



MEMORANDUM
DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Date: July 23, 2014

From: Fleming Crim, Assistant Director, MPS

Subject: Response to the Division of Materials Research Committee of Visitors Report of 2011

To: MPS Advisory Committee

MPS and DMR continue to address the suggestions of the 2011 Committee of Visitors (COV). This document serves to update the MPSAC on progress by DMR. There are seven major and seven minor points addressed below.

1. Facilities and Instrumentation: DMR should make a larger share of their facilities/instrumentation funds available for instrumentation for all scales from 30K to \$10 M+. Efforts should be made in program solicitations and review to see that large instruments are appropriately shared. NSF should develop a facilities stewardship strategy with the materials community in the context of its mission and the role of other NSF divisions and agencies. The previous COV recommended moving the facilities to the NSF Director's level; this was not implemented. The current COV does not recommend this but they 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.

RESPONSE: In fall 2011, DMR requested the MPS-AC to charge a subcommittee (Materials 2022) to study DMR's facilities and instrumentation balance, and ways to best utilize the DMR's resources to meet national needs in instrumentation and user programs at national facilities. Materials 2022 was co-chaired by Roger Falcone (UC Berkeley) and Matt Tirrell (U. Chicago) and consisted of a dozen other members representing broad interests with respect to instrumentation and facilities within the materials research community. The charge and July 2012 report can be found at http://www.nsf.gov/attachments/124926/public/DMR_Materials_2022_Report.pdf. The group sought input from the community through a public webinar (attended by over 100) and accepted emailed comments from about 150. The report recommended that DMR restore a portion of its instrumentation investments (including development) that had previously been cut due to growing facility costs. DMR responded in the short term by providing an extra \$1 M per year to supplement the Major Research Instrumentation (MRI) program, which includes development.

The report recommended that DMR establish instrumentation networks, which would provide instrumentation and characterization tools to users. DMR included Midscale support in the FY 2015 NSF budget request to be used towards this goal – the establishment of Materials Innovation Platforms (MIPs). Materials 2022 also recommended that such a network should provide support for professional staffing and for stewardship of the instruments; these recommendations are being considered in the design of MIPs. The report also recommended increasing support for instruments in the \$100,000-\$500,000 range. In the short-term, DMR encourages its program officers to respond to such requests in the Individual Investigator Programs. In the longer-term if budgets become more favorable, a program such as the cancelled Instrumentation for Materials Research (IMR) could be brought back. As for facilities, Materials 2022 emphasized that DMR should fund facilities that “provide unique capabilities” rather than capacity building efforts.

In spring 2013, DMR requested the MPSAC to charge a subcommittee to examine the facilities efforts in light of DMR’s entire portfolio. This subcommittee was co-chaired by George Crabtree (Argonne National Lab) and Cherry Murray (Harvard U.) and consisted of 11 other members representing broad interests of the materials research community. In January 2014, the subcommittee held a public meeting in Arlington, VA where facility and instrumentation experts were able to present to the group. The report entitled “Closing the Loop” was approved (with revisions) at the MPSAC meeting on July 18, 2014 and is available online in its final form (http://www.nsf.gov/mps/advisory/mpsac_other_reports/materials_instrumentation-final_from_subcommittee.pdf). As noted at the public meeting, the subcommittee deepened the concept of MIPs to include Materials Genome Initiative-like goals: to close the loop among synthesis, characterization, theory-modeling, and targeted material outcomes in support of ground-breaking advances of the frontier for new science and applications. A great number of suggestions for the MIPs are included in the report and these were considered in crafting the new MIP solicitation, already published. The subcommittee also opined about DMR-funded facilities and agreed with Materials 2022 that DMR should only fund unique large facilities that are not otherwise available in the research landscape. They agreed with the National Academy report “High Magnetic Field Science and Its Application in the United States: Current Status and Future Directions” that the National High Magnetic Field Lab is unique and should continue to be funded. They remarked that for CHESS to continue, it should develop a unique role among the many synchrotrons now available.

