is thus a key step in the review process. The program directors should take every opportunity at review panels, in communication to ad hoc reviewers, and during outreach presentations to educate and remind the review community as to the importance of substantive reviews.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	**APPROPRIATE,** **NOT APPROPRIATE[6],** **OR DATA NOT AVAILABLE**
1. Overall quality of the research and/or education projects supported by the program. Comments: **Quality of research projects:** Information found in the Highlights was very helpful. The overview presentations showed impressive figures with respect to how many students (undergrad and graduate) and post-docs were impacted by the funded programs. The general conclusion was that the funded research topics were timely and the awarded programs were strong. **Quality of education** It appeared that there were not many projects that specifically addressed education only, but that the education component was addressed in the "broader impacts" section of the proposals. PIs should be encouraged to utilize 1) personnel who are familiar with pedagogy and 2) existing programs on campus to assist them with the design and implementation of efforts to address broader impact areas related to education / outreach / diversity. A good example was cited of a PI who proposed working with a faculty colleague in the social sciences to examine issues of gender equity in science and engineering. The emphasis for the individual PI should be on quality and effectiveness of the proposed broader impacts, and not quantity or innovation just for innovation's sake. Larger proposals tend to put more effort into consulting with groups on campus to address broader impacts. An effort also needs to be made to educate the reviewing community as to how to evaluate the broader impacts components of proposals; doing so	APPROPRIATE

[6] If "Not Appropriate" please explain why in the "Comments" section.

should improve the consistency and quality of the reviews. Source: Highlights and Program Director Presentations.	
2. Does the program portfolio promote the integration of research and education? Comments: Program directors do give advice to PIs, encouraging them to rebalance research and education components of their proposals and to adjust proposal budgets as appropriate. Broader impacts involving the integration of research and education can be achieved in many ways. We strongly suggest that individual investigators be encouraged to focus their efforts on one or two broader impacts activities based on their strengths and interests and to exploit the particular strengths of their institution and department in this regard. In this way, the portfolio of many grants will combine to have the most effective integration of research and education outcomes by building on local strengths with reasonable effort. We note that too much effort at the individual investigator level on reinventing well-developed approaches or on new innovations may be less effective in terms of outcomes. We encourage program directors to communicate these aspects of value to integration to individual investigators. For CAREER proposals, education is an important component, and perhaps emphasized more than in other individual investigator proposals. However, this question is related to the larger issue of broader impacts discussed above. PIs need to be further educated on how to incorporate education into the broader impacts section and reviewers on how to evaluate education and broader impacts. Also it is important for PIs to provide feedback to program directors regarding broader impacts. While PIs do respond to the broader impacts area in their highlights and reports, they do not always include their results of prior accomplishments in subsequent proposals. PIs should continue to be encouraged to discuss the integration of research and education in all aspects of their reporting. Source: Program Director Presentations.	APPROPRIATE
3. Are awards appropriate in size and duration for the scope of the projects?	APPROPRIATE GIVEN CURRENT

Comments: There is a clear need to stretch the funding amongst worthy PIs given the current level of available funding and the large number of high quality proposals that are not funded. At the same time it is critical that the average award size remain large enough to support at least one graduate student. The program directors need maximum flexibility in making awards to fund at least one student full-time for three or four years, High risk innovative research benefits from interactions between students. A priority should be given to finding ways to fund two students on the same grant. This would enhance our nation's competitiveness and drive innovation. Additional funding is needed to achieve this goal. Source: Jackets and Data available on website.	BUDGET CONSTRAINTS
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: MMN Specific: The portfolio contains a spectrum of projects with diverse applications in a traditional area of materials science. It includes projects that will continue the development and characterization of structural materials, which are critical to the defense, economy, and infrastructure of the US. Cutting edge research involves 1. The behavior of materials at small length scales, an understanding of which is crucial to advancing the field of nanotechnology. 2. Development of new materials including shape memory foams that can undergo a 9% strain, which will enable actuators and sensors. 3. Bulk metallic glasses, which have gained renewed interest due to recent advances in thermoplastic forming. EPM Specific: Project funding within the EPM Program reflects the interdisciplinary nature of the field and supports a balance of traditional and emerging research topics. This includes research on silicon and III-V semiconductors, which are integrated into commercial devices, and emerging	APPROPRIATE APPROPRIATE

materials such as organics, carbon-based devices and nanostructures. CER Specific: Yes, there does appear to be appropriate balance. For example, ARRA awards support research in solid oxide fuel cells advancing understanding of the interrelationships between defect chemistry/structure and diffusion that is essential to the advancement of SOFC devices. Additionally, the work on Fe-based high temperature superconductors is another strong example of innovative work. The RAPID award made in CER in an effort to address the gulf oil spill is of particular interest. This is a good example of innovation in the presence of a crisis that addresses a national need. The ARRA portfolio reflects a similarly wide spectrum of proposal topics and balance of traditional and emerging research topics for each of these topic areas. Source: Highlights and Program Director Presentations.	
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: (can combine with question 10 on p. 12) MMN Specific: About half of the projects in MMN have two or more investigators. Additionally there are projects that are funded between programs, and collaborative efforts that cannot be captured with statistics. EPM Specific: Approximately 30% of the projects supported by EPM involve two or more investigators. These are funded through the individual investigator programs as well as through focused research group projects and collaborative proposals. EPM co-funds a number of projects with other programs and divisions within NSF, in particular, with the Electronic Materials and Devices Program within the Engineering Directorate. CER Specific: Both interdisciplinary awards and multidisciplinary awards exist within CER. This can be supported by several different metrics. For example, 13% of the funded projects were Materials World activities, 25% of the projects were co-funded (multiple divisional support), and ~40% of the projects have multiple investigators. Source: Jackets, program information, and data e.g. on jointly funded projects.	APPROPRIATE
6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The program portfolio does contain an appropriate balance of award sizes.	APPROPRIATE

The size of awards scales with the number of investigators, but not linearly. There were about 60% single investigator awards, ~25-30% two-person awards, and 10-15% three- and four-person awards. This seems appropriate for the program. Also, while multiple investigator awards tend to be larger than single investigator awards, there are synergies involved in combining investigator efforts. Thus the funding for multiple investigator awards would not be expected to increase in direct proportion to the number of investigators and this is the case. We note the size of awards can also be a function of the type of institution, e.g., primarily undergraduate vs. larger research institutions. Source: Program Director Presentations.	
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PIs or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: The program portfolio has an appropriate balance of awards to new investigators through the CAREER program and awards to established individual investigators. In response to the 2008 COV, the programs made a specific effort to increase the number of new investigator awards and this effort was aided by ARRA funds. For example, ARRA funds supported funding for six new PIs within EPM, two in MMN and three in CER. The COV recognizes the importance of continued support for new PIs. CAREER awards, in particular, are highly regarded by the academic community. Source: Program Director Presentations.	APPROPRIATE APPROPRIATE
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The program portfolio exhibits an appropriate geographical balance and distribution across the country. Certain regions of the country receive a higher proportion of funding, but this is in line with the number of major research institutions that are located in those areas. Source: Data available on website.	APPROPRIATE

9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: A review of recent awards in EPM, CER and MMN indicates support for a variety of institutional types. In addition to major research institutions with traditional strengths in materials, awards have also been made to investigators at predominantly undergraduate institutions, historically black colleges and universities (HBCU) and colleges and universities in EPSCOR states. There have also been several awards to art museums through the SCIART program. Source: Data available on website.	APPROPRIATE
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: MMN Specific: The portfolio contains projects related to traditional metallurgy topics as well as cutting edge research in materials development and characterization. EPM Specific: Program awards reflect the interdisciplinary nature of the research. The majority of scientists supported by this program are affiliated with Physics, Chemistry, Materials Science and Engineering or Electrical Engineering Departments. CER Specific: Program awards in CER reflect the fact that research and scholarship in material science and engineering necessarily involves investigators with a wide array of backgrounds and discipline affiliations. Source: Jackets and program information	APPROPRIATE
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: The program managers are to be commended for their efforts to encourage the participation of underrepresented groups. The percent of awards to female and minority investigators is substantially higher than their current average representation within the academic faculty of their respective disciplines. Given the generally low number of female and minority investigators, the COV believes that the funding percentages are appropriate to encourage participation of these underrepresented groups in science and technology.	APPROPRIATE

Source: Data available on Web and Program Director Presentations.	
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The project portfolios directly address issues relevant to national priorities and the agency mission. Specific examples include Science and Engineering Beyond Moore's Law within EPM, the EPM solar initiative done in collaboration with the mathematics and chemistry areas of NSF, research in MMN on structural metals to address the 2009 Infrastructure Grade Report from the American Society of Civil Engineers and RAPID research awards through CER to address oil spill clean-up and recovery. The programs have also made effective use of the American Competitiveness and Innovation Fellows to recognize transformative research and broaden participation of underrepresented groups. Source: Program Director Presentations and information on DMR COV website under public attachments.	YES

13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards). ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: This program cluster is being well managed with active attention to instituting improvements by all the program directors. The panel applauds a number of special actions carried out within this cluster, including program director initiatives to proactively engage the technical community through PI workshops, outreach, presentations, young investigator mentoring, and technical coordination and publications. These activities and the concurrent high level of program director engagement were felt to be beneficial to the entire disciplinary area and are suggested for consideration as 'best practices' across all DMR program areas. We also note that the program director considerations go well beyond proposal review scoring with in depth analyses of the content of review reports, including taking into account the detailed strengths and weaknesses identified in the reviews, identifying any

fatal flaws in proposals, taking into consideration broader NSF goals including sensitivity to underrepresented groups, and maintaining consistency and balance within their program areas while ensuring a high quality program. The panel notes that this high level of program performance can only be maintained by providing adequate staffing and that if continued growth in proposal submissions occurs it will be essential to provide some increase in staffing or other solution.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

There is good awareness of emerging research areas and responsiveness to important developments has been good. Examples include the RAPID grants related to the Gulf oil spill which were reviewed and awarded on an extremely rapid basis (~6 weeks), the solar initiative which was carried out jointly with chemistry and mathematics divisions, the American Competitiveness and Innovation Fellows program which involved supplemental grant support and extensions for a number of meritorious grantees, and consideration of national initiatives such as the American Civil Infrastructure (ASCE Report) and American Competitiveness (e.g. Integrated Computational Material Engineering) areas.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

There has been very good responsiveness to NSF goals and national priorities (such as in competitiveness and energy/environment initiatives). We also commend the responsiveness to the major opportunity provided by the ARRA initiative support and the panel felt that the rational and use of these one-time funds were well done with consideration for future needs. For example, not only were success rates for new investigators increased but planning has provided for a sustained effort to continue these improved rates in CAREER awards. As another example, there has been active consideration given to increasing the grant period (e.g. from typical 3 year to 4 year awards) where appropriate (for example for particularly high level proposals or sustained performance) and program directors have been proactive in managing this evolution in program duration. In addition, there has been strong engagement with other divisions within NSF in the joint reviewing and funding of proposals as well as attention to the transfer of proposals between program areas and different divisions in order to ensure a well-coordinated treatment of submitted proposals.

4. Responsiveness of program to previous COV comments and recommendations. Comments: The program directors have been responsive to previous COV recommendations and comments in a number of areas. For example, regarding the trade-off between funding rate and award size a concerted effort has been made to increase the size of CAREER awards from $80K/yr. to $90K/yr. and goals set to further increase this to $100K/yr. in the ceramics area. Further, the cluster area has also been responsive to concerns to increase participation by underrepresented groups, to improving the effectiveness of highlights and to getting the message out about Foundation goals and changes to their technical community.
5. Additional comments on program management: We note that there are clear awards and clear declinations for some proposals, whereas proposals at the boundary often take a significant amount of time. Considering the heavy work load on program directors, proposals should be handled as efficiently as possible, It may be worthwhile to consider methods for reducing pressure on program directors and the reviewing community by streamlining the review process for proposals that are clear declinations. In such cases, two concurring reviews could be sufficient to make a recommendation compared to the usual three. Additionally we suggest that abbreviated program director review analysis be provided for clear declinations.

PART B. RESULTS OF NSF INVESTMENTS

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: ***"Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."***

This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:

The 54 awarded proposals that were reviewed provide many excellent examples of research highlights that have or are anticipated to lead to fundamental discoveries with significant impact demonstrating global leadership in fundamental and transformational science and engineering. NSF/DMR continues to push frontiers of materials research through funding of the most competitive research proposals.

Specific examples include:

DMR-0846573l; **CAREER: Spin Injection and Transport in Germanium Nanowires**; PI: Emanuel Tutuc; This research has developed spin injection on vapor-liquid-solid grown germanium nanowires through tunnel junction based magnetic contact structures. Multi-terminal devices have demonstrated spin valve detection which is sensitive to the relative polarization of the ferromagnetic contacts. Spin injection and control in semiconductors represents a key ingredient for exploiting the spin degree of freedom for information processing.

DMR-0602716; **Materials World Network: Combining Compound Semiconductors with Polymers for New Optoelectronic Capabilities**; PI: Terry Alford; This project, which is a collaboration between Arizona State University and researchers at the University of Western Cape in South Africa, demonstrated the integration of indium phosphide onto plastic substrates by combining semiconductor device materials with flexible substrates by a smart cut transfer technique using ion irradiation and microwave annealing. The integration of functional materials onto low cost substrates offers the possibility of achieving new performance of materials and devices with greater flexibility enabling new applications in solar cells and displays.

DMR-0507146; **Alchemy Made Possible by Strain**; Collaboration between Nanotechnology Interdisciplinary Research Team (NIRT) and three Materials Research Science and Engineering Centers at Cornell University, Penn State University and Ohio State University (24 scholars). These theorists proposed a route for simultaneously achieving ferromagnetism and ferroelectricity that if true can be applied to a multitude of materials. This work shows that strain is a viable means to dramatically alter the properties of thin films.

DMR-0404972; **Temperature Effects on Borosilicate Glass Structures**; P.I. Jonathan Stebbins; High-resolution nuclear magnetic resonance (NMR) spectroscopy is used to detect and quantify changes in borosilicate glass. Oxide glasses rich in silicon, boron and aluminum are widely used in high-tech materials ranging from composites to liquid crystal displays. The influence of temperature on changing the structure of glass is being directly measured. This advances the understanding of glass manufacturing and ultimately their application, as there is currently little known about how these bonding arrangements are modified within the glass structure as a function of temperature.

DMR 0956171; **CAREER: Very Large Magnetoresistance in Graphene Nanoribbons for High Performance Electronics**; PI: Xiangfeng Duan; This project has demonstrated graphene nanoribbons and nanomeshes with tunable bandgaps and investigated their fundamental electronic properties. A physical assembly method was developed to fabricate top-gated graphene field-effect transistors that exhibit a record cutoff frequency of up to 300 GHz. A significant enhancement in the conductance of the graphene transistors was observed under a perpendicular magnetic field resulting in a large negative magnetoresistance at room temperature. This work represents the first discovery of very large and tunable magnetoresistance in graphene nanoribbons.

DMR-0804744: **Novel Nanostructures for High-Energy Permanent Magnets** PI: Jeffrey E. Shield

This project develops novel ways of combining two magnetic materials for use in high-energy permanent magnets. Higher energy densities can be achieved by assembling two different kinds of magnetic materials at the nanoscale, as short-range interactions result in superior properties. The invariant point that naturally separates a material as it freezes is used to control the scale of the microstructure.

DMR-0804984 **Foams with Magnetic Memory,** PIs: Peter Mullner and David Dunand

Shape-memory alloys "remember" their shape on cooling below a certain temperature. Magnetic shape-memory alloys (MSMA) respond to magnetic fields instead of temperature, by expanding or contracting, typically with a strain on the order of 0.12%. This project makes metallic foams of a MSMA alloy which attains strains as high as 8.7%, which potentially enables their use for sensors and actuators.

DMR-0955338: **Grain Boundary Engineering,** PI: Andrea Hodges

Nanocrystalline materials exhibit high strengths due to their small grain size. The presence of nanoscale growth twins controls the characteristics of other boundaries, improves mechanical properties and stabilizes the microstructure. By control of the evolution of growth twins (i.e., grain boundary engineering) it will be possible to achieve extremely high strengths.

B.2 OUTCOME GOAL for Learning: ***"Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."***

This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

The 54 awarded proposals that were reviewed have a strong component of education and career development for undergraduate students, graduate students, K-12 teachers, and postdoctoral researchers. These activities, taken together, have provided training and have cultivated a world-class, broadly inclusive science and engineering workforce.

DMR 0513968; **A Common Sunscreen Material Emerges as a Promising Semiconductor,** PI: Leonard Brillson; This project provided summer research opportunities for several female high school students from the Columbus School for Girls. Over a three year period, the high school interns worked in Dr. Brillson's laboratory on the characterization of ZnO nanostructures and devices.

