

Executive Summary

The Committee of Visitors (COV) for the Civil, Mechanical and Manufacturing Innovation (CMMI) Division in the Directorate for Engineering met on June 26 – 27, 2019. The COV review covered the four clusters of programs that the division was organized into for the majority of the four-year period under review (fiscal year 2015 – fiscal year 2018), along with Special Solicitations the division participated in. The four clusters are Advanced Manufacturing (AM), Mechanics and Engineering Materials (MEM), Operations, Design, and Dynamic Systems (ODDS), and Resilient and Sustainable Infrastructure (RSI). The report summarizes the findings for the review, along with several recommendations the COV developed to address these findings.

In advance of the meeting, the sixteen members of the COV participated in one of two kick-off webinars in April 2019, where informative presentations were made by the CMMI Division Director Robert Stone and Deputy Division Director Mary Toney, along with COV review logistics by Analyst Steven Zehnder and Program Analyst Kevin Webster. Engineering Directorate Assistant Director Dawn Tilbury provided the letter charging the COV. The COV Chair and Co-chair provided additional details regarding the COV. To facilitate the work of the COV, the use of the Electronic Jacket (eJacket) COV site and a NSF External Collaboration Portal (SharePoint) were demonstrated. The 2015 COV Report and the 2019 COV Info Guide document containing definitions and data for the four-year period were uploaded onto the portal prior to the meeting. The guide was helpful as information and data were organized by the sections of the COV report template. The guide also included the annual responses by the division to each of the findings and recommendations from the FY15 COV report.

CMMI is the largest division in the Engineering Directorate and one of the largest at the National Science Foundation. In the four-year span (FY2015-2018) that the COV reviewed, just over 14,000 proposals were submitted to the division. The majority of these were competitive proposals subject to the merit review process, such as unsolicited and CAREER proposals for early faculty development. Other jackets reviewed included EAGER (Early-concept grants for exploratory research), RAPID (Rapid Response Research), as well as special solicitations such as Engineering for America's Prosperity, Health, and Infrastructure (LEAP-HI) a CMMI-initiated interdisciplinary solicitation that along with the Natural Hazards Engineering Research Infrastructure (NHERI), supports larger research activities. The COV reviewed, discussed and provided the following comments, findings, and recommendations regarding the operations of the CMMI division.

Assess the quality and integrity of the NSF merit review process within the division.

The majority of the proposals are reviewed by panel in CMMI, and the COV found that overall, review processes were effective and followed consistently by programs across the division. CMMI is to be commended on mechanisms they have adopted over the four years to improve the handling of large numbers of proposals, panels, and review documentation. The adoption of a division-level compliance check mechanism provides consistent evaluation of proposals, with those proposals that are non-compliant to NSF requirements being returned without review. This has become a directorate-wide process. The new Program Officer (PO) training activities and guide addressing issues related to the selection of reviewers and award-decline decision documentation appear to be resolving some dwell-time and decision concerns. Given the large number of proposals managed by each PO, the COV found the panel summaries to be excellent, comprehensive critiques of the

proposed work. In general, the panel summary provided the basis for the rationale for the PO's decision documented in the review analysis (RA) and context statement. In cases where the decision varied from the panel recommendation, the PO typically provided a strong justification for the decision. The COV did notice that with the use of the RA template, designed to streamline the documentation process, some responses to the PIs were limited to template wording or did not clearly convey specific information regarding the decision.

The qualifications of selected reviewers were very strong, confirming that CMMI continues to recruit reviewers with high technical qualifications. For some special solicitations, a two-stage review process was used, and the COV commends the work of CMMI POs in trying to ensure a balanced view of the proposed work. The COV does recommend that special review criteria be added to the review template as well as the panel summary template, so that adequate attention is given to these additional requirements.

Finding. *The overall quality and integrity of the review processes were excellent, with new mechanisms employed to help maintain the effective productivity of the division. In general, the documentation supporting the decisions made by the Program Officers was complete, with clear justification for the award decisions. A few outliers were noted and addressed in the following sections of the report.*

Recommendation. *The division staff is encouraged to continue training, oversight and streamlining activities promoting the high standards of the division.*

Assess the balance of award portfolios of CMMI programs.

COV members expressed concern with the size of the CMMI program portfolios. Some programs and clusters had an even higher workload than others. The program clusters in CMMI manage significant numbers of awards as well as the merit review process, with the unsolicited awards typically being three-year duration with \$300,000 - \$400,000 budgets. All programs continue to make a substantial effort to support early career development through the funding of CAREER proposals at \$500,000 for 5 years. All program portfolios have a strong and diverse portfolio supporting workshops, REU supplements, RAPID, and EAGER proposals as well.