To balance support of the DMR interdisciplinary facilities, MPS was able to acquired co-funding from the Directorates of Engineering and Biological Sciences for CHESS. This frees some DMR funds for establishing the MIPs and beginning to accomplish the goal of rebalancing the DMR instrumentation and facilities portfolios to address national needs in materials research.

2. The COV is concerned that broader impacts are not consistently reviewed or assessed. The COV recommends that the NSF develop clearer guidelines for both reviewers and proposers, with emphasis on effectiveness. The COV does not recommend taking the responsibility from the individual (even new) PI, but they encourage institutions and centers to provide support to outreach activities and assessment. The COV encourages DMR to emphasize quality and effectiveness of the proposed broader impacts, and not quantity or innovation just for innovation’s

sake. The COV encourages DMR to educate PIs that they should discuss the integration of research and education in all aspects of their reporting.

RESPONSE: DMR formed an internal team of Program Directors to study the practices in DMR regarding weighting of the merit review criteria. At the Fall 2011 DMR retreat, program directors acted in three mock panels to rank a set of proposals that were wildly varying in terms of intellectual merit and broader impacts. These three independent assessments resulted in astounding consistency in terms of the panel rankings – showing that at least among Program Directors, there is agreement about how to consider the merit review criteria. The Program Directors then developed a consensus set of talking points about what is expected of PIs with respect to broader impacts, and quality and effectiveness were among the top considerations, as was the practice of building on the successes at the PI's institution. Program Officers consistently require panels to discuss Broader Impacts and their significance is part of the training for new Program Officers.

3. 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.

RESPONSE: DMR pursued this idea with MPS and at the level of the Office of the Director, and it was considered too difficult to achieve. DMR decided that it was more productive to unite materials research efforts at the NSF and beyond through the national Materials Genome Initiative. DMR started a program Designing Materials to Revolutionize and Engineer our Future (DMREF), which has, in a short time, grown to bridge materials research efforts in the MPS (DMR, Chemistry and Mathematical Sciences), ENG (CBET, ECCS and CMMI) and CISE Directorates. In its 4th year, DMREF has its own solicitation and the FY 2015 request is \$31 M. DMREF is noteworthy because it funds proposals on all kinds of materials and thus supports all of the regular DMR programs. Annual PI meetings have begun and are of general interest to all seven divisions that participate.

4. Staffing in DMR should be increased to reflect its budget and responsibilities. Virtually every breakout group commented on this in their sub-reports.

RESPONSE: Realizing that arguments for more staffing have not yielded the desired results in the past decade, DMR continued efforts to improve efficiency. Workload continues to be a major concern for MPS senior management. The past ten years have seen a doubling of the number of DMR proposals, with flat staffing. An internal team on the topic of staffing and improving efficiency provided a large number of recommendations at the fall 2011 retreat. Simultaneously, there was an NSF-level Merit Review Working Group report. One suggestion was to pursue the idea of declination of non-competitive proposals based on two consistent written reviews, which would reduce the number of ad hoc reviewers and panelists. It was found that the process for getting permission internally to run this pilot and the documentation to implement the pilot were too burdensome and so DMR decided not to pursue it. DMR also studied the idea of using a solicitation for all its “unsolicited” programs where more rules about

factors like multiple submissions can be set up. DMR's analysis showed that because they get few multiple submissions, on the balance this would not save that much work. Instead, DMR decided to maximize use of current NSF policies: e.g. the ability to return without review proposals that duplicate other submissions, or that are not substantially changed from a previous declination. Further, DMR made strong suggestions for changes to the Grant Proposal Guide so that time-consuming mistakes by PIs can be avoided. Noncompliant proposals take up an inordinate amount of Program Directors' time. For three years, DMR took a strict stance on compliance, returning noncompliant proposals without review. This was difficult on the community, but DMR saw the number of noncompliant proposals decrease by more than half. DMR found that the overhead in compliance checking and returning proposals also contributed to workload.