DMR 0804433; **Optical Science Discovery Program**; PI: Miriam Deutsch; This project supported a one-week summer camp for girls which explored the optical sciences. Using ordinary household items and high tech laboratory equipment, the girls learned about waves, the electromagnetic spectrum, human vision, astronomy and lasers. The week culminated in small group presentations and the demonstration of a laser communication system which the high school students had assembled. A moderated Facebook page was developed to enable participants to remain in contact and return to campus on a regular basis to participate in monthly Spectrum Club activities.

DMR 0704197; **Electronic Raman Scattering in Metallic Carbon Nanotubes**; PI: Mildred Dresselhaus; This project supported the PIs continuing participation as the conference summary speaker for the NTXX Carbon Nanotube Conference. This week-long conference is the centerpiece of the carbon nanotube field including numerous invited and contributed talks covering every aspect of carbon nanotube science and applications. For the past ten years, the PI has given the conference summary presentation, highlighting the advances that have been made over the past year and identifying open issues and research opportunities. 2009 marked the 10th year that the PI provided this service to the carbon nanotube community to promote the advancement of this important field.

DMR 0804583; **A Freshman Seminar Course on Solar Energy and the Environment**; PI: Xiaoyang Zhu; This project supported the development of a new freshman seminar entitled “Solar Energy and the Environment” which focused on critical issues of global warming and the new energy crisis. The course was the most popular freshman seminar course at the University of Minnesota. It included lectures, discussions and debates as well as in-class experiments and student presentations.

DMR 42740; **Microstructural and Chemical Mapping of Solid Oxide Fuel Cell Electrodes**

PI: S. Barnett

In this program three-dimensional images of the oxides in an electrode were obtained through advanced electron microscopy techniques. This was a collaborative program involving multiple institutions (Northwestern, University of Washington, University of Michigan, UC-Irvine, Rutgers). The preparation and characterization of some of the samples in this study were carried out by Sherri Dukes, a research experience for teachers (RET) high school chemistry teacher, and she was included as a co-author on two publications arising from this work. Subsequently, Ms. Dukes helped to develop a solid oxide fuel cell demonstration, which she used in her grade 11-12 classroom to initiate discussions on various topics related to energy, fuel cells, matter transport, and chemical reactions. This program impacted a large number of students at both the college and high school levels.

DMR 0804770; **Enhanced Photochemical Reactions** PI: Gregory Rohrer

In this program, two undergraduate students worked together for 10 weeks in the summer to study the photochemical properties of self-cleaning surfaces. The students, both from underrepresented groups, developed a technique to deposit films on surfaces and then to monitor photochemical degradation by Atomic Force Microscopy. One of the students comes from another institution, which is also likely to benefit from her summer research experience. Historically, 70% of the students from underrepresented groups who have worked in the PIs lab have continued on to graduate school.

DMR 0652634; **Materials and Engineering for a Sustainable Future,** PI: David Richerson

The PI on this program formed a partnership between the MS&E Department at the University of Utah and local 5^{th} and 6^{th} grade classes. The objective was to help the young students learn about key issues related to energy so that they could plan and implement community outreach projects. They conducted effective outreach on energy conservation, alternative fuels, renewable energy sources, and recycling. The multi-year effort of one class culminated in a state law to decrease school bus idling. Another outcome is a local Festival of Science and Art which involves broad participation from a variety of community organizations. This program has been very effective in mentoring grade school students, and in educating, involving, and impacting the community.

DMR-0800048: **Virginia Tech Summer Experience**, PI: Yu U. Wang

High school students attended a seminar on computational materials research presented by the PI and his graduate students and ran programs on Virginia Tech's Supercomputer thereby gaining experience with advanced computational tools.

DMR-0907616: **Experience Engineering Camp**, PI: Matthew N. Cavalli

High school students carried out metal casting, fabrication of composites, computer bridge design, production of ethanol and flight training for unmanned aerial vehicles under the guidance of the PI. Final reviews of the students included "Awesome!" and "I love this program!".

B.3 <u>OUTCOME GOAL for Research Infrastructure:</u> "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

This category includes facilities, research instrumentation, and cyberinfrastructure.

Comments:

The funded awards through the electronic and photonic materials, ceramics, and metals and metallic nanomaterials do not have large investments in research infrastructure. Large investments can be found through the MRSEC and research instrumentation programs. However development of useful instrumentation, tools and experimental techniques are found within these research clusters and contribute to the national research infrastructure. A few examples include:

DMR 0449933; **CAREER: Ultimate Limits of Dopant Junctions in Nanowires**; PI: Lincoln Lauhon: This project developed a technique to use atom probe tomography to quantitatively profile the dopant concentration in silicon and germanium nanowires as small as 30 nm in diameter that were grown by the vapor-liquid-solid technique. The results demonstrated that junction abruptness is limited by the dopant solubility in the liquid catalyst and provided directions for improving dopant control in semiconductor nanowires.

DMR 0449422; **Time-Resolved Electrostatic Force Microscopy of Polymer Solar Cells**; PI: David Ginger: This project developed a method to use time-resolved electrostatic force microscopy to directly map variations in local charging rates when donor/acceptor polymer blends are illuminated. The maps provide information on regions of loss in these photovoltaic blends thereby pointing to ways to improve solar cell efficiency.

DMR 0804631; **Image Contrast in Atomic Resolution STEM** PI: Susanne Stemmer: In order to obtain quantitative composition information from scanning transmission electron microscopy (STEM) analyses, accurate knowledge of the sample thickness is required. This project developed a new technique to locally measure specimen thickness in STEM measurements. Using this new method, known at position-averaged convergent beam electron diffraction (PACBED), experimental and simulated patterns are compared to provide local thicknesses with an accuracy of 1 nm or better.

DMR 0907030; **Three-Dimensional Microstructural and Chemical Mapping of Solid Oxide Fuel Cell Electrodes: Processing, Structure, Stability, and Electrochemistry**; PI: Collaborative Research: The limited quantitative information available on electrode structure and interfacial chemistry poses a major barrier to fundamental understanding of fuel cell performance and stability. This Focused Research Group is examining the relationships between the processing, structure, and electrochemical properties of key SOFC materials, utilizing a set of tools based on focused ion beam - scanning electron microscopy (FIB-SEM) to determine the microstructure of SOFC electrodes in three-dimensions (3D). The availability of this 3D microstructure information will be instrumental for transforming our understanding of how fuel cell electrodes work to a more quantitative science. Broad impacts of the project include the continued growth of a 3D structural data library available to researchers/developers nationwide, and development of analysis tools relevant to the broader 3D microstructure community.

DMR 0706606; **Phase Transformations in the Hafnia-Tantala-Titania System,** PI: Waltraud M. Kriven: High temperature diffraction experiments are essential for determining phase structure and phase transformations in-situ. In this program, a quadrupole lamp furnace (QLF), developed earlier by the PI with NSF funding, was incorporated into a setup at the National Synchrotron Light Source (NSLS) and the Advanced Photon Source (APS). The new technique that was developed enables enhanced acquisition of data when working at extreme temperatures, leading to a better understanding of material behavior as a function of temperature. It is anticipated that the QLF and the analysis techniques developed on this program will be adopted eventually by the broader research community who utilize these national facilities.

DMR 0748267; **CAREER: Experimental Investigation of Plasticity at the Nano-scale** PI: Julia Greer: A useful tool for investigating the plasticity of small scale structures is micro and nanopillar compression testing using the flat punch tip of the nanoindenter. Samples are typically fabricated using the focused ion beam; however, gallium implantation into the surface of the pillars causes surface damage that is known to influence the mechanical behavior. This work involves using a template formed from a polymer to create crystalline nanopillars by electrodeposion. The polymer is removed after the pillars are formed. Such pillars are free from Ga implantation; thus, the subsequent mechanical testing reflects intrinsic behavior.

DMR 0856199 **Structure, Phase Formation and Phase Transitions in Supercooled Metallic Liquids and Glasses** PI: Kenneth Kelton; A new facility was constructed for x-ray scattering studies of electrostatically levitated liquids. The facility will be used to study order in supercooled alloy liquids to develop a better understanding of glass formation and the glass transition.

CONDENSED MATTER PHYSICS AND CONDENSED MATTER AND MATERIALS THEORY CLUSTER REVIEW (PARTS A and B)

FY 2010 REPORT TEMPLATE FOR

NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: *February 9-11, 2011*

Program/Cluster/Section: CMP/CMMT

Division: Division of Materials Research

Directorate: Mathematical & Physical Sciences

Number of actions reviewed:

Status	2008	2009	2010
Awards	7	17	12
Declines	5	10	6
Other			

Total number of actions within Program/Cluster/Division during period under review:

Status	2008	2009	2010
Awards	134	162	141
Declines	427	339	347
Other			

Manner in which reviewed actions were selected:

15 Proposals from Each Program

- 5 Clear Awards/Declinations
  - 2 Awards
  - 2 Declinations (including one renewal)
  - 1 Creativity Extension
- 5 Awards in the Decision Interval
  - 1 Renewal
  - 1 New proposal
  - 1 RUI
  - 2 Other
- 5 Declines in the Decision Interval
  - 2 Declined Renewals
  - 2 Declined New (young and established)
  - 1 Other

10 Proposals culled from the different programs in each breakout

- 2 Specialty proposals in Each Breakout (1 award and 1 declination from each solicitation)
    - SciArt
    - Solar
    - SI2
    - CDI
    - Etc.
- Co-reviewed Proposals (1 award and 1 declination)
    - Between Programs
    - Between Divisions
    - Between Directorates

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. **Provide comments in the space below the question**. **Discuss areas of concern in the space provided.**

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS

**YES, NO,
DATA NOT AVAILABLE, or
NOT APPLICABLE**

1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Yes

Comments:

The CMMT program uses primarily mail reviews. A panel review was used in at least one case where it was felt that it would expedite the decision process in an essential way. The CMP program uses both panels and mail reviews. Panels can only be used effectively when there are a cluster of proposals that are sufficiently close in subject that one panel of experts can review and compare all the proposals.

Overall, there does not seem to be a clear advantage to panels or mail reviews. However, mail reviews tend to provide more useful feedback for the PI's of declined proposals.

Site visits would not be appropriate for the single-investigator grants in these programs, and were not used.

Source: Jackets and Program Director Presentations.

- Are both merit review criteria addressed

- In individual reviews? Yes
- In panel summaries? Yes
- In Program Officer review analyses? Yes

Comments:

In some cases, however, the individual and panel reviews were too short to be very useful.. The program officer review analyses were quite detailed and addressed both criteria.

Source: Jackets

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Yes

Comments:

In the large majority of cases, this was true, but some reports were too brief to be useful. Some other reports were lengthy but were not very useful because they just repeated statements contained in the proposal itself with little additional insight.

Source: Jackets

4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Yes

Yes, but the summaries were rather short in some cases. For proposals near the funding boundary that are declined, perhaps providing more details about the context would be useful to the proposer.

Source: Jackets

5. Does the documentation in the jacket provide the rationale for the award/decline decision?

Yes. The documentation by the program officers was thorough. The analyses by the program officers of the reviews by panelists or external reviewers were very careful, and went well beyond simple letter ratings. The notes described all factors that entered the final decision including considerations of diversity, program balance, and the overall funding situation of the proposer where applicable.

(Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.)

During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.)

- Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made?

*Rated "Very Good or above" or the functional equivalent by review panels.

Of all 59 ARRA awards in the combined CMP/CMMT area, there were no reversal of declinations in CMMT, because their decisions had not been made yet when ARRA was announced. In CMP, 33% of ARRA awards were reversal of a decision to decline a proposal.

The reversals were based on both the quality of the reviews as well as other factors in the case of proposals with equal merits. In CMP, all reversals were for CAREER grants. For these grants, a closely-reasoned priority list was created by the original panels, and the ARRA reversals were taken from the top of the ‘competitive’ category. In general these were from the top quartile overall. Other factors such as diversity (broadly interpreted: institutional type and geography as well as gender) were factors. Additional factors were support of critical skills such as being a master materials synthesist, potential applications, and satisfying programmatic distribution goals.

- Is documentation provided, including a revised Review Analysis, to support the award decisions?

ii) Documentation is provided by the detailed reports of the PD’s, including mostly well-reasoned revised review analyses, to support the ARRA decisions. In some cases it was not immediately clear why some originally declined CAREER awards were taken and others not, but the ‘additional factors’ mentioned above in programmatic goals likely cover these cases.

6. Does the documentation to PI provide the rationale for the award/decline decision?

(Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.)

Comments:

In communications with the PI, rationale for an award is rarely an issue. Rationale for a declination is typically of much greater concern to the PI, either because the PI is angry about the decision or because he/she wants to learn how to formulate a better proposal next time. Verbatim reports from mail reviewers or from a panel summary are not generally sufficient for this purpose, and it appears that the program directors have devoted a significant amount of time to communication with declined proposers about the reasons for decisions and how they might improve their chances next time. As a large fraction of these discussions were conducted by telephone, rather than in writing, the COV did not have complete records of these conversations.

Source: Jackets

7. Is the time to decision appropriate?

Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals.

Comments:

The goal of 70% decisions within six months was not generally met during this period in either CMMT or CMP. A major factor was the effect of the ARRA program, which did not come in until late in the 2009 decision cycle, and thus prevented earlier decisions in that year. Low levels of staffing and changes at the PD level were other factors involved.

In CMP, for which we have the figures, about 40% of proposals were decided within six months, approximately 35% took around seven months, and the rest between 8 and 12 months.

Source: Jackets and Data available on Website.

8. Additional Comments

- Additional comments on the quality and effectiveness of the program's use of merit review process.

- To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

The documentation in the jacket provides good details about the rationale for the use of ARRA funding. In general the awards that did not involve a reversal of a declination had a clearer justification based on scientific impact than those in the smaller fraction where a declination had been reversed. The goals of 'transformative' research are realized in the ARRA grants as was made clear in the PD analysis reports.

Source: document "American Recovery and Reinvestment Act (ARRA) in DMR"

A.2 Questions concerning the selection of reviewers. **Provide comments in the space below the question. Discuss areas of concern in the space provided.**
Selection of Reviewers

YES , NO,
DATA NOT AVAILABLE,
or NOT APPLICABLE

1. Did the program make use of reviewers having appropriate expertise and/or qualifications?

Comments:

Yes. However, problems arose in some cases where only three reports were received, which were sometimes only a minimal basis for a decision. In some cases, where the reports are not strong enough to warrant a positive funding decision, it might be worthwhile delaying a decision until a new set of reports can be solicited and obtained. Presumably the proposer might be happier with this delay than with a rejection on the basis of relatively few reports. Admittedly, this would cause considerable extra work for the program directors, and would not help in the effort to get 70% of decisions made within six months of submission.

Source: Jackets

- Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups?

Note: Demographic data is self reported, with only about 25% of reviewers reporting this information.

Comments:

The Program Officers have clearly made a strong effort to use reviewers that are balanced with respect to geography, type of institution, and underrepresented groups, and we believe they have done well in achieving this balance. However, it is difficult to judge the success of the effort to obtain reviewers from underrepresented groups on the basis of data which is available from only 25% of reviewers. It did appear that as many of 30% of reviewers were women, which we would consider to be a strong record.

Source: Jackets.

3. Did the program recognize and resolve conflicts of interest when appropriate?

Comments: Yes, as far as we could see.

Source: Jackets and Program Director Presentations

4. Additional comments on reviewer selection:

The most important criterion for selection of reviewers is that they have expertise in the topic of the proposal. In many cases this may limit the number of possible reviewers. The program managers seem to have done an excellent job in finding well qualified reviewers. In many cases, they have turned to reviewers outside the United States to get the desired expertise.

A.3 Questions concerning the resulting portfolio of awards under review. **Provide comments in the space below the question. Discuss areas of concern in the space provided.**

RESULTING PORTFOLIO OF AWARDS

APPROPRIATE,
NOT APPROPRIATE,
OR DATA NOT AVAILABLE

1. Overall quality of the research and/or education projects supported by the program.

Comments:

The quality of the supported projects is extremely high. Specific examples will be discussed in Section B.

Source: Highlights and Program Director Presentations.

2. Does the program portfolio promote the integration of research and education?

Comments:

Yes. The research projects supported by these programs are all excellent training grounds for graduate students and postdoctoral fellows, and most frequently, for undergraduate students as well. The proposals often contain impressive plans for educating high school students and the general public, as well as for instituting new courses of instruction at the undergraduate level. However, our committee does not have the means to properly assess how successful these programs will be, or how successful similar programs have been in the past.

Source: Program Director Presentations.