The addition of data analysts to the staff of the division during the review interval allows the division to better track the balance of the portfolios in terms of gender, geographical distribution, award size and type, and disciplines and sub-disciplines. Mechanical Engineering and Civil Engineering investigators constitute the two largest disciplines within the division, with a number of other disciplines also represented. The COV was provided with comprehensive data prior to the meeting, and quickly supplied additional information at the request of COV members at the meeting.

Special solicitations such as LEAP-HI are important to the division, both in moving investigators towards more integrative projects beyond the division and larger, longer awards. The program is small compared to the core programs, but provides CMMI an opportunity to lead in this area of high importance to the nation. The COV encourages the division to continue to grow the LEAP-HI activity and look for similar opportunities to expand the research portfolio.

NHERI, an expansion on the George E. Brown, Jr. Network for Earthquake Engineering Simulation Operation that broadens the scope of natural hazards providing a unique opportunity to utilize NEES sites, has made eleven awards that are the largest in the division.

Finding. *Overall, at the division level, the COV commends CMMI on the management of the division portfolio to balance limited resources across a diverse set of investigators, a large number of proposals, and emerging areas of research. The efficacy of the clusters and the consolidation of four programs into one in AM is still to be determined.*

Recommendation. *The COV recommends that CMMI would benefit from a long-term analysis of the impact of the organizational structural changes, particularly in terms of demographics and award size and duration.*

Finding. *With regard to individual programs, due to the limited sample of proposals provided, the COV found it difficult to accurately assess award portfolios within programs. Reviewing numbers of proposals, awards, and funding rates is not enough to understand program balance and prioritization.*

Recommendation. *The COV encourages CMMI to do a full analysis of portfolio data by program, comparing across programs, and benchmarking with programs across NSF.*

Other observations and recommendations.

The COV discussed a number of topics related to the review of data and jacket documentation, and made some observations and recommendations concerning issues or actions taken within the past four years. These are presented below and supported with more detail in the following report.

1. Addressing Broader Impacts in proposals, reviews, panel summaries, and PO decision documentation had been noted as an issue in prior COV reports and across NSF. Overall, more attention continues to be paid to Intellectual Merit, and the community continues to struggle with the implications of Broader Impacts (BI). Requiring proposers as well as reviewers to view the short video through FASTLANE before uploading proposals or reviews might help clarify the mechanisms available for BI. Panel requirements addressing strengths and weaknesses in the discussion as well as panel summaries, along with “suggestions for improvement” could also play a role in disseminating information to PIs.
2. Responsiveness of the division to previous COV comments on an annual basis, point by point, was highly appreciated by the COV members. The report provided to the COV prior to the meeting was very helpful, as it clarified that some issues were readily addressed, but some are broader or require more than the four-year span.
3. Workload issues for the programs within the division, and for the division as a whole were of concern to all of the COV members. The COV could see the creative and proactive attempts the division had made to reduce the workload for staff and POs through various ways. The division leadership and staff are commended for the approaches they have taken over the past four years. The COV believes that small inconsistencies observed in the merit review process, and detailed in the report, are very much due to the intense workload.

RECOMMENDATION. *In line with the recommendation regarding balancing and prioritization within programs already given, the COV suggests that a thorough analysis of program portfolios be conducted. The division could then perform several analyses regarding “right-sizing” and resource management for programs and the division, as benchmarked against NSF as a whole. It may provide an impetus for the resource reallocation to the division.*

**CORE QUESTIONS and REPORT TEMPLATE
for
FY 2019 NSF COMMITTEE OF VISITOR (COV) REVIEWS**

Guidance to NSF Staff: This document includes the FY 2019 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2019. Specific guidance for NSF staff describing the COV review process is described in the “COV Reviews” section of NSF’s Administrative Policies and Procedures which can be obtained at <https://inside.nsf.gov/tools/toolsdocuments/Inside%20NSF%20Documents/COV%20Policy%20and%20Procedures%20070915.pdf>¹.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. COV reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations; and (2) program-level technical and managerial matters pertaining to proposal decisions.

The program(s) under review may include several sub-activities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the sub-activities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may add questions relevant to the activities under review. Copies of the report template and the charge to the COV should be provided to OIA prior to forwarding to the COV. In order to provide COV members adequate time to read and consider the COV materials, including proposal jackets, COV members should be given access to the materials in the eJacket COV module approximately four weeks before the scheduled face-to-face meeting of the COV members. Before providing access to jackets, the Conflict of Interest and Confidentiality briefing for COV members should be conducted by webinar, during which, NSF staff should also summarize the scope of the program(s) under review and answer COV questions about the template.