DMR is supporting the MPS pilot in fall 2014 for accepting all proposals that come through the recently instituted NSF automatic compliance checking, with no further compliance checking other than for substantially similar proposals under consideration or those not substantially revised after prior declination. The savings in time for administrative and scientific staff will be significant; this will be weighed against the potentially uneven playing field for proposals. In sum, the merit review processes that NSF has been using are difficult to further optimize, but DMR is constantly attempting to improve efficiency without sacrificing quality.

Addition of virtual panels in FY 2013 also impacted workloads and at the Fall 2013 retreat, DMR staff evaluated and optimized divisional procedures for running these panels at maximum efficiency.

5. Funding balance: The COV has concerns about the relative balance of funding for the various modes (centers, facilities, individuals, teams) and within one mode, the interplay of grant size, duration and success rate. The COV advises to prevent erosion of support for individual investigators, centers, or mid-scale instrumentation, to restore and balance funding for instrumentation at the mid-scale and to maintain the relative proportion of individual awards at current levels (or even increase if the opportunity arises). The COV feels that the current funding rate and award size are a reasonable compromise, however, many outstanding proposals are unfunded and the award value is dropping. The COV also feels it is important not to let the acceptance rate for proposals fall below the current already-low levels. There is a significant need to increase REU funding as the program provides extremely valuable experiences to students. At the current funding level many qualified students must be turned away from sites across the country. As for Centers the COV was concerned that the flat MRSEC budget over the last 10 years – amounting to a 15% decrease when adjusted for inflation - makes it increasingly harder for MRSECs to accomplish their missions.

With the ongoing phase-out of NSF-wide NSECs and NIRTs, the MRCT program will fill a unique role. The COV foresees strong budgetary pressure on a program that has been flat-funded for years. The previous COV was concerned by the limited funds for PREM and this COV notes that the award size has not been substantially changed (excluding ARRA money.)

RESPONSE: The past three years have presented relatively flat budgets for DMR and the NSF as a whole. Maintaining the 2011 buying power of grants has been a major challenge. In response to the 2008 National Academy report on MRSECs, the MRSEC program now requires centers to have at least two interdisciplinary research groups. DMR increased the MRSEC budget to \$56 M per year in FY 2014 to allow for larger awards. With the renewals of its two major facilities (CHESS and NHMFL), DMR allowed for small increases in the NHMFL budget and held CHESS at \$20 M per year. Within the Individual Investigator programs, the grant sizes have been increasing slightly and the success rates decreasing due to the growing numbers of proposals. REU and PREM programs have been maintained at relatively strong levels because of DMR's commitment to advancing the materials research workforce.

6. The COV advises to develop instrumentation networks, as has been done very well by the MRSECs, and to make sure that instrumentation is shared between institutions as much as reasonably possible. 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.

RESPONSE: As discussed in point 1 above, DMR included Midscale support in the FY 2015 NSF budget request to be used towards the goal of establishing Materials Innovation Platforms (MIPs). The FY 2014 MRSEC competition required all MRSECs to participate in the MRFN network, increasing community access to equipment. DMR also supports the National nanotechnology Infrastructure Network, which provides researchers access to state-of-the-art equipment.

7. The COV advises increased effort in targeted outreach to diversify the pool of applicants further. The Centers panel encourages DMR to research discipline-specific data to benchmark MRSEC diversity with respect to women and underrepresented minorities.

RESPONSE: DMR has a Diversity Working Group that has developed extensive best practices for DMR Program Directors, accepted by the Division at a staff meeting dedicated to diversity in July 2014. DMR sponsored a workshop with the community entitled: "Workshop On Ethnic Diversity In Materials Science & Engineering" in December 2012. The report has been published. The recommendations for federal agencies include: support for an expansive national survey of graduate students, establishment of diversity-focused post-doc programs, encouragement and support of Minority Serving Institution (MSI) consortia and enabling their participation at national laboratories, supporting research and teaching infrastructure at MSIs, and re-examining some aspects of the PREM program.