3. Are awards appropriate in size and duration for the scope of the projects? Yes/ No.

Comments:

The three year duration most commonly used in these programs is appropriate for the proposed projects in most cases. A longer period of four or five years has been awarded in exceptional cases. Routine use of a four or five year funding period would not be desirable as it would unduly reduce the ability of the programs to respond flexibly to new developments, in an uncertain funding environment.

The size of the awards has been less than ideal in many cases, and funding levels have not kept up with inflation. For example, according to the NAS report CMMP 2010, During the past 5 years, the size of grants increased only 15%, while the cost of supporting students increased by 25% in as-spent dollars. However, it is also important not to let the acceptance rate for proposals fall below the current already-low levels, so it is not clear how to increase grant sizes, when the overall budget is severely limited.

Source: Jackets and Data available on website.

4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects?

ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects?

Comments:

Overall the portfolio of 29 theory and 30 experimental ARRA awards well fulfills the goal of assembling a collection of innovative and potentially transformative projects. On the theory side, projects include systems that have strong connections to biology and technology, sensors, and biomedical applications. Their topics range from soft condensed matter to quantum nano-scaled networks, fibers, gels, superconductivity in hydrogen, aging in out-of-equilibrium processes, and polymer layers. Another subset of the projects focuses on major improvements in computational and analytical methods. These projects will produce tools and codes for the community, which are taught in detail to students, and will be used for new physics. Other projects focus on fundamentals, disorder on the nanoscale, topologically ordered states, non-equilibrium dynamics, magnetic properties of large molecules, and cold atoms. The outreach components are often notable, with highlights such as a Festival of Physics, emphasis on strong local community interactions, and extensive involvement of high school and undergraduate students in research.

Applications on the experimental side of the award projects include storage, energy, nonvolatile memory, batteries, and spintronics, in addition to all the applications mentioned above for the theory projects. The experimental programs were in general somewhat less varied, focusing mainly in strongly correlated electrons and magnetism.

Source: Highlights and Program Director Presentations.

5. Does the program portfolio have an appropriate balance of:

- Inter- and Multi- disciplinary projects?

Comments: (can combine with question 10 on p. 12)

See answer to question 10.

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program?

Comments:

The portfolios are primarily single investigator awards, as one would expect for these programs. In the case of CMP, we were given the statistic that 10% of grants involve more than one PI.

Source: Program Director Presentations.

7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators?

ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators?

NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.)

Comments:

Approximately 35 percent of ARRA awards are CAREER grants. Overall, 60% of the CMP ARRA awardees and 62% of CMMT ARRA awardees were new to NSF (not former PI's). This is a fairly large preponderance of new awards and has an appropriate balance, meeting the NSF priorities in this regard.

Source: Program Director Presentations.

8. Does the program portfolio have an appropriate balance of:

- Geographical distribution of Principal Investigators?

Comments:

Yes. We note that the program directors have worked with EPSCOR to improve the geographic representation of states.

Source: Data available on website.

9. Does the program portfolio have an appropriate balance of:

- Institutional types?

Yes. Although the majority of funding has gone to large research universities, research at undergraduate institutions is highly valued within the program and has been funded where appropriate.

Comments:

Source: Data available on website.

10. Does the program portfolio have an appropriate balance:

- Across disciplines and subdisciplines of the activity?

Comments:

Yes: The supported projects seem to be a good mix, which covers the field. The PDs take balance of fields into account on borderline proposals.

Source: Jackets and program information

11. Does the program portfolio have appropriate participation of underrepresented groups?

Comments:

It is difficult to judge the amount of participation of investigators from underrepresented groups on the basis of self-reported data from only 25% of the participants. It seems that the representation of female investigators has increased steadily, if slowly, over the years, but it is very difficult to say anything reliable about minority groups.

In both programs the reported percentage of awards to female and underrepresented investigators was 14-15%. In 2009, under ARRA, the number was 18%. These percentages are comparable to the populations in physics departments at American universities

Source: Data available on Web and Program Director Presentations.

12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports.

Comments:

Of the six crosscutting strategic areas identified by OSTP as being crucial for achieving national science and technology priorities, CMP and CMMT science contributes directly to the strengthening of STEM education at every level, the vitality and productivity of research universities, and sustained support for fundamental research, including high impact collaborations with the private sector, universities, and international partners. Different national research initiatives have been launched that address these high level goals, and of the stated NSF Strategic Goals, CMP/CMMT are important partners in the National Nanotechnology Initiative, Science and Engineering beyond Moore's Law, and most recently, Energy and Solar Energy initiatives. By participating in MWN and PIRE, the CMP/CMMT programs have placed an increased emphasis on enabling international relationships for students and researchers, in addition to their historically strong presence in programs like REU, RUI, and RET that are aimed at increasing the number and diversity of STEM students.

Source: Program Director Presentations and information on DMR COV website under public attachments.

13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards).

ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?

Program-specific priorities for ARRA funding were to further support new NSF PI's, particularly CAREER awards, and to fund particularly transformative research that spans fields, involves computational development, or involves particularly challenging experiments, or important applications.

Taken as a whole, the selected ARRA projects exemplify the best that the CMP/CMMT programs have to offer, and as well provided much needed flexibility to CMP/CMMT to address important program goals, such as enhancing diversity, supporting new materials synthesis efforts, and projects that promise new high potential applications.

A.4 Management of the program under review. PLEASE COMMENT ON:

1. Management of the program.

Comments:

The two programs have been fortunate in having program officers who are very competent and extremely dedicated. They have been very skilled at managing the many demands of their operation, and have worked well in cooperation with program directors and managers from other programs and areas of NSF where proposals have crossed program lines. However, it does appear that they are severely overworked, as the number of proposals to be reviewed has been steadily increasing, and support staff has decreased. During the period of the review, there was a turnover of several program officers, which put considerable extra strain on the system.

2. Responsiveness of the program to emerging research and education opportunities.

Comments

The two programs are largely responsive to the mix of proposals submitted by the community. In addition, the PDs sponsored workshops designed to increase activity in key emerging areas, including workshops on supersolids, matter-by-design, and nanoelectronics beyond Moore's law. There will be a special panel in 2011 to review proposals in the growing field of topological insulators.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

The PDs met frequently to discuss questions of balance in the portfolio. Such discussions were particularly relevant following a panel review of a group of related proposals, or at the time of comparison between related proposals at the border between acceptance and declination.

CAREER awards were initially prioritized and put into categories. When ARRA funds came in, the PDs used this prioritization in choosing to choose which of the previously unfunded proposals could now be supported.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

The CMMT program took note of the recommendation for assuring wider access to the CMMT program, and has taken care that proposals from university departments other than physics departments were welcomed in the portfolio. The PDs cited numerous examples of funded proposals from engineering and from computer science departments, as well as from chemistry departments.

The recommendation to increase funding for equipment in the range of 30 to 100K was not followed, because of lack of funds.

5. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

In addition to identifying particularly noteworthy accomplishments or "highlights," the COV is encouraged to comment on the impact of NSF supported contributions to the field. For example, the COV report may include comments on NSF supported work in context of contributions to advance a field, impact of NSF investments to stimulate emerging new areas, and potential for transformative impact in research or education.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: ***"Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."***

This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:

CMP and CMMT have supported some of the most important developments in condensed matter in the period 2008-2011. The emerging field of topological insulators was nurtured from its start in the theoretical community (Zhang DMR0904264, Kane DMR 0906175, Moore 0804413). Subsequently, CMP supported key experimental work in the exploration phase of materials that manifest this new state of matter, notably photoemission measurements (Hasan 1006492). Similarly, the importance of graphene was quickly recognized. Among the CMP supported work, we highlight that of Andrei (DMR0906711), who was the first to observe the fractional quantized Hall effect in unsupported graphene films, and that of Kawakami (DMR040037), who demonstrated vastly improved spin transport in graphene, an important step towards the eventual incorporation of graphene into spintronic devices. The fact that 6 CAREER awards involve research in this area is an indication of the future importance of this field.

During this period, the discovery of high temperature superconductivity in iron based compounds was a major development in materials science. CMP/CMMT supported the first US workshop that introduced this emerging area to US researchers (Greene 0853158). CMP/CMMT-funded research highlights in the area included the measurement of the superconducting gap (Chien 0403849), and the explication of its possible symmetry via point-contact Andreev reflection spectroscopy (Greene 0706013). The technological promise of this new class of superconductors was investigated in experiments at the Applied Superconductivity Research Center (Boebinger 0654118) that probed the role of grain boundaries in supercurrent transport.

The NAS report "Frontiers in Crystalline Matter: From Discovery to Technology" noted that US researchers in materials-inspired research will be increasingly at a disadvantage, internationally, without more investment in the US materials synthesis enterprise. It is notable that CMP has supported one of the best young materials synthesists (Morosan (CAREER 0847681)).

It is widely felt that electronic structure calculations may have developed to the point that they can provide useful input into the design of new materials, transforming synthesis from a process that has traditionally been serendipitous into directed searches, where synthesis and theory are partnered to discover new materials with purpose built functionality. The CMMT-supported work of Curtarolo on binary metallic alloys (DMR 0639822) and 2010 McGroddy prizewinner Nicola Spaldin (DMR605852) on multiferroic oxides are particular highlights of this approach.

The understanding of the electronic ground states of a semiconductor at the metal insulator boundary received an important boost from the work of Ali Yazdani, DMR 0704314, who found, utilizing scanning tunneling microscopy, that the texture of conducting states is inhomogeneous and fractal-like. In addition, by introducing magnetic Mn impurities, he deduced that the magnetic long-range order in these diluted magnetic semiconductors develops initially in a nonuniform manner.

Demonstrating the breadth of activities in CMP is the program's support of fundamental work that seeks to understand the transition between macroscopic classical and microscopic quantum effects. Under what conditions can *large* objects exhibit quantum properties? This question was pursued in molecular magnets by Friedman (DMR 0449516), who probed the quantum states of single molecule magnets using microwave techniques, in research conducted at an undergraduate-only institution. Equally intriguing are two CMP projects that seek quantum mechanical effects in mechanical systems, including that of Cleland (DMR 0605818), who has developed a mechanical resonator and observed and controlled its quantum ground state at low temperatures, and the related work of Schwab (DMR0804567) , a new investigator.

The area of soft matter was distinguished as well by several significant advances. The importance of defects in complex ground states was highlighted in the theoretical work of Grason on filament bundles, and that of Olvera on topological twists in molecular assemblies. A new insight into the phenomenon of "jamming", in which a classical many-body system undergoes a transition from fluid-like to solid-like behavior, was provided by the work of Behringer (DMR 0906908). Although shear typically has the tendency to fluidize a jammed system, Behringer showed that the opposite can also happen if the friction between grains is brought into play. This result requires rethinking the nature of the jamming transition, a paradigm that is central to the dynamics and flow of systems as diverse granular materials, glasses, foams, and colloidal suspensions.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

Grants funded under CMP and CMMT provide superb mentoring and training of students at all levels. Participation by graduate students is a core feature of these grants. Undergraduates have also had a major role in many projects, and this has often served to motivate them to move onto graduate school. PIs have often presented their research in a way to inspire undergraduates. For example Jeevak Parpia at Cornell University (DMR-0806629) presented a brilliant lunchtime talk to undergraduate students to illustrate how to perform "back of the envelope" calculations to understand real world phenomena such as the Gulf oil spill and the ocean level rise. An example of an undergraduate making an important contribution in the research laboratory is illustrated by a student working with PI Jonathan R. Friedman at Amherst College (DMR 0449516), who designed and constructed a resonant microwave cavity to study the collective coupling of ~10^{16} single-molecule magnets. A female URM undergraduate student, working with Sara A. Majetich at Carnegie Mellon University (DMR-0804779), developed an electronic circuit to enable joystick control of four solenoids for magnetic actuation in order to understand magnetic nanoparticle interactions.

The CMMT program is supporting some excellent summer schools that bring together a large number of students and introduces them to advanced topics in condensed matter physics. The Boulder Summer School for condensed matter physics organized on-site by PI Leo Radzihovsky at University of Colorado (DMR-0437903) has been very successful, year after year, as it has moved across the many sub-disciplines of condensed matter physics. Recently, PI K. Thornton at University of Michigan (DMR-1058314) has initiated a pilot summer school to introduce undergraduate and graduate students to computational research and train future "ambassadors" of computational physics.

Outreach activities by PIs supported in the programs have brought recent discoveries to the general public and K-12 students, often in very vivid way. A recent striking example is the exhibit "Forces of Nature", led by PI Robert P. Behringer at Duke University (DMR 0906908), at the Chicago Museum of Science and Industry, illustrating the concept of force chains in granular materials.

B.3 OUTCOME GOAL for Research Infrastructure: ***"Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."***

This category includes facilities, research instrumentation, and cyberinfrastructure.

Comments:

Both CMMT and CMP contribute to research infrastructure in multiple ways.

- CMMT contributes to the funding of several schools and centers, including the Boulder Summer School for Condensed Matter Physics, the Aspen Center for Physics, and the Kavli Institute for Theoretical Physics. These schools and centers offer opportunities for researchers to collaborate, learn about emerging fields, and disseminate their results to a broader community. They also provide important training and educational opportunities for graduate students and postdoctoral associates in theoretical physics.
- The Materials Computation Center at the University of Illinois (DMR 0325939) contributes to the development of the nation's cyber-infrastructure by developing new software tools for electronic structure calculations, and making these tools available to the scientific community. The MCC also holds summer schools for young scientists and makes travel grants to young scientists to attend European summer schools in computational science.
- Several investigators supported by CMP have made important advances miniaturizing mechanical devices, to the point where quantum mechanical effects play an important role in the device behavior (Cleland, DMR 0605818, Kikkawa, DMR 0907226). These projects contribute to the nation's nanotechnology infrastructure. In fact, Kikkawa makes his equipment available as a shared facility to users on and off campus (including remote control usage from Africa).
- Two CMMT researchers (Olvera de la Cruz, DMR 090778, Ashcroft, DMR 09074251) have used new Graphics-Processing-Unit technologies to implement highly efficient numerical codes for molecular dynamics and Monte Carlo techniques. These projects advance the nation's cyber-infrastructure, and could be useful in other commercial applications, such as drug discovery.

CENTERS, AND PARTNERSHIPS FOR RESEARCH IN EDUCATION AND MATERIALS CLUSTER REVIEW (PARTS A AND B)

FY 2010 REPORT TEMPLATE FOR

NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: *February 9-11, 2011*

Program/Cluster/Section: CENTERS/PREM

Division: Division of Materials Research

Directorate: Mathematical & Physical Sciences

Number of actions reviewed:

Status	2008	2009	2010
MRSEC Preproposal Invites	5		
MRSEC Preproposal Do Not Invite	5		
MRSEC and PREM Full Proposal Awards	5	5	
MRSEC and PREM Full Proposal Declines	9	5	
Other	6	3	

Total number of actions within Program/Cluster/Division during period under review:

Status	2008	2009	2010
MRSEC Preproposal Invites	35		
MRSEC Preproposal Do Not Invite	65		
MRSEC and PREM Full Proposal Awards	14	8	
MRSEC and PREM Full Proposal Declines	21	17	
MRSEC Increments	26	27	27

Manner in which reviewed actions were selected:

We selected a number of proposals for each stage of the MRSEC and PREM competitions. The selections show straightforward decisions as well as those that required discussion by the Program Directors (PDs). In addition, we included a number of proposals for evaluation of post-award management.