In addition, DMR held diversity training at the Fall 2011 Retreat for the entire division. Diversity is an element in all performance plans and is part of the evaluation process of all DMR staff. The goal is to diversify the pool of applicants to all DMR programs.

In preparation for a TMS Diversity Summit, DMR collected diversity information for women and minorities across the materials and condensed matter communities. This data will be used to benchmark DMR programs.

Other topics:

A. The COV is supportive of the recent re-organization of the Materials Research Centers and Teams (MRCT) program, but had some concerns: they think it is important that MIRTs can be incubated into CEMRIs so that the program does not become two tiers. The COV thinks that the MIRTs may need longer than 3 years to bring their research to fruition and asks DMR to consider a longer duration. The COV agrees with DMR's decision to limit the number of proposals to one CEMRI or MIRT per institution, and also to one PREM per institution, as an appropriate means of encouraging geographic diversity and intra-institutional prioritization. The COV suggests that the original name for Centers, MRSEC, be retained because it was a successful brand name.

RESPONSE: With the flat budget landscape, it became clear that the MIRT (single IRG) program was not sustainable, and DMREF emerged as a similar (but not identical) team opportunity with awards that frequently span four years. Thus, the MIRT program was discontinued in the FY 2014 triennial MRSEC competition. This competition required 2 or more IRGs per MRSEC. The MRSEC brand name was restored as suggested by the COV.

B. It would be great to see more instrument development proposals and the COV invites 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.

RESPONSE: As noted above, DMR added an extra \$1 M to the NSF-wide Major Research Instrumentation program in FY 2013 and FY 2014, and encouraged the Program Director to prioritize instrument development projects.

Program Directors were advised to prioritize the somewhat rare proposals focusing on instrument development in the individual investigator programs.

C. NSF as a whole, and DMR in particular, presently have no program for accommodating instrumentation/facilities with construction budgets within the range of \$10 M to \$100 M; 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.

RESPONSE: In FY 2014, MPS launched a Mid-Scale initiative starting with the Divisions of Astronomy and Physics. DMR is slated to join this initiative in FY 2015 with the Materials Innovation Platforms, as described above. MIPs will be funded in the \$6 to \$8 M per year range and provided users with access to equipment as well as encourage equipment development. It is difficult to start a full mid-scale program in this budget climate.

D. 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.

RESPONSE: While DMR must adhere to the NSF-wide MRI rules, the Division has advocated for changes with the Office of Integrative Activities (in charge of the MRI program), including the extension of MRI grant periods. We do not see a way to collect statistics on the MRI proposals submitted for the intra-university competition.

E. The COV members suggest that some portion of the Program Director's review analysis could be included in the declination decision letter to help the PI understand better the rationale for the decision. Alternatively, as is currently done by at least several Program Directors, 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.

DMR Program Directors are encouraged to use the "PO Comments" section of Fastlane to provide feedback to PIs. They are encouraged to tell proposers to call them for discussion of the reviews once they receive them. These practices have been communicated to the Program Directors and included in new Program Director training. DMR will emphasize this in FY 2015 to increase the utilization of this practice.

F. 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.

RESPONSE: The REU program is generously funded in DMR with over \$5 M, one of the largest REU budgets for any division in the NSF. Even in tight budgets, the program budget has not been reduced. While appreciating the high demand, DMR regrets that the budgets cannot be increased at this time.

G. 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. 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).

RESPONSE: Given many changes in the international portfolio NSF-wide, it was thought that the IMI program was not as high a priority as it once was. The NSF International Science and Engineering office began several institute-like programs open to all PIs: PIRE, which is an international collaboration involving an extensive team, and SAVI, which serves to join networks in different countries together. In light of budget pressures, DMR decided to terminate the IMI program. In FY 2014 DMR did a detailed analysis of its international programs and is now in the process of redesigning them. A website has been established which provides PIs with extensive descriptions on international opportunities. (<https://www.nsf.gov/mps/dmr/international.jsp>)