<u>10 MRSEC Preliminary Proposals</u>

- 3 Clear Invite
- 2 PD Decision: Invite
- 2 PD Decision: Do Not Invite
- 3 Clear Do Not Invite

<u>19 MRSEC Full Proposals</u>

10 illustrating the Full Proposal to Reverse Site Visit decision making process

- 3 Clear Invite
- 2 PD Decision: Invite
- 2 PD Decision: Decline
- 3 Clear Decline

9 illustrating the Reverse Site Visit to Award decision making process

- 2 Clear Award
- 3 PD Decision: Award
- 2 PD Decision: Decline
- 2 Clear Decline

<u>6 MRSEC Awards – Post Award Management</u>

- 2 small MRSECs
- 2 mid-sized MRSECs
- 2 large MRSECs

<u>10 PREM Proposals</u>

- 3 Clear Award
- 2 PD Decision: Award
- 2 PD Decision: Decline
- 3 Clear Decline

<u>3 PREM Awards – Post Award Management</u>

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[7]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: For the MRSEC Program, a sequence of pre-proposal selection panels, full proposals with extensive individual reviews (≈ 8-21), and reverse site visits are used to evaluate the proposals and to select the most appropriate for funding. For the PREM program, proposals were sent out for ad-hoc review by experts (≈ 4) followed by a panel review at NSF. The panel felt that the review methods were highly appropriate for and well matched to each of the several stages of the review process for both MRSECs and PREMs. In addition, extensive post-award monitoring (including site visits and panel reviews) is used to review status and progress of awardees. This multi-stage process is intensive and puts considerable workload burden on both the proposers/awardees and the NSF staff, but is seen by the panel as critical in maintaining the high standards of the MRSEC and PREM programs in terms of quality and effectiveness. Source: Jackets and Program Director Presentations.	YES
4. Are both merit review criteria addressed d) In individual reviews?	YES

[7] If "Not Applicable" please explain why in the "Comments" section.

e) In panel summaries? f) In Program Officer review analyses? Comments: a) Individual reviews of MRSEC and PREM proposals did address both merit criteria with appropriate detail. Only in a few instances did individual reviews neglect to address broader impacts. b) Panel summaries did always address both merit review criteria. The findings under a) and b) reflect the continued improvement in the comprehensiveness of the reviews in this DMR program. c) The program officer review analyses did a very good job in summarizing the reviews and panel reports in terms of both merit review criteria, and also made clear what the compelling case was in terms of breadth, impact and broader impact and rationale for funding or decline. Source: Jackets	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: For both the MRSEC and PREM Programs, individual reviews were obtained for each proposal and these reviews were quite extensive, commenting on the overall case for a center, the broader impact and also the individual IRG proposed research, or the PREM-specific criteria. Different reviewers are likely to provide reviews of differing comprehensiveness and some variation in the (letter grade) assessment must be expected. The panel felt that the program directors are doing an excellent job in dealing with such variations by using reviewers with overlapping expertise and by paying careful attention to the quality and detail of the comments. Source: Jackets	YES
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: For MRSEC proposals, panel summaries were prepared for the pre-proposals and at the reverse site visits. For PREM proposals, panel summaries were prepared for the proposals. In all cases, these summaries were	YES

comprehensive. Source: Jackets	
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) v) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. vi) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: The documentation in the jacket is comprehensive. The review analysis created for each proposal is very thorough, clearly indicating the rationale for the decision. In one case (PREM) where the Program Directors' recommendation was not accepted by the Division Director, the review analysis provided the basis (geographic/institutional balance) for the decision. In the case of the MRSECs, the competition is multi-stage (preliminary proposal, full proposal, reverse site visit), with documentation at each stage. The MRSEC program received no ARRA funds. The PREM program received ARRA funds prior to the decision date of the competition, which allowed it to make three additional awards beyond the five awards which would otherwise have been possible. The option to reverse decline decisions was thus not used (i.e., all eight awards were made simultaneously). Source: Jackets	YES

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The documentation should be helpful to the PI. The written materials which are sent to the PI (reviews and panel summaries, for both MRSEC and PREM programs) are sufficient to make clear the strengths and weaknesses of the proposal, and consequently the decision. Source: Jackets	YES
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The MRSEC program is a multi-stage competition, with preliminary proposals, full proposals, and reverse site visits. Each phase has 100% completion in under six months, i.e., submitters of preliminary proposals learn whether they will be invited to submit full proposals; submitters of full proposals learn whether they will be invited for a reverse site visit; and reverse site visit presenters learn whether they will be funded, each in under six months (with the last phase in less than three months). The PREM competition is a single round, with 100% of the decisions within six months. Source: Jackets and Data available on Website.	YES
8. Additional Comments e) Additional comments on the quality and effectiveness of the program's use of merit review process. f) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? The MRSEC program is arguably the most selective program in DMR in terms of final number	

of awards made to number of initial, pre-proposals submitted. The panel feels that, in dealing with this selection pressure, the MRSEC program makes excellent use of the merit review process. The program applies different processes (ad hoc, panels, reverse site visits, site visits) very effectively to different stages of a proposal or award (including post-award reviewing). The panel observed similarly effective use of the merit review process for the PREM program. ARRA funds were not applied to the MRSEC program. For the three PREM awards supported with ARRA funds, the review analysis for each proposal clearly states the rationale and appropriateness for ARRA funding; for example, the analysis for one proposal states that "This is a well-conceived partnership with research in energy materials and biomedical applications that clearly qualifies for ARRA funding… Moreover, *** University is in an EPSCoR jurisdiction and also recovering from substantial damage to its facilities during the Katrina Hurricane." Source: document "American Recovery and Reinvestment Act (ARRA) in DMR"

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[8]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Selection of appropriate reviewers for interdisciplinary research enterprises such as the MRSECs is extremely challenging. For example, the last MRSEC round (in 2008) involved a total of 235 ad hoc (mail) reviewers and 9 review panels, altogether generating over 1,100 reviews and reports.	YES

[8] If "Not Applicable" please explain why in the "Comments" section.

The panel felt that the program directors for the MRSECs and PREMs are performing a superb job in reviewer selection, involving reviewers with the requisite technical expertise to judge specific research components as well as, in the case of MRSECs, “generalists” to look at the center aspects of a proposal, and reviewers able to assess educational activities in a broader context. Source: Jackets	
4. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: Overall the MRSEC and PREM programs do an excellent job in terms of demographic balance. The participation of women and underrepresented minorities in the review process exceeds the national average for STEM disciplines. Specifically, in the last MRSEC round (in 2008) women formed 20% of the reviewer pool and underrepresented minorities 12%. In PREM reviews the fraction of reviewers who are underrepresented minorities is at least 23%, and 48% for site visits. In addition, the program directors are to be commended for involving a substantial number of reviewers from industry (11%) and national labs (13%) in the MRSEC evaluations (out of ~350 reviewers during the last MRSEC competition). Source: Jackets.	YES
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Potential reviewers were vetted using exclusion lists from the PIs as prescribed by NSF guidelines. Further examination and consideration by program directors of applicant relationships such as common committee service were also considered. Source: Jackets and Program Director Presentations	YES

4. Additional comments on reviewer selection:
The PDs do an excellent job in managing the MRSEC and PREM programs through multiple review mechanisms, and there is no doubt that these programs benefit greatly from this intensive pre- and post-award management. In the case of the MRSECs, there is a substantial review process (pre-proposal, full proposal, reverse site visit) in addition to two site visits during the 6-year award. The PREM program requires one site visit and one reverse site visit during the 5-year award. The MRSEC and PREM topics span the entire DMR research spectrum and beyond. As a result of the size and breadth of many of the centers, the list of reviewers excluded due to conflict-of-interest considerations is often substantial, making it challenging to find appropriate reviewers. The attention the PDs give to selecting a diverse reviewer base (with experts from academe, industry and national labs, who have both subject area and broad area expertise) has been critical to maintaining excellence in the MRSEC selection process and center success.

Recommendation:
Given how important good management of the review process is to all aspects of the continued success of the MRSEC and PREM programs, and given the added review workload associated with the creation of CEMRIs and MIRTs, the panel recommends that NSF consider adding a scientific support staff ("science assistant") to help with the administration of the program. This will enable the level of PD management to be maintained and focused towards ensuring excellence in the selection process and post-award management, and ensuring the best outcome for NSF investment.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	**APPROPRIATE, NOT APPROPRIATE[9], OR DATA NOT AVAILABLE**
1. Overall quality of the research and/or education projects supported by the program.	APPROPRIATE

[9] If "Not Appropriate" please explain why in the "Comments" section.

Comments: MRSEC: The quality of research and education projects for supported MRSEC programs is excellent. These programs are well conceived and highly integrated in their approaches to research, education, and outreach activities. The MRSEC programs facilitate the creation of forefront technologies among participating units. PREM: The quality of the supported PREM projects is outstanding, allowing the development of materials research strength at minority institutions and facilitating the interaction of students and faculty with major academic programs and researchers. Source: Highlights and Program Director Presentations.	
2. Does the program portfolio promote the integration of research and education? Comments: MRSEC: The MRSEC program offers high quality research, involving many educational institutions and faculty working in preeminent areas. The students involved are from various institutions and with various educational and ethnic backgrounds. By this process, all levels of students are exposed to forefront research. PREM: The PREM program offers minority institutions an opportunity to collaborate with major research institutions, allowing minority students and their respective faculty the ability to interact on major research issues. This is an excellent program to strengthen traditional minority-based academic institutions. The MRSECs and, more recently the PREM program, have been highly recognized models within DMR and beyond for the effective integration of high impact research and broadly based education efforts. The MRSEC-associated REU programs stand out in offering summer research opportunities to undergraduates, with a strong effort made to support women and underrepresented minorities (over the last three years about 45% of REU participants were women and 35-40% were underrepresented minorities). Education outreach takes a variety of forms, with researchers partnering with museums and local schools. Education coordinators at the MRSECs meet annually to discuss evaluation, to broaden participation, and to seek additional sources of support. Source: Program Director Presentations.	APPROPRIATE

3. Are awards appropriate in size and duration for the scope of the projects? Comments: For both MRSEC and PREM, the awards are appropriate to the scope and duration of their respective projects. MRSECs require significant funding because of the complexity of their operation, their education and outreach activities, their facilities, and their overall management. However, the MRSEC program budget has decreased by about 15% over the last 10 years when adjusted for inflation. The ongoing reorganization of the MRSECs into CEMRIs and MIRTs will allow the larger CEMRIs, as successors of the multi-IRG MRSECs, to fulfill their mission by increasing their average funding level. Six years appears to be an appropriate time for the duration of a MRSEC. The funding for PREMs is reasonable considering the number of faculty and students involved. The duration of PREM of five years is appropriate, allowing for the collaborations with the partnering centers to mature and for students to finish their degree programs. Source: Jackets and Data available on website.	APPROPRIATE
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: The MRSEC portfolio program is composed of highly innovative projects that are potentially transformative in nature. The PREM program, which includes ARRA funding, enhances the capability of minority institutions to participate in world-class research with primary academic institutions, thus facilitating faculty and student interaction with potentially innovative/transformative projects. Source: Highlights and Program Director Presentations.	APPROPRIATE

5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: The MRSEC programs have an appropriate balance of interdisciplinary and multidisciplinary projects, involving a primary academic institution and multiple scientific/technical/academic partners. The PREM programs allow faculty and student interactions from minority institutions to interact with major academic research programs, facilitating both inter- and multi-disciplinary projects. Source: Jackets, program information, and data e.g. on jointly funded projects.	APPROPRIATE

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The MRSEC program is well balanced in terms of the size of the centers (ranging from small to large MRSECs comprised of 1 to 5 IRGs; ~\$1M/yr - \$3.5M/yr). Within a given MRSEC, activities can range from individual investigator projects in a small Seed to thematic efforts involving perhaps a half a dozen investigators in a full scale IRG. The PREM program similarly appears to be well balanced in terms of research activities. PREM award sizes are, however, much more uniform (~\$0.5M/yr). Source: Program Director Presentations.	APPROPRIATE
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments:	APPROPRIATE

First, the healthy turnover in funded MRSECs each cycle (for example, 4 out of 13 centers were phased out in the last competition, 2008, and 5 new centers were created) allows for new investigators to enter the program. In addition, the recompetition of existing MRSECs, with the accompanying change in research foci and thus IRGs, also brings a significant number of new investigators into the program every six years. Second, while almost all MRSECs are led by senior PIs, the Seed component required of each MRSEC typically is used to bring on board new and/or newly hired junior faculty. As already pointed out in the last COV report, this is an increasingly important support mechanism in a time of flat or reduced funding levels. MRSECs did not receive ARRA funding. The ARRA-funded PREMs have an appropriate balance. Source: Program Director Presentations.	
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: Considering that the geographic balance is affected by the existing concentration of research institutions in any given state, both MRSECs and PREMs are geographically distributed broadly. The geographic distribution of the PREMs reflects, furthermore, the concentration of minority-serving institutions in various states. Source: Data available on website.	APPROPRIATE
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: The MRSEC program includes 27 centers at academic institutions ranging from large public universities to small private campuses. The PREM program currently partners 14 minority serving institutions, from small HBCUs to large city colleges, with research centers. Source: Data available on website.	APPROPRIATE
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: The MRSEC programmatic balance closely reflects the whole spectrum of DMR subdisciplines and research activities. Across the	APPROPRIATE

program, the DMR areas (biomaterials, ceramics, condensed matter physics, electronic/photonic materials, metals, polymers and solid-state chemistry) are all covered by a multitude (5-23) of IRGs. Since the number and size of PREMs is smaller, their programmatic scope might be expected to be less broad. However, the panel notes that the PREM program effectively covers the full spectrum of DMR research programs, with thematic foci ranging from computational materials science to metamaterials/surface plasmons to nanomaterials to nonequilibrium dynamics. Source: Jackets and program information	
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: The MRSEC program has been a trailblazer within DMR for increasing the participation of underrepresented minorities, most recently by coupling these centers with minority serving institutions through the PREM program. The MRSEC program does very well when compared with the national trends in STEM institutions. The percentage of MRSEC women faculty has risen to ~17% in 2009 and the percentage of underrepresented minority faculty to ~5%. The corresponding numbers for postdocs and grad students are ~22% (7%) and 25% (7%), respectively. The panel encourages NSF to gather discipline-specific data to benchmark MRSEC diversity with respect to women and underrepresented minorities. Source: Data available on Web and Program Director Presentations.	
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The MRSEC and PREM programs directly address the challenges associated with transformative research in materials science. The MRSEC program's high risk/high payoff approach makes it particularly well suited to meeting the challenges articulated in the National Academy's CMMP2010 decadal report. The MRSECs have become a community resource by operating mid-size materials research facilities which are broadly accessible, a need clearly identified in the 2005 NRC report, "Midsize Facilities: The Infrastructure of Materials Research". This highly valuable service has been enhanced recently by the establishment and growth of the Materials Research Facilities	

Network (MRFN). However, an important aspect is the support which individual MRSECs (MRFN sites) receive for their facilities from their home institutions, not only through the construction of specialized buildings (e.g., with low-vibration space for electron microscopes), but also operating funds which cover a portion of technical staff salaries and maintenance contracts. The panel has two concerns: a. The flat MRSEC budget over the last 10 years makes it increasingly harder for MRSECs to provide and maintain state-of-the-art facilities. b. With the recent change in NSF policy to exclude even voluntary cost-sharing from proposals, institutional support may be more difficult to secure in the future, which could negatively impact the collective capability of these facilities and their benefit to the community. -- Source: Program Director Presentations and information on DMR COV website under public attachments.	

13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards).

The recent re-organization of the MRSEC program into large CEMRIs and smaller MIRTs is a response to the National Academy's 2007 assessment of the MRSEC program. At this point, it is too early to comment on the effect of this reorganization. The panel sees advantages in the MIRTs for opening up access to smaller institutions, and advantages in increasing the average level of funding available to the CEMRIs so as to allow them to sustain more effectively the high level of research and education excellence required.

The panel sees two potential issues that should be watched for signs of negative impact on the program as a whole:

- the re-organization de facto turns a single program, the MRSECs, into a two-tier system; to prevent a full disconnect, it will be important to ensure that MIRTs can be incubated into CEMRIs.
- the MIRTs may need a time frame longer than a typical single investigator award to bring their research to fruition; an award duration longer than the currently projected 3 years (before re-competition) may be required.

ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments: The PDs do an outstanding job managing the MRSECs and PREMs, and are clearly committed to proper review and oversight. The continued success of these programs has been due to, in large part, the active and expert management provided by the PDs.

As pointed out earlier, the workload is particularly large in this program. There has been substantial turnover in PDs over the last few years. The panel is very encouraged by the fact a second full time PD has joined the MRSEC program. However, the other two PDs responsible for the MRSEC and PREM programs are half-time only, splitting their responsibilities with other DMR programs. Therefore, the panel recommends that NSF consider adding a scientific support staff ("science assistant") to help with the administration of the program (see also A2.4).

The plan to limit the number of proposals to one CEMRI or MIRT per institution, and also to one PREM per institution, is seen by the panel as an appropriate means of encouraging geographic diversity and intra-institutional prioritization.

MRSEC: The PDs perform excellent work, despite the intense nature of the management along with all the other demands on their time. The substantial review process and post award management are appropriate and necessary for the scope and mission of these centers. The three step review process (pre-proposal, full proposal, reverse site visit) and two site visits during the lifetime of the six year award generates considerable work, in addition to handling the meaningful annual reports and managing PI meetings. The six year length of the award is appropriate for the size and scope of the program, allowing for longer term planning and management of facilities and outreach programs, while addressing flexibility through mechanisms like the Seed program for launching new, innovative projects.

PREM: The PDs do a similarly excellent job managing the PREM program, requiring one site visit and one reverse site visit during the five year program.

2. Responsiveness of the program to emerging research and education opportunities.

Comments: Both MRSECs and PREMs are sufficiently autonomous and flexible that they have the option of responding to changing opportunities as is appropriate, throughout the lifetime of the grant.

MRSEC: For the MRSEC program overall, the portfolio evolves every three years, when the outcome of a new round of MRSEC competitions reflects evolving research areas and opportunities. For funded MRSECs, a variety of opportunities exist to respond to emerging opportunities on a shorter time scale. A built-in mechanism within each MRSEC is the allocation of funds (typically around 10% of the total) to Seed initiatives, which offer a way to support innovative, high-risk research and incorporate new PIs into the center. There is supplemental support available through the DMR Center Supplemental Fellowship Competition, with a focus on supporting post-docs from under-represented groups. The Materials Research Facilities Network offers grants to enable new users of MRSEC facilities who would otherwise not be able to access the critical equipment or expertise.

PREM: PREMs handle their responsiveness in a less documented way, but may have programs like the Seed program to bring in new investigators and projects or make use of supplements like those from the Materials Research Facilities Network.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments: The MRSECs have been a tremendously successful program since their start in 1994 and have become a unique community resource for the whole of DMR and beyond. As a new program started a few years ago, the PREM program similarly has been recognized as outstanding. Together, the two programs provide for a very well balanced portfolio in terms of research activities, education activities, and geographical diversity. The PREM program specifically adds an innovative mechanism for increasing the participation of underrepresented minorities.

The assessment of the MRSEC program by a NAS/NRC MRSEC review panel four years ago (report released in 2007) triggered a reorganization of the MRSECs into two types of activities, large multi-IRG centers (currently called CEMRIs) and small, single-IRG efforts (MIRTs). This re-organization is being implemented for the first time with the current round of competitions for the 2011 class of centers/MIRTs.

4. Responsiveness of program to previous COV comments and recommendations.

Comments: The previous COV report had no real concerns and encouraged continuing the very successful, program-specific practices.

MRSEC: Specifically, the COV identified Seeds as an excellent vehicle for incorporating young PIs as well as incubating new high-risk/high-pay-off projects and encouraged their continuation. Over the last three years, Seed funding across MRSECs has increased from 8% to 11%. In addition, the COV encouraged increasing the networking among MRSECs to enhance their role as providers of access to research instrumentation not available at many smaller institutions. Over the last three years, the Materials Research Facilities Network and shared experimental facilities portion of the MRSEC budget has increased from 12% to 16%.

PREM: Best practices have been maintained by the PDs. The previous COV was mostly concerned by the limited funds for such an outstanding program. Average award size has not substantially changed (excluding ARRA money).

5. Additional comments on program management:

A) Responsiveness to the National Academies / NRC review of the MRSEC program in 2007:

The NAS/NRC review of the MRSEC program in 2007 made a variety of suggestions, many of which have been addressed in the three years since. The two primary concerns were the increasing requirements on the centers without an increase in resources, and an imbalance in the center based activities, in part due to the varied size of the MRSECs.

The NAS/NRC review suggested increasing the mean award size and to restructure the MRSEC program to create smaller collaborative groups that would have been single IRG centers, and "Centers of Excellence" that would be a full-fledged center with corresponding outreach. While the mean size of the award has not increased, the centers have been restructured, beginning this year with the MIRT (single IRG) and CEMRI (Centers of Excellence) programs.

Additionally, the centers were encouraged by the NAS/NRC review to operate as a national network. In response, the Materials Research Facilities Network, started in 2006, was expanded in 2009 to 16 MRSECs, an education coordinators network was established in Fall 2008, and a webinar was held for MRSEC webmasters in Feb 2011.

Industrial collaborations were identified by the NAS/NRC review as an area that could use better evaluation and improvement. A working group was established to examine the challenges. The consensus was that no one solution would fit all centers given their diversity. Thus, no overarching solution or approach was implemented.

The NAS/NRC review identified some confusion among reviewers and centers on what was expected for educational outreach, with more and new being perceived as better than tried and true. PDs have reached out to the community to focus on impact over number of efforts and innovation in the competition review instructions, site visits, and meetings. The present COV sees the effects of this effort, with more focused educational outreach and appropriate reviewer comments.

The NAS/NRC review identified assessment of the impact of the education programs as an area for improvement. A REESE award was made in partnership with the Cornell MRSEC in 2007 to build an evaluation system, and this pilot was expanded to 11 centers by 2009. An undergraduate research self-assessment tool was deployed and is being tested, and education coordinators are collaborating to develop new assessment tools.

B) Additional suggestions by this panel:

B1. The MRSEC name has tremendous cache nationally as well as internationally. In comparing MRSECs internationally, the NAS/NRC review ranked them favorably with the highly recognized Max Planck Institutes. The MRSEC name also carries significant recognition value in collaborations with industry, with outreach partners such as science museums, as well as internally with the top administrators at the academic institutions were the MRSECs are located. *This name recognition has taken time to build up. It would be lost almost instantaneously by changing the name of these centers to CEMRIs, as currently planned*. The panel strongly encourages DMR to keep the MRSEC “brand name” for the larger centers (while calling the smaller activities MIRTs).

B2. The 2007 NAS/NRC study of MRSECs considered a re-organization of the program into larger, multi-IRG centers and small, single-IRG activities. This recommendation was not budget neutral: the scenario was based on a $60M program budget, while the actual MRSEC program budget in FY’06, when the report was compiled, was $51M. The current, FY’10 MRSEC budget of $55M represents flat funding or even a slight budget reduction when adjusted for inflation. Therefore, an implementation of the NRC scenario without commensurate budget increase threatens the program’s effectiveness.

Furthermore, with the ongoing phase-out of NSF-wide NSECs and NIRTs, the MRSECs and their successors fulfill a unique role. In particular, the MIRTs will be the only possibility for collaborative research on a scale intermediate between FRGs and large centers. As a result, the panel foresees strong budgetary pressure on a program that has been flat-funded for years. The panel strongly advises to consider a budget increase commensurate with the increased responsibilities taken up by this program.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

In addition to identifying particularly noteworthy accomplishments or "highlights," the COV is encouraged to comment on the impact of NSF supported contributions to the field. For example, the COV report may include comments on NSF supported work in context of contributions to advance a field, impact of NSF investments to stimulate emerging new areas, and potential for transformative impact in research or education.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 <u>OUTCOME GOAL for Discovery:</u> "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*"

This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:
The MRSECs have been highly successful leaders at the forefront of materials science. They focus on fundamental research that is interdisciplinary and of a scope that goes beyond the capabilities of single investigators. MRSECs provide an effective platform for the integration of research, education and outreach while maintaining partnerships with industry, other non-academic sectors, and international collaborating teams. PREMs provide faculty and students at minority-serving institutions with long-term collaborative partnerships with research centers such as MRSECs. Given below are specific examples of how MRSECs and PREMs have met the goal of advancing the frontier of knowledge.

The MIT Center for Materials Science and Engineering (DMR-0819762) made a significant advance in basic battery research. For the first time, this MRSEC used genetically engineered viruses to build both the positively and negatively charged ends of a lithium-ion battery, demonstrating performance within 15% of the theoretical value. Virus growth of nanomaterials might be scaled up as an effective way to fabricate novel battery materials due to the self-replication of the viruses. This would result in commercial batteries that are lightweight, flexible, and conformable to their containers, with high-energy capacity and power performance, that could be manufactured cheaply through a non-toxic process. This work was published in Science **324**, 1051 (2009).

Recently discovered topological insulators exhibit exotic physics, with an insulating bulk and conducting surface states. This makes them a promising class of materials for spintronics and other electronic applications. The Princeton Center for Complex Materials (PCCM; DMR-0213706) made several breakthroughs in observing topological insulator states in bismuth-based compounds (Nature **452**, 970 (2008)), in particular demonstrating the absence of backscattering in topological insulators (Nature **460**, 1106 (2009)) and transmission through naturally occurring surface defects (Nature **466**, 343 (2010)).

Random sphere packings have long been used to model and predict the behavior of amorphous materials. So far, however, almost all known results concerned packings of spheres of no more than a few different sizes. A breakthrough was achieved at the NYU MRSEC (DMR-0820341) with a new "granocentric" approach that can deal with amorphous packings of spheres with a wide size distribution and accurately predict the resulting density of the material. This result, published in Nature **460**, 611-615 (2009), impacts our understanding of the structure as well as the response to applied stresses in materials ranging from glass-forming liquids to granular matter. It was named #15 in Discover Magazine's 100 Top Stories of 2009.

A thin sheet, such as a piece of paper, will buckle and then fold when compressed from the sides. Similar folding occurs with thin liquid supported films within lung sacs (the effective lung area changes by a factor of 3 during each breathing event), where folds not only change the mechanical properties but also have important biological function. The Chicago MRSEC (DMR-0820054) together with international collaborators in Chile developed a new understanding of the wrinkle-to-fold transition in lung surfactants and generalized these results to other tissue surfaces. Published in Science **320**, 920 (2008), this important work opened up new territory for designing man-made molecular sheets of high strength and resiliency.

The Clark Atlanta University PREM (DMR-0934142) explained the observed lattice contraction in graphene upon hydrogenation via first principles density functional calculations, showing that twist-boat conformations are largely responsible (ACS Nano **3**, 4017 (2009)). The theoretical strength of this PREM, which involves three Atlanta University Center schools, makes an excellent complement to the experimental research underway at its neighboring MRSEC partner, Georgia Tech.

The UNM PREM (DMR-0611616) developed novel high-performance, low-cost diagnostic tools for microfluidic devices. This research was performed together with the PREM's partnering center, the Harvard MRSEC. The collaborating team used experiments in concert with extensive simulations to analyze the typical lateral flow in point-of-care assays (e.g., pregnancy tests) and extended these results to the design of optimized paper-based microfluidic systems (Langmuir ***26***, 1380-1385 (2010)).

B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

The MRSEC and PREM programs serve as stellar examples of effective research and education across all levels, while broadening the participation of women and under-represented minorities. The six-year length of the MRSEC program with competitive renewal allows for investment of time and resources in education and outreach programs that may take some time to develop effectively, aided by education coordinators who now meet annually.

From 2008 - 2010, 1374 undergraduates participated in the summer-long Research Experience for Undergraduates (REU) programs that are operated by every MRSEC, with 47% of the participants women and 39% underrepresented minorities (URM). In the same 3-year time period, 2747 graduate students were supported by MRSECs, with 27% women and 7.5% URM, as well as 919 post-docs, with 24% women and 8% URM. The MRSECs also maintain a wide spectrum of innovative outreach and effective education activities aimed at pre-college students, their teachers, as well as the general public. These are tailored to the local communities and take place in schools, science museums, malls and elsewhere. While difficult to estimate precisely, based on the reported numbers a conservative estimate is that these programs reached more than half a million pre-college students over the last three years.

Given below are specific examples of how the MRSECs and PREMs have met the goal of cultivating a world-class, broadly inclusive science and engineering workforce and expand scientific literacy of all citizens.

The Penn State MRSEC (DMR-0213623) has partnered with the Franklin Institute, a leading science museum in Philadelphia, to develop three cart-based science demonstrations that highlight materials science. By providing these carts to each of 41 science museums nationwide, they have greatly leveraged their effort, improving the science literacy of a broad swath of the citizenry across a wide geographic base.

The University of Maryland MRSEC (DMR-0520471) has developed a pre-engineering program as part of a six-year partnership with Charles Herbert Flowers High School *Project Lead the Way* (PLTW). The goals of the program are to increase the number of young people who pursue engineering and engineering technology, and to provide equitable and inclusive opportunities for all academically qualified students. The Maryland MRSEC is providing students with an exciting series of curriculum activities, including inquiry-based lessons and university-based tours and instruction days.

The University of Colorado Liquid Crystals Materials Research Center (DMR-0820579) provides a host of K-12 outreach programs designed to excite children about science and engineering while also supporting the Colorado Model Content Standard. Activities range from *Cool and Creative Chemistry*, to *States of Matter*, to *Exploring the Nanoworld*. This program has been offered to 65,000 children in the past 10 years.

The PREM at the University of Puerto Rico-Mayaguez (DMR-0934115) developed activities that presented current topics in nanoscience to the general public. One such activity was “DiasNano 2010 en el Mall” or *Nano Day at the Mall*. Ninety students (87 Hispanic, 39 women) presented four demonstration modules highlighting the properties of nano-materials. More than 2,000 mall visitors participated in the demonstrations.

B.3 <u>OUTCOME GOAL for Research Infrastructure:</u> “*Build the nation’s research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.”*

This category includes facilities, research instrumentation, and cyberinfrastructure.

Comments:

The Nation’s research infrastructure relies on the invention and innovation of advanced instrumentation and tools. The MRSECs provide the optimum organization to gather scientists, engineers and students that work in the areas where the needs are most demanding. Necessarily the focus of investment must be at this nexus of education and discovery. Within each MRSEC, shared experimental facilities provide access to advanced instrumentation for measurement and characterization. Nationwide, these facilities form a unique network available to users both from within the centers and from outside. Given below are two specific examples of how the MRSECs have met the goal of building national infrastructure in the material sciences.

At Yale University's Center for Research on Interface Structures and Phenomena (CRISP, DMR-0520495) a unique ultra-high vacuum, variable temperature, variable magnetic field atomic force microscope has been developed. The microscope is capable of magnetic, electrostatic, piezoelectric, and friction force microscopy. It operates in non-contact mode, thereby enabling atomic resolution. The present focus is on complex oxides, looking at ferromagnetic and ferroelectric properties of multiferroic materials.

During the FY08-10 period, the Materials Research Facilities Network (MRFN) expanded from its initial four sites to encompass 16 (now 20) of the MRSECs. The MRFN represents an effective means of operating a network of mid-size facilities that can support a broad range of both academic and industrial materials research across the country. The network is coordinated by the UCSB MRSEC (DMR05-20415) and provides a compendious list of available facilities at MRFN member sites, along with some funds to support access by users from non-member institutions.

OFFICE OF MATERIALS INSTRUMENTATION AND NATIONAL FACILITIES CLUSTER REVIEW (PARTS A AND B)

FY 2010 REPORT TEMPLATE FOR

NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: *February 9-11, 2011*

Program/Cluster/Section: OMINAF

Division: Division of Materials Research

Directorate: Mathematical & Physical Sciences

Number of actions reviewed:

Status	2008	2009	2010
Awards	12	9	9
Declines			
ARRA		4	
ARRA Total			2

Total number of actions within Program/Cluster/Division during period under review:

Status	2008	2009	2010
Awards	26	52	24
Declines	107	84	136
ARRA		38	
ARRA Total		177	

Manner in which reviewed actions were selected:

15 Proposals from Each Program

- 5 Clear Awards/Declinations
  - 2 Awards
  - 2 Declinations (including one renewal)
  - 1 Creativity Extension
- 5 Awards in the Decision Interval
  - 1 Renewal
  - 1 New proposal
  - 1 RUI
  - 2 Other
- 5 Declines in the Decision Interval

2 Declined Renewals

2 Declined New (young and established)

1 Other

10 Proposals culled from the different programs in each breakout

2 Specialty proposals in Each Breakout (1 award and 1 declination from each solicitation)

SciArt

Solar

SI2

CDI

Etc.

Co-reviewed Proposals (1 award and 1 declination)

Between Programs

Between Divisions

Between Directorates

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE**[10]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: Instrumentation panels are better than ad hoc due to synergy of panel members. For facilities both ad hoc and site visits are also critical. Source: Jackets and Program Director Presentations.	YES
5. Are both merit review criteria addressed g) In individual reviews? Most of the time. h) In panel summaries? Yes i) In Program Officer review analyses? Yes Comments: In individual reviews there are sometimes comments which are not helpful. Source: Jackets	YES

[10] If "Not Applicable" please explain why in the "Comments" section.

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: On the order of 5% will have overly simple comments such as for weaknesses they will reply with “none found.” Source: Jackets	YES
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Yes. Source: Jackets and facilities and MIP site visit reports	YES
5. Does the documentation in the jacket provide the rationale for the award/decline decision? Yes (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) vii) Were the reversals of the decision to decline based on both the	YES

high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. viii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: For the highly rated proposals which are not funded the decision is explained in the Program Director's analysis. Source: Jackets	

6. Does the documentation to PI provide the rationale for the award/decline decision? Yes (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: For the instrumentation proposals the panel summary is usually sufficient for this. For the highly rated proposals which are declined, we usually found documentation of a discussion between the PD and PI of the Program Director's analysis occurs. For the facilities proposals there are significant interactions between the PIs, the PDs and other NSF officials to address criticisms and budgetary issues. Source: Jackets	YES

7. Is the time to decision appropriate? YES Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: They were slightly over the goal in FY 2010 for the MRI program but this was a result of almost double the usual number of proposals and difficulties with multiple overlapping competitions, both of these due to ARRA funding. For facilities and MIP's the six-month goal should not be applicable as they are rather complex; the program officers are handling renewals well in advance of required dates. Source: Jackets and Data available on Website.	YES
8. Additional Comments g) Additional comments on the quality and effectiveness of the program's use of merit review process. h) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? Yes there are explanations on the jackets on the rationale for use of ARRA funding. Source: document "American Recovery and Reinvestment Act (ARRA) in DMR"	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[11]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Yes Comments: For the facilities they have made use of world class leaders from international and national groups. The reviewers came from a wide cross section for the instrumentation program Source: Jackets	YES
5. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? YES Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: From geography it is clear that there is a balanced choice including international reviewers as needed. From the demographics data available there is an effort to include underrepresented groups. Source: Jackets.	YES

[11] If "Not Applicable" please explain why in the "Comments" section.

3. Did the program recognize and resolve conflicts of interest when appropriate?
YES
Comments:

They were handled properly.

Source: Jackets and Program Director discussions

4. Additional comments on reviewer selection:

The Program Directors execution of these duties is excellent.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	**APPROPRIATE,** **NOT APPROPRIATE**[12]**,** **OR DATA NOT AVAILABLE**
1. Overall quality of the research and/or education projects supported by the program. Comments: Facilities: Excellent research and education programs. Instrumentation: Difficult to assess as many times the instrument becomes useful after the end of the grant period; as the grant is solely for the instrument. Source: Highlights and Program Director Presentations.	APPROPRIATE
2. Does the program portfolio promote the integration of research and education? Comments:	APPROPRIATE

[12] If "Not Appropriate" please explain why in the "Comments" section.

Successful proposals for facilities and MRI have included a clear statement about training of undergraduate, graduate students, and postdocs. In some cases, it even extends to high school students. Source: Program Director Presentations.	
3. Are awards appropriate in size and duration for the scope of the projects? Comments: The answer is yes for the Instrumentation program but there is a significant need to increase the funding for instrumentation at the scale of $100k or less. Stewardship of a facility implies a special relationship between NSF and the operator of a facility, including consideration of both appropriate metrics for review and consideration of the future, especially in light of the significant investments in capital equipment and personnel associated with a facility . Periodic and timely review of stewarded facilities is critical and should continue as presently performed. The result of such reviews could include modification of goals of the facility, renewal, closure, re-competition, or a determination to invest NSF funds in other activities.	APPROPRIATE

Source: Jackets and Data available on website.	
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: Instrumentation: To advance research it is often important to purchase off-the-shelf instrumentation while also it would be great to see more instrument development proposals and we invite NSF to make PIs aware of this. Development of innovative research equipment often takes many years and a mechanism to fund these long term (greater than 5 yrs.) project should be developed. In addition, there is a significant need to increase the funding for instrumentation proposals other than the MRI program which is decided at a higher level. Source: Highlights and Program Director Presentations.	APPROPRIATE
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: (can combine with question 10 on p. 12) These programs are inherently multi-disciplinary. Source: Jackets, program information, and data e.g. on jointly funded projects.	APPROPRIATE

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? YES Comments: All these proposals are inherently multi PI. Source: Program Director Presentations.	NOT APPLICABLE FOR SINGLE PI, OTHERWISE APPROPRIATE
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: As much as 1/3 of the lead PIs for MRI grants are new PIs. Source: Program Director Presentations.	APPROPRIATE
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The geographical distribution is appropriate. Source: Data available on website.	APPROPRIATE

9. Does the program portfolio have an appropriate balance of: • Institutional types? Facilities: 4 Universities 1 National Laboratory In the MRI program there is a good balance. Comments: Source: Data available on website.	APPROPRIATE
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: Source: Jackets and program information	NOT APPLICABLE
11. Does the program portfolio have appropriate participation of underrepresented groups? YES Comments:	NOT APPROPRIATE FOR FACILITIES BUT IS FOR INSTRUMENT-ATION

<table>
<tr><td>Source: Data available on Web and Program Director Presentations.</td><td></td></tr>
<tr><td>12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports.

YES

There have been numerous reports on the importance of user facilities in light sources, neutron facilities, and high field magnet labs such as the Light Source Panel Report and Basic Research Needs for Materials Under Extreme Environments.

Comments:

Source: Program Director Presentations and information on DMR COV website under public attachments. Condensed-Matter and Materials Physics: The Science of the World Around Us (NRC, 2007) - also known as CMMP2010. In it Chap. 11 discusses instrumentation and facilities.</td><td>APPROPRIATE</td></tr>
<tr><td colspan="2">13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards).

ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?

The role of NSF as a steward of facilities within DMR is in tension with flexibility and broad competition. Stewardship requires commitment and a reasonable potential to invest in improvements. The size of the facility budgets (CHESS and NHMFL) and related R&D investments use much of the budget allocated to OMINAF, putting pressure on funds for IMR and IMR/MIP. The latter parts of the portfolio are important but suffering, especially in terms of breadth of research areas supported.</td></tr>
</table>

As to the funding level of the facilities overall, it is difficult to judge as there is not an easily identified metric. In general DMR should develop a process which looks at the complete DMR portfolio to decide how the resources should be allocated.

NSF as a whole, and DMR in particular, presently has no program for accommodating instrumentation/facilities with construction budgets within the range of $10M to $100M; the lower boundary may be slightly flexible. Proposals for instrumentation enabling transformative research that fall into this window must presently be rejected without review. Given the challenges of providing funding at this level, it might be appropriate to consider an NSF-wide program to fill the gap.

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Excellent

Comments:

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

Stewardship of major facilities inherently implies slow response. Within the constraints implied, however, in the areas of photon science and high magnetic fields, they have been proactive.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

The program has effectively utilized panel reports, proposal reviews, and site visits to inform program directors and higher level officers for decision making.

4. Responsiveness of program to previous COV comments and recommendations.

Difficulties with the low cost instrumentation funding remain; significant support for IMR and IMR/MIP must be found.

There was also a recommendation to move the facilities to the NSF Director's level which was not implemented. We are not recommending this but we do recognize the critical need to gain support for the facilities from other NSF Divisions and not at the expense of either the instrumentation program or other parts of DMR.

5. Additional comments on program management:

Extend MRI grant period to five years or two years beyond instrument qualification this will allow adequate time for research and broader impact so proper credit can be realized.

MRI diversity statistics are in general very good but they should also include statistics based on submissions in addition to other pools due to prescreening by submitting organizations.

The PDs are extremely professional and excellent in the performance of their duties but suffer from their work load. In fact, beyond their normal duties they have over seen the ARI program. It would be very useful to expand the number of PDs overseeing these programs.

There is additional effort and responsibility involved in monitoring projects as progress must be reviewed monthly.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

In addition to identifying particularly noteworthy accomplishments or "highlights," the COV is encouraged to comment on the impact of NSF supported contributions to the field. For example, the COV report may include comments on NSF supported work in context of contributions to advance a field, impact of NSF investments to stimulate emerging new areas, and potential for transformative impact in research or education.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 <u>OUTCOME GOAL for Discovery:</u> "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:
MRI:

1. DMR—0619759: M. Nasse, M. Walsh, R. Bhargava, and C.J. Hirschmugl, Univresity Wisconsin-

Milwaukee and U. Illinois, Urbana. Improves the mapping of biological cells. This instrument increases spacial resolution by 20x (10um to 0.5um), improve time resolution 240x (4 hrs to 1 minute), and improve s/n ratio. The pictures show these very dramatic differences.

2. DMR—0821450: Kenneth J. Rothschild, Boston University. Development of ultra-fast (35 fs) ultra-low noise optical spectroscopy system.

3. DMR—0722631: G.B. Thompson, M.L. Weaver, T. Klein, W. Butler, and D.E. Nikles, University of Alabama (Tuscaloosa). Add a fast pulse laser for an atom probe system which adds thermal heating to assist the field evaporation of the atoms which are detected to generate an atomic scale 3D reconstruction of materials.

National Facilities

1. DMR—0936384: Wang and Gruner, Argons National Lab and Cornell. For the first time, measure the dynamic behavior of shock waves generated by and interacting with a supersonic and disintegrating-liquid jet.

2. DMR—0654118: Gregory S. Boebinger, National High Magnetic Field Laboratory. Used pulsed electron magnetic resonance to demonstrate the initialization, manipulation, and storage of quantum information using bismuth atoms in silicon.

3. DMR—0454672: X. Shi, J. Yang, J.R.D. Copley, and J.J. Rush, GM R&D, NIST, and University of Maryland. Skutterudites (cage structured compounds) increase thermal to electrical conversion efficiency by a factor of 2 making this material very attractive for power generation applications.

B.2 <u>OUTCOME GOAL for Learning:</u> ***"Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."***

This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

The High Field Magnetic Field facility has developed excellent outreach activities and programs which can be seen at http://www.magnet.fsu.edu/education/ . We also applaud their Magnet Lab User Summer School for developing skilled users.

All three NSF supported National facilities have REU and RET programs.

DMR 0654118

DMR 0454672

DMR 0936384

B.3 <u>OUTCOME GOAL for Research Infrastructure:</u> ***"Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."***

This category includes facilities, research instrumentation, and cyberinfrastructure.

Comments:

Instrument for in situ study of atom-by-atom synthesis with small-angle x-ray scattering (CHESS)

Construction of a neutron spectrometer with vastly enhanced efficiency (CHRNS)

Construction of a novel hybrid superconductive plus resistive high-field magnet (NHMFL)

OFFICE OF SPECIAL PROGRAMS CLUSTER REVIEW (PARTS A AND B)

FY 2010 REPORT TEMPLATE FOR

NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: *February 9-11, 2011*

Program/Cluster/Section: Office of Special Programs (OSP)

Division: Division of Materials Research

Directorate: Mathematical & Physical Sciences

Number of actions reviewed:

Status	2008	2009	2010
Awards (incl. MWN awards managed by Indiv. Invest. programs)	9	16	7
Declines	9	12	7
Other			

Total number of actions within OSP during period under review:

Status	2008	2009	2010
Awards (incl. MWN awards managed by Indiv. Invest. programs)	45	50	49
Declines	159	203	179
Other			

Manner in which reviewed actions were selected:

Selection includes clear awards and clear declinations, and awards and declinations within the decision interval, including new proposals, renewal proposals, co-reviewed proposals and ARRA awards for activities managed by OSP (REU Sites, Materials World Network, International Materials Institutes).

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review.

Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE**[13]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: All proposals in OSP are reviewed by panels, and some have additional mail reviews. This method seems to be quite appropriate and works well. Additional joint reviews with foreign funding agencies are performed where needed and this process also seems to be appropriate and works well. Source: Jackets and Program Director Presentations.	YES
2. Are both merit review criteria addressed j) In individual reviews? k) In panel summaries? l) In Program Officer review analyses? Comments: In general, both criteria are addressed, as is a third criterion for MWN and IMI proposals regarding their international impact and international collaborations. One item noted by the committee was that the thoroughness of comments regarding broader impact varied considerably, particularly in individual reviews and/or in panel review when the intellectual merit of a proposal was ranked low. A stated and consistent method for assessing the broader impacts might be useful. Source: Jackets	 YES YES YES

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals?	YES

[13] If "Not Applicable" please explain why in the "Comments" section.

Comments: Generally, the individual reviewers do indeed provide substantive comments. Occasionally the ratings and the comments did not appear to be consistent with each other. A slightly more extensive template for reviews (dividing aspects now considered under intellectual merit and broader impacts into subsections that reviewers could answer separately, such as separating the PI's track record from the merit of the proposal, etc.) would be very useful. Source: Jackets	
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Panel summaries are generally quite good, although they are occasionally somewhat brief for proposals that are obviously weak in terms of intellectual merit. Source: Jackets	YES
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) ix) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. x) Is documentation provided, including a revised Review Analysis, to support the award decisions?	YES YES YES

Comments: Yes, documentation in the eJackets, particularly the review analyses by the program officers, provided very clear rationale for each decision (including ARRA acceptances). Source: Jackets	

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The PI gets adequate documentation in the form of reviews, panel summaries and the context statements. Sometimes the panel summaries are brief, and do not fully explain the rationale for declinations. The program director's Review Analysis provides a more comprehensive perspective, and helped the COV understand the award/decline decisions much better. The COV members suggest that some portion of this review analysis could be included in the declination decision letters to help PIs understand better the rationale for the decision. Alternatively, as is currently done by the program director in OSP, the PIs could be asked to read the reviews and then call the PD for more clarification. In this manner the PI is provided more information helping them understand the weaknesses of their proposal and suggestions on how to improve the proposal. Source: Jackets	YES
7. Is the time to decision appropriate?	YES

Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The OSP program does a spectacular job of meeting the NSF goals of time to decision. 100% of the REU program decisions are made well within the 6 month goal. Considering the complexity of the MWN proposals to coordinate funding with foreign agencies, it is commendable that the OSP has managed to provide decisions for a majority of the MWN proposals within the 6 month window. Some MWN proposal decisions can be delayed due to the funding timeline of the collaborator's research proposals in the foreign countries, and clearly outside the control of the NSF. Source: Jackets and Data available on Website.	

8. Additional Comments

i) Additional comments on the quality and effectiveness of the program's use of merit review process.

The MWN program has been innovative in using reviewers from foreign countries to participate in the merit review process, and by conducting panel reviews jointly with funding agencies from the foreign counterparts, where possible.

j) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

The Review Analyses provide adequate justification of the rationale for using ARRA funds for specific proposals.

Source: document "American Recovery and Reinvestment Act (ARRA) in DMR"

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[14]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The reviewers are very well qualified in the various areas of research represented in the portfolio of projects supported by the OSP. Source: Jackets	YES
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: The COV panel noted that the demographics of the reviewers for panel reviews reflects the demographics of the PIs submitting proposals to these programs. The percentage of reviewers (URM, female, PUI) meets or slightly exceeds the corresponding percentage among the PIs submitting proposals to these programs. This shows that the OSP program is being proactive to include a diverse pool of reviewers. The reviewer pool is well balanced with regard to geography, type of institution and underrepresented groups. Source: Jackets.	YES
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: The program directors have taken care to recognize and resolve conflicts of interest. Source: Jackets and Program Director Presentations	YES

[14] If "Not Applicable" please explain why in the "Comments" section.

4. Additional comments on reviewer selection: We commend the OSP program on a proactive approach to involving reviewers from diverse demographic groups and from institutions across the US, from undergraduate institutions as well as research universities, and also from foreign funding agencies and foreign research institutions.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	**APPROPRIATE,** **NOT APPROPRIATE[15],** **OR DATA NOT AVAILABLE**
1. Overall quality of the research and/or education projects supported by the program. Comments: Overall the quality of the projects supported was excellent. Source: Highlights and Program Director Presentations.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: The REU program does an excellent job of integrating research and education. The IMI program promotes networking and direct integration of evolving research areas with advanced training such as workshops and summer schools. The MWN program promotes international education along with research. Source: Program Director Presentations.	Appropriate

[15] If "Not Appropriate" please explain why in the "Comments" section.

3. Are awards appropriate in size and duration for the scope of the projects? Comments: The funding level for individual REU awards is relatively low, but this allows more sites to be funded in diverse areas of research. The administrative burden to run an REU site is high, hence a higher funding level per award would allow more students to take advantage of the infrastructure and research opportunities. However, the COV felt strongly that this should happen only if the overall budget for the REU program can increase, so that the number of awards is not reduced. There is a high demand by undergraduate students for these NSF funded research experiences, and an increasing number of graduate schools are requiring that Ph.D. applicants have research experience. The funding level of MWN awards was considered reasonable, especially in view of the cost of international collaboration and travel. Questions were raised about the size of the IMI awards. The NSF might consider more awards of smaller amounts in future competitions and require awards to focus only on networking and international research opportunities, without funds to support 12 months/year of full time graduate students and post-docs at the home sites to conduct research. The IMI projects that were awarded were of high quality. Concerns were raised about the awareness in the broader community of the current IMI programs and opportunities for participation. Hence, such opportunities for participation from outside the immediate collaborators can be limited. Better publicity of all international opportunities for summer schools, workshops, etc. on an NSF website to alert the broader community of these opportunities would be helpful (similar to the REU website that lists links to all the REU opportunities). Source: Jackets and Data available on website.	Appropriate

4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: The COV was satisfied that there was an appropriate balance of high risk, potentially high reward and transformative research. The COV in particular noted the innovative aspects of the Materials World Network in which scientists with complementary areas of research are brought together, such as theory/modeling experts with experimentalists. Source: Highlights and Program Director Presentations.	Appropriate Appropriate
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: (can combine with question 10 on p. 12) The COV was fully satisfied as to the extent and balance of inter- and multi-disciplinary projects. The REUs are naturally interdisciplinary and multidisciplinary due to the nature of the research to be undertaken by many students at one site. The MWN receives over 180 proposals that cover all sub-divisions of DMR and evidence shows that this program has brought theory and experiment based scientists together, as well as scientists from complementary research areas within DMR. The COV noted that the significant number of MWN proposals reviewed by more than one panel (outside DMR) was a strong testament to the interdisciplinary and multidisciplinary nature of the projects. Additionally, some of the IMIs are multidisciplinary in nature. Source: Jackets, program information, and data e.g. on jointly funded projects.	Appropriate

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The COV felt that the high number of applications for places on REUs justifies an increase in the number of places available. The panel noted that many graduate admissions committee look favorably on students who have research experience. The COV was satisfied with the balance and award size for projects in MWN. From the comments of reviewers available in the eJackets, the COV was very satisfied with the attention paid to monitoring the work load balance between the US and international investigators. The COV commented favorably, in particular, on the diversity of partner countries for research in MWN funded proposals, reaching collaborators in 38 different countries across the world. The COV thought that the size of awards for the IMI could be reduced, thereby allowing a greater number of IMI awards to be given to promote networking in additional areas of materials research. The COV further noted that budget adjustments reflected the comments of reviewers, the panel summary, and review analysis of the program director. Source: Program Director Presentations.	Appropriate except for IMI
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: The COV was satisfied with the balance of awards to new investigators in the ARRA and MWN programs. The participation of new	Appropriate

investigators for the REU is appropriate to the nature of the program. Source: Program Director Presentations.	
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The COV was satisfied with the evidence of geographical distribution of principal investigators taking into consideration the population density of different states. Source: Data available on website.	Appropriate
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: The COV was pleased to see the PUIs have been successful in receiving not just REUs, but also MWN awards. Source: Data available on website.	Appropriate

10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: The proposals cover an appropriate range of disciplines. Source: Jackets and program information	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Using the “Funding Rate” as a reference point, a significant percentage of awards went to female PIs and PIs representing minority groups. The percentage of female applicants and female awardees for REUs was greater than for MWN grants. Source: Data available on Web and Program Director Presentations.	Appropriate
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: As indicated in the following National Academy studies, Educating the Engineer of 2020, The Engineer of 2020, The Gathering Storm, and Rapidly Approaching Category Five, materials research and education and international collaborations are essential for the future of our country and the betterment of the world security, environment, and human health.	Appropriate

Source: Program Director Presentations and information on DMR COV website under public attachments.	

13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards).

ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?

The current portfolio is broad and well balanced. There is a significant need to increase REU funding as they provide extremely valuable experiences to students. At the current funding level many qualified students must be turned away from programs across the country.

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments: The program director has done an excellent job of managing a very diverse portfolio, including creating mechanisms to foster international collaboration and increase participation from developing countries. The program director has made special efforts to visit countries in order to understand the funding mechanisms in different countries that are not currently able to participate in MWN, developing an understanding of the different models used in different countries so that NSF can provide flexibility, when needed, to facilitate international collaboration. The review analyses of the individual proposals by the program directors are very informative and insightful, and provided added depth and rationale. However, the COV is very concerned that there is only one program director currently for such a large, diverse, and critical portfolio of OSP programs in DMR.

2. Responsiveness of the program to emerging research and education opportunities.

Comments: The REU sites provide opportunities for research in emerging areas and offer extensive educational and research opportunities for students outside of the host campus. The program director directly interacts with the REUs to ensure that student populations outside of the host institution are served, and this beneficial oversight has also resulted in REUs overall demonstrating strong participation by women and underrepresented minorities. The MWN program has provided a means for NSF to identify emerging areas from around the globe by funding US participants to collaborate internationally, offering international education and research opportunities for undergraduates and graduate students.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments: There is much groundwork and planning that has to be accomplished prior to establishing an opportunity to participate in applying for the international collaborative grants (the home country must also have a peer review system that approves and funds collaborative proposals in order for the U.S. side to be funded by NSF), and the program director has done an excellent job. For the REUs, the establishment of a central website (and Googlemap) has been extremely helpful for providing access for the larger materials science community and allowed students to easily find research opportunities across the U.S. in preparation for graduate school.

4. Responsiveness of program to previous COV comments and recommendations.

Comments: The previous COV report does not contain specific recommendations for OSP, with the exception of concerns about the high workload for staff at NSF. That issue does not seem to have been resolved.

5. Additional comments on program management:

OSP has been managed in a proactive and responsive manner.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

In addition to identifying particularly noteworthy accomplishments or "highlights," the COV is encouraged to comment on the impact of NSF supported contributions to the field. For example, the COV report may include comments on NSF supported work in context of contributions to advance a field, impact of NSF investments to stimulate emerging new areas, and potential for transformative impact in research or education.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 <u>OUTCOME GOAL for Discovery:</u> "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*"

This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:

IMI

Liaw, Choo, and Huang at the University of Tennessee and collaborators with the International Materials Institute for Advanced Neutron Scattering Network for Education and Research (DMR-0231320) studied nano-particle-strengthened nickel-based superalloys using in-situ neutron-diffraction and small-angle neutron scattering and were able to deduce the strengthening and deformation mechanisms operational in nickel-based superalloys, commonly used for turbine blades and other high temperature material applications where strength is critical.

MWN

The Materials World Network (MWN) program on Anisotropic Colloidal Magnetic Nanostructures, PI – Vinayak P. Dravid, Northwestern University, DMR- 0603184, has developed "multi-modal" magnetic nanostructures which can be targeted to cancer cells with appropriate surface receptors for in-vivo imaging with magnetic resonance imaging (MRI). These innovative magnetic nanoparticles allow target-specific therapy with thermal activation for brain cancer cells.

Nano-Macro Porous Glass Bone-Scaffolds by Himanshu Jain Lehigh University DMR 0602975 by has created new materials for bone repair with a bimodal pore size distribution in a glass scaffold, difficult to create when making materials as the smaller pores tend to be agglomerated into larger pores. This collaborative research required input from scientists from Egypt, students from Senegal and students from Tuskegee University, an HBCU.

Brian A. Korgel (The University of Texas at Austin) DMR-0807065 has demonstrated how a transmission electron microscope could be used to create a rigid carbon "nano test tube" around a Ge nanowire, thereby enabling the study of melting and diffusion within this nanoscale volume restricting "test tube." This research provides an innovative route to obtain information on how confined nanoscale geometry greatly influences physical phase transformations in materials. This work was featured in *Science*, **2009**, *326*, 405.

Semiconductor Electronics inside an Optical Fiber (DMR-0502906) by Badding at Penn State showed that how a new type optical fiber can be produced by creating additional functionality by incorporating semiconducting materials inside the optical fiber. They have successfully demonstrated transistor operation and optical switching for this novel material.

REU

At the College of Wooster, the REU program sponsored summer collaborative research on the /. (slash dot) body problem, which concerns gravitational interactions of line and point masses relevant to the trajectories of asteroids. The PI, John Lindner and three undergraduates produced an elegant solution to the problem using computational approaches that was published as a major paper, John F. Lindner, Jacob Lynn, Frank W. King, Amanda Logue, *Phys. Rev. E* **81**, 036208 (2010). Two of the undergraduates also presented portions of this work at the national American Physical Society (APS) meetings.

B.2 OUTCOME GOAL for Learning: ***"Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."***

This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

IMI

The African School on Electronic Structure Methods and Applications at Cape Town, South Africa was sponsored by Nicola A. Spaldin (UC Santa Barbara) of the International Center for Materials Research (ICMR) DMR-0843934. This was a highly effective two week summer school on computational materials science with 40 hours of lecture and 18 hours of hands on computation that brought students together from not only across the U.S., but also students from a dozen countries in Africa.

A novel approach to increase the ability of graduate students to explain research to broad audiences was developed by the same International Materials Institute (IMI) (PI- Nicola A. Spaldin at UC Santa Barbara, DMR-0409848) in collaboration with the Materials Research Society (MRS). This program called 'Apprentice Science Reporters' provides opportunities for graduate students to accompany professional reporters from MRS to international MRS meetings as trainee science journalists. They attend talks, work with the MRS reporters to compile technical summaries for the Meeting Scene website and maintain the student blog, http://materials.typepad.com. Here is a comment from one of the students which sums up how this writing experience can contribute to student learning. "Spending a week as a reporter at the European Materials Research Society turned into a unique conference experience for me. I attended a broader range of symposia than I normally would and synthesizing my conference notes into write-ups allowed me to consider the connections between the different fields of materials research."

H. Jain, Lehigh University and C. Pantano, Penn State, DMR-0409588, have created 14 science camps to help students at the middle school and high school level to understand glass science. Innovative approaches include using candy equivalents for glass processing, including spinning candy "glass" and studying phase separation of fudge. These experiments were developed based upon science fair projects created by actual middle school and high school students, making the science both accessible and attractive. Their subsequent IMI grant, DMR 0844014, titled "New Functionality in Glasses" co-sponsored with ArtsLehigh of Lehigh University the US visit of internationally-known glass artist Ioannis Michaloudis, who delivered a series of lectures about his

"Aerosculptures" at universities and pre-college venues across Pennsylvania. These creations use aerogel as sculpture media. Due to their exceptional physical properties, such as extremely high electrical and thermal insulation, aerogels are remarkable materials that fascinate researchers and space engineers - and now also visual artists. The artist's lectures showcased the one-of-a-kind ethereal sculptures made only possible by modern materials science.

MWN

The Chicago-Chile Materials Exchange (DMR-0807012) by Witten at the University of Chicago since 2004 has sponsored 44 Chilean students on 10 week exchange visits to the University of Chicago with reciprocal visits made by a similar number of University of Chicago students to the University of Chile in Santiago. Their projects have led to co-authorship of papers in key research journals as listed below.

(a) J. Royer, D. Evans, L. Oyarte*, Q. Guo, E. Kapit, M. Moebius, S. Waitukaitis, and H. Jaeger, Nature 459, 1110 (2009) is based on research during Loreto Oyarte's internship January-March 2007.

(b) M.G. Clerc, P. Cordero, J. Dunstan, K. Huff, N. Mujica, D. Risso, & G. Varas, *Nature Physics* **4**, 249 - 254 (2008) is a paper involving three interns from the program.

(c) Luka Pocivavsek, Robert Dellsy, Andrew Kern, Sebastian Johnson, Binhua Lin, Ka Yee C. Lee, and Enrique Cerda, *Science*, **320** 912-916 (2008), is a project driven by Pocivavsek's internship with Prof. Cerda in Chile where he developed the ideas for this paper, then returned to Chicago to explore its experimental implications with the help of Chilean intern Sebastian Johnson.

Bridging Atomistic to Continuum Scales – Multiscale Investigation of Self-Assembling Magnetic Dots in Heteroepitaxial (DMR-0502737) is an MWN grant by Katsuyo Thornton. Thornton and her group at the University of Michigan have developed several workshops for girls in fifth to eighth grade introducing the power of computing in understanding material structure and design. This early introduction to computational materials science can help spark girls' interests in computing and engineering.

REU

The REU/RET Site on "Structure-Property Relations in Advanced Materials for Biological/Sensor, Structural/Environment, and Energy Usage" by N.N. Thadhani, A.M. Gokhale, C. Summers, V.T. Milam, and F. Alamgir, at Georgia Tech, DMR-0851574, has created research experiences during the summers for 20 undergraduates (including sending 2 overseas) and 7 teachers. The students and faculty continue throughout the year to work with teachers in the classroom on labs and lectures, integrating current research on sensors for biological, environmental and energy use into the high school science curriculum.

The REU Summer Research Program in Materials Science and Nanotechnology (DMR-1004869) has Tarr and O'Connor at the University of New Orleans and colleagues running a 9 week intensive summer program covering all aspects of nanotechnology and developing students' transferrable skills in topics such as research concepts, lab safety, and scientific ethics. Since 2003, a total of 37 presentations at conferences and several peer reviewed publications by students have emerged directly from this program. 63% of the participants were African American and 52% were female.

B.3 <u>OUTCOME GOAL for Research Infrastructure:</u> "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

This category includes facilities, research instrumentation, and cyberinfrastructure.

The OSP program has produced several examples of cyber-enabled learning tools. Two notable examples are highlighted below:

The IMI at Penn State University with PIs H. Jain, Lehigh University and C. Pantano, Penn State (DMR-0409588) has developed a novel solution to a generic problem facing many U.S. universities. Often, there are not enough students at a single university to take an advanced class, especially in small fields like glass, and the course may not be taught. The co-operative glass course developed by the IMI combines the expertise of instructors from six universities and is taught to students from seven universities (taught remotely to students not on site). The archived lectures are permanently available as a course or as a refresher on the web.

The International Materials Institute on Neutron Scattering by P. K. Liaw and H. Choo works on application on neutron scattering to mechanical properties of materials at the University of Tennessee DMR-0231320. This IMI has developed On-line Open Courses. The tutorials, workshops, and short courses, are available on the Internet for the public access (http://answer.utk.edu).

Jun Jiao (Portland State University, DMR 0649280) developed a summer REU program that is unique in that it exposes undergraduates to the actual use of highly sophisticated research instrumentation including Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), and Focused Ion Beam (FIB) microscopy. Students also have field trips to a major company that manufactures electron microscopes in order to understand how such instrumentation is developed.

PART C. OTHER TOPICS

These questions were posed to the committee of visitors. Responses and recommendations are identified for each question.

1. QUESTION - Organization

Materials science and materials engineering research in its broadest sense is conducted in divisions within the Directorate for Mathematical and Physical Sciences (MPS) as well as in other directorates throughout the Foundation. This distribution of programs and efforts may be seen as reflective of the vibrancy of the field but is it the most efficient and effective model for driving innovative high-risk materials research?

If there were the opportunity to configure a new materials research directorate within the Foundation, what would the COV like to see included in such a directorate and should it be structured along traditional or thematic areas?

If it were impractical to create a new directorate, is the current structure of DMR appropriate and sufficiently agile to catalyze emerging research areas? If not, what structure(s) would you recommend be considered?

Response from COV:

There was a wide ranging discussion concerning the current and future structure of materials research within NSF. On the question of the identity of materials-based research within the Foundation:

- It was noted that DMR is the largest division within the MPS, which itself is the largest directorate in the NSF. The materials research field plays a crucial role in driving the economy of the nation and of the world. The field is also very broad and large in terms of number of researchers. A new Directorate for materials research is endorsed by the COV since this Directorate would provide a better representation of materials related research within NSF and would raise the profile of materials research both nationally and internationally.
- A new Directorate would permit a better allocation of resources within NSF towards materials related fields. Similarly, the distribution of resources from national programs (such as America Competes or ARRA) that target funds towards areas involving materials research will be simplified. Formation of a Materials Research Directorate would permit a coherent voice for this research community not only within NSF but also towards external agencies. A new Directorate would also permit improved control of national facilities and instrumentation funds for materials-related activities.
- Whatever reorganization might occur, it should remain consistent with the current long-term horizon of the research mission of the Foundation's materials research effort.

Concerning the program structure within DMR, or within a new Directorate if it were to be formed:

- The present traditional program areas of DMR seem to work quite well (most proposals to DMR currently are submitted to non-thematic Calls for Proposals), and should be retained at least at the top organizational levels. Thematic areas (such as "synthesis" or "nanofabrication") at lower levels might be appropriate.
- The balance between basic research when compared with applied research must be considered. A significant amount of applied materials-based research presently takes place in Engineering programs, and it is felt that very applied materials engineering work should *not* be incorporated in a new Directorate. Of course, funding recommendations for applied research could be (and have been) made in consultation between staff of different directorates or divisions.
- The importance of being able to successfully obtain funding for proposals that cut across areas, and hence cannot be simply categorized, is a crucial consideration in any reorganization of DMR. Similarly, the importance of adequately capturing and funding new and emerging areas of research is also crucial. The COV feels that the present structure of DMR is sufficiently agile to catalyze emerging research areas, and this structure should not be changed in a new directorate.

RECOMMENDATIONS:

- The COV endorses the creation of a Materials Directorate within NSF, provided that proper attention is given to seamless connections with areas of materials research within other directorates or divisions. Any reorganization must be consistent with long-term research horizons and the full breadth of DMR.
- Staffing in DMR should be increased to reflect its budget and responsibilities.

2. Question: Facilities and Instrumentation

DMR is invested in providing the materials research community with state-of-the-art facilities and instruments. It supports research and development of major facilities such as Coherent Light Sources, is the steward of national user facilities such as light sources and the high magnetic field laboratory, and supports the acquisition, conceptual design and/or construction of midscale instrumentation by/for the materials research community. The support for facilities and instrumentation initiatives amounts to approximately 20% of the annual budget.

Is the current portfolio of user facilities and instrumentation programs appropriate or are there activities that should be receiving more attention?

How does this portfolio fit within the national context of tools for materials research?

Within the 20% of annual budget for tools, is the balance across all scales healthy and appropriate?

Response from COV:

Instrumentation (<$100M):

Access to state-of-the-art instrumentation/facilities is necessary for United States universities to continue leading-edge research activities. There are major gaps in instrumentation funding between $10k and $100K, and from $100K to $10M-$100M. Instruments below $10k are easily covered in individual investigator or CAREER awards. While instruments above $10k can be funded through these awards, the use of these funds for instruments is relatively rare (a few %). The MRI program, which is NSF wide and not a strictly DMR program, is available for instruments between $100k and $4M. There is a 30% match required for major Ph.D. institutions.   The IMR program, which also funds mid-scale instrumentation, has been interrupted due to lack of funds in the last couple of years.

The COV found the following issues in this area:

- Including instrument funding in individual or CAREER awards, at those awards current funding level, would seriously limit the research that can be done and limit the number of students supported. Increasing their funding would greatly reduce the number of awards and success percentage.
- Efficiency of use of the instruments needs to be considered. In some other countries, overfunding of instruments in this price range leads to mass underutilization of those instruments.
- Having a separate call for proposals for instrumentation between $10k and $100k is not feasible for several reasons. The NSF overhead in evaluating and awarding/declining these proposals is almost the same as for a $1M instrument. As the cost of an instrument goes down, so does the innovative breakthrough scientific impact. We believe that such additional funds could be made available to funded PIs through the instrumentation program and the PIs program directors.
- A long-term plan, encompassing the entire NSF instrument portfolio, needs to include balance to prioritize the types of facilities or instrumentation needs so that resources are used more efficiently.
- How much and which classes of instruments should go into individual laboratories or in centers?
- The previous IMR program, which covers part of this instrument cost range, was discontinued because of lack of funding. There has only been one such solicitation in the past 3 years. We believe that more funds for this activity are very important.

These concerns are equally important and difficult to solve under the current limited budget. However, some process changes can help.

- A national listing of intermediate and higher cost instruments could enable more efficient usage of existing equipment thereby reducing redundant equipment and requests.
- MRI equipment awards, although above $100k, should include permanent access to external academic users at usage costs comparable to those for internal users. In addition, grant recipients should be polled for broader impacts and instrument usage statistics after the grant period has expired.
- An idea could be to use part of any future increases in the overall individual contributor or CAREER budget to increase the size of the individual awards for instrumentation, instead of using the entire budget increase for expanding the number of awards. Over time, this could add practical levels of instrumentation funding to these awards without severely reducing the number of awards available or their success rate.

National Facilities:

The current funding of the national facilities at 20% of the DMR budget may be a long term issue. The COV discussed:

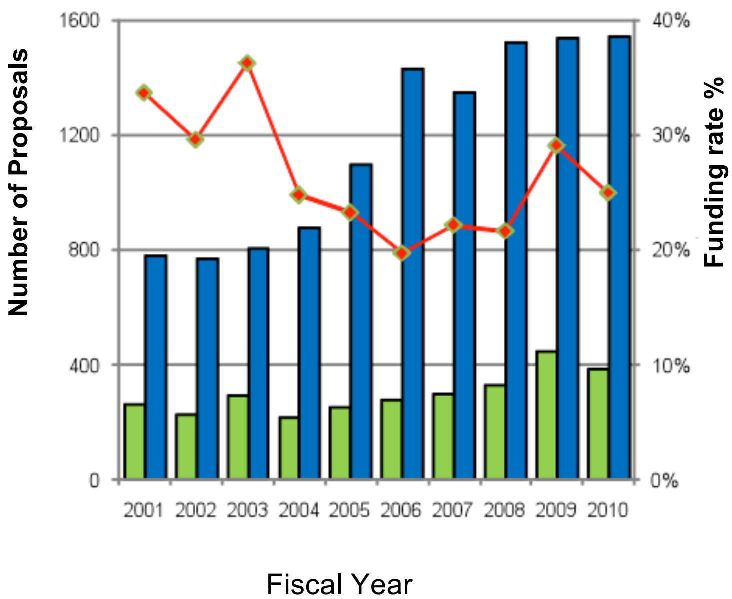
- The return-on-investment of the base facility as opposed to the actual research costs. For example, research discoveries that are funded using the $9M R&D budget may seem very worthwhile, but not so much when the entire ~$30M budget (which includes the $20M operating budget) is considered.
- As the facilities age and competing facilities (e.g. light sources) become practical, these facilities may consume even more of the DMR budget.
- Does this level of spending limit the flexibility of DMR to exploit emerging technologies?
- Should these facilities be in a separate directorate? The COV felt strongly that this could leave them with no champion and, as a consequence, drying up funding.
- The operations mode adopted by these facilities, which allow users instrument time to prototype and prove-in their experiments, is critical to advances in the areas these laboratories support. For example, this year's Nobel Prize in Chemistry was prototyped in such a facility. DOE facilities do not have this crucial flexibility.
- Is the Physics Division's share of CHESS funding going to be shifted to DMR's budget since DMR is taking over those responsibilities?

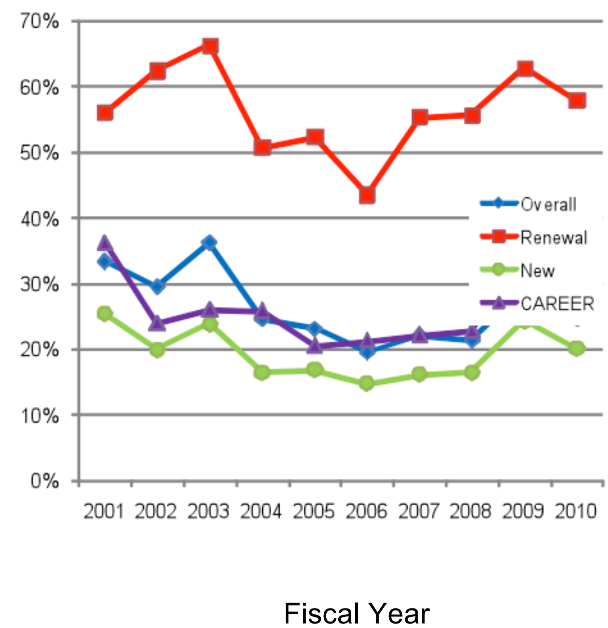
RECCOMENDATIONS:

- DMR should make a larger share of their facilities/instrumentation funds available for instrumentation for all scales from 30K to $10M+. Efforts should be made in program solicitations and review to see that large instruments are appropriately shared.
- *Especially in these expected challenging budget times*, NSF should develop a facilities stewardship strategy with the materials community in the context of its mission and the role of other agencies.

3. Question: Balancing system pressure, award size and success rate.

The following figures summarize the historical trend in number of proposals submitted, number of awards made, funding rate and the success rate for renewal proposals as well as for new proposals:





DMR 10-year funding history for Individual Investigator awards. Funding rate, Funded proposals proposals submitted.

DMR ten-year history of funding success rate for Individual Investigator awards.

Given this information along with the workload pressure this places on the entire systems, program directors, reviewers and budget, what would you recommend with regard to:

- Restricting the number of submissions a PI can make in any one funding cycle in DMR, to any division within MPS, and to the Foundation.

Note: The following appears on the NSF DMR homepage:

"DMR discourages the submission of more than one proposal from the same Principal Investigator during the proposal-submission window."

- Restricting the number of times a declined proposal can be resubmitted by the PI. Here it is important to remember that if the proposal is submitted with substantial changes, it must be reviewed; the program managers have little flexibility to reject a proposal without review.

- Balancing the size of the award with the success rate

- Rebalancing the research portfolio to make the award size larger and have an acceptable funding rate, but in fewer research areas.

Response from COV:

The average award size increased by approximately 15% over the past five-year period, however, this increase was significantly outpaced by the approximately 25% increase in the cost to support a graduate student. The increased graduate student cost has been driven primarily by increases in tuition, overhead and benefits. As a result, current individual investigator awards can typically support only one graduate student. It was noted that many PIs need to write multiple grant proposals in order to maintain the size of their research groups. This distracts the PIs from focusing on science and education. It was also pointed out that the increase in costs versus award size will have a detrimental effect on materials research, particularly on the materials synthesis field. However, increases in grant size should not be at the expense of success rate for excellent individual investigator proposals, but requires additional funding.

The proposal funding rate of approximately 25% for DMR (and NSF as a whole) was recognized as a remarkable feat given the large number of excellent proposals under consideration. The COV believes that it is important to maintain a sufficiently high success rate for proposal submission but this must be balanced against increases in the average award size and duration. It was also recognized that DMR needs to balance funds for individual investigator awards with support for facilities and instrumentation and that budget pressure in the future will make this more challenging. It is important for DMR to determine the optimum scope of research projects in terms of the number of students supported by grants. This aspect is particularly important to the synthetic materials scientists as their projects tend to be more labor-intensive. These competing factors can be dealt with with a spectrum of award sizes.

It was noted that some universities use the number of submitted proposals as a metric for promotion and reward. This incentive unnecessarily increases the number of grant proposals submitted to the agency. The community needs to be advised not to resubmit rejected proposals without substantial revisions. In some other funding systems, resubmissions are only invited by the program director based on reviewer/panel recommendations. This was generally viewed as undesirable by the COV given the potential negative consequences for new investigators. It was noted that program managers can already decline proposals that have been resubmitted without modification. A suggestion was made to require resubmitted proposals to include a summary of changes that were made in response to previous reviews.

A concern was raised regarding thematic proposal solicitations and whether this might push investigators to prepare and submit proposals on topics that are not suitable fits for their expertise but are considered “fundable” areas. It was pointed out that these represent only a small portion of the DMR budget and that the majority of proposals that are supported are unsolicited. Consequently, research topics are primarily driven by the community rather than being proposed from top down. For example, the BMAT program has grown tremendously as a result of the increased number of proposals in this emerging area.

In summary, we feel that the current funding rate and award size are a reasonable compromise in view of the pressures facing DMR. However, many outstanding proposals are unfunded and award value is dropping. This should be a compelling argument to increase funding.

4. Question: Broader impacts

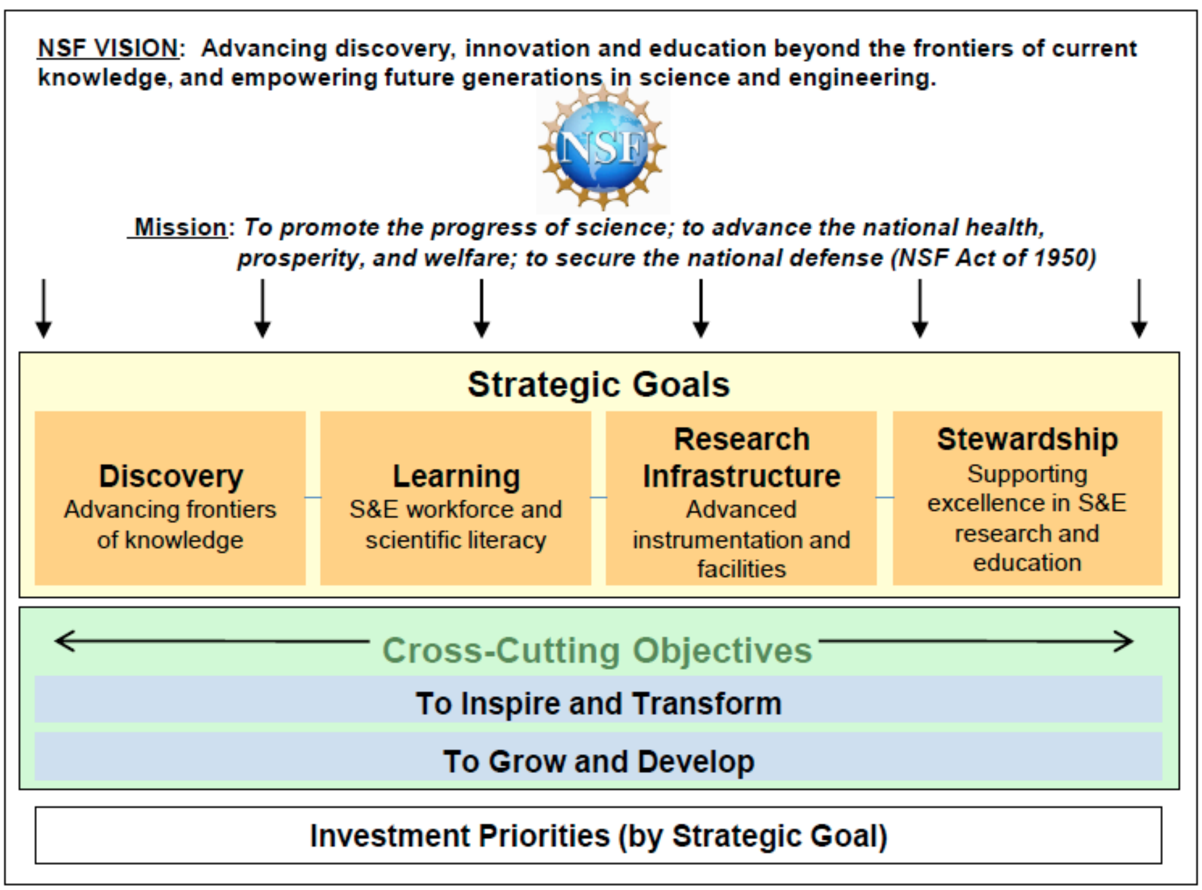
The director of NSF, Dr. Subra Suresh, indicated in a recent article in Science that he might like to see some rethinking of the review criterion related to the "broader impacts" component of research proposals.

The following, extracted from the Grant proposal Guide, gives different categories of broader impacts:

a. How well does the activity advance discovery and understanding while promoting teaching, training, and learning?
b. How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?
c. To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?
d. Will the results be disseminated broadly to enhance scientific and technological understanding?
e. What may be the benefits of the proposed activity to society?
f. Mentoring activities provided to postdoctoral researchers

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf.

What recommendations would the COV give regarding how to reformulate the broader impacts



component of research programs, including individual investigator as well as centers, to make it more effective and meaningful such that the Foundation goals are met?

Response from COV:

The Broader Impacts requirement is not consistently reviewed or assessed and this causes frustration for the proposers and the reviewers. Participating in broader impact activities is essential for a successful proposal however excellence in the intellectual merit criteria is what results in a successful proposal. This fact is acceptable but not clearly communicated. The most critical aspect is that a consistent message about the extent, effectiveness and quality of these criteria should be clearly communicated to proposers and reviewers.

Outreach to general public and k-12 (a, b)

- At all levels there is a responsibility towards communication of our research and its impact to the general public. All researchers share these responsibilities.
- Broader impacts need to be effective, not necessarily innovative.
- Effective proposals should take advantage of existing programs within the institution such as MRSECs, PREMs, REUs and any other well-established outreach system. Junior faculty should especially be encouraged to take advantage of established opportunities that have been shown to be effective. However, PI's need to be explicit about their participation within these programs.
- PI's should collaborate with experts in outreach activities including museum personnel and education faculty and this will alleviate the responsibility of completely organizing the activities (contact schools, invite groups to campus,…). For example, serving as a consultant to museum staff can be as valuable as directly interacting with the public. As another example, offering a workshop to teachers is as important as visiting K-12 classrooms.

Teaching, mentoring (a, b, f)

- Faculty need to become effective teachers and mentors. One of the most fundamental impacts a university faculty member can have is to foster effective learning in their undergraduate classroom. An example of a broader impact could be the implementation of effective teaching techniques learned in a teaching workshop.
- Diversity within research groups should be an important metric for reviewers to consider especially for proposal renewals. Large projects should be required to report diversity metrics. In small research groups, it may not be possible to have women and minorities, however diversity can also be obtained by including undergraduate students within the group.
- Mentoring of postdocs is another critical activity. This mentoring should not just be related to research activities but also include mentoring in effective teaching, involving them in community activities, providing them with the opportunity to mentor UG and graduate students, and inviting them to attend teaching workshops.

Infrastructure for research and education and dissemination

- Several of the activities currently listed under broader impacts are more appropriately considered activities associated with the intellectual merit of the proposal. For example dissemination of the scientific findings in journals and at conferences should not be considered a broader impact; rather, it is a metric for intellectual merit. Enhancing the infrastructure for research and education through facilities and instrumentation is another example of the intellectual merit of the proposal more so than the broader impact.

- In order to have a clear expectation of what is required under broader impacts, it is recommended that these activities be removed from the description of broader impacts.

RECCOMENDATIONS AND OBSERVATIONS:

- COV is concerned that broader impacts are not consistently reviewed or assessed.
- We **recommend** that the NSF develop clearer guidelines for both reviewers and proposers, with emphasis on effectiveness.
- We **do not recommend** to take the responsibility from the individual (even new) PI, but we encourage institutions and centers to provide support to outreach activities and assessment.
  DMR should continue to support activities devoted to materials education and outreach.

SIGNATURE BLOCK:

For the 2011 Division of Materials Research Committee of Visitors

Dr. J. Murray Gibson

Chair