Suggested sources of information for COVs to consider are provided for each item. As indicated, a resource for NSF staff preparing data for COVs is the Enterprise InformationSystem (EIS) –Web COV module, which can be accessed by NSF staff only at <http://budg-eis-01/eisportal/default.aspx>. In addition, NSF staff preparing for the COV should consider other sources of information, as appropriate for the programs under review.

For programs using section IV (addressing portfolio balance), the program should provide the COV with a statement of the program’s portfolio goals and ask specific questions about the program under review. Some suggestions regarding portfolio dimensions are given on the template. These suggestions will not be appropriate for all programs.

¹ This document has three parts: (1) Policy, (2) Procedures, and (3) Roles & Responsibilities.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in the integrity and efficiency of the **processes** related to proposal review. Discussions leading to answers 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.*** The reports generated by COVs are made available to the public.

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/>.

**FY 2019 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)**

The table below should be completed by program staff.

Date of COV: June 26-27, 2019
Program/Cluster/Section:
Division: Division of Civil, Mechanical, and Manufacturing Innovation (CMMI)
Directorate: Directorate for Engineering (ENG)
Number of actions reviewed: 320 Awards: 154 Declinations: 154 Returned without Review (RWR): 12
Total number of actions within Program/Cluster/Division during the period under review: Awards: 2386 Declinations: 12,371 Returned without Review (RWR): 841
Manner in which reviewed actions were selected: Stratified Random Sampling 22-23 Jackets per member. Jackets are randomly selected to include the desired distribution of awards, declinations, and returned proposals within each cluster and special initiatives across the 4 fiscal years under review. Additional jackets are selected to provide geographic or demographic balance as needed. COV members may request additional jackets for review, as needed.

COV Membership

	Name	Affiliation
COV Chair or Co-Chairs:	Chair: Dr. Delcie Durham	University of South Florida
	Co-Chair: Dr. Yan Jin	University of Southern California
COV Members:	Dr. Lesley Berhan	University of Toledo
	Dr. Tabbetha Dobbins	Rowan Universtiy
	Dr. Neil Duffie	University of Wisconsin-Madison
	Dr. Sara Wadia-Fascetti	Northeastern University
	Dr. Carol Friedland	Louisiana State University
	Dr. Scott Grasman	Kettering University
	Dr. Robert Ivester	Department of Energy
	Dr. Byun-Lip Lee	Air Force Office of Sponsored Research
	Dr. Majid Manzari	George Washington University
	Dr. Daniel McAdams	Texas A&M University
	Dr. David Meaney	University of Pennsylvania
	Dr. Grace Peng	National Institutes of Health
	Dr. Lawrence Seiford	University of Michigan
	Dr. Gregory Washington ²	University of California – Irvine

² Member of the Directorate for Engineering Advisory Committee

MERIT REVIEW CRITERIA

An understanding of NSF's merit review criteria is important in order to answer some of the questions on the template. Reproduced below is the information provided to proposers in the Grant Proposal Guide about the merit review criteria and the principles associated with them. Also included is a description of some examples of broader impacts, provided by the National Science Board

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These broader impacts may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if the assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities. These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. Both criteria are to be given full consideration during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. ([PAPPG Chapter II.C.2.d.\(i\)](#) contains additional information for use by proposers in the development of the Project Description section of the proposal.) Reviewers are strongly encouraged to review the criteria, including [PAPPG Chapter II.C.2.d.\(i\)](#), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to:
 - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

3. Examples of Broader Impacts

The National Science Board described some examples of broader impacts of research, beyond the intrinsic importance of advancing knowledge.³ “These outcomes include (but are not limited to) increased participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education at all levels; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a globally competitive STEM workforce; increased partnerships between academia, industry, and others; increased national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education. These examples of societally relevant outcomes should not be considered either

³ [NSB-MR-11-22](#)

comprehensive or prescriptive. Investigators may include appropriate outcomes not covered by these examples.”

**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, returns without review, and withdrawals) that were *completed within the past four fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program(s) under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

I. Questions about the quality and effectiveness of the program’s use of merit review process. Please answer the following questions about the effectiveness of the merit review process and provide comments or concerns in the space below the question.

<p style="text-align: center;">QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS</p>	<p style="text-align: center;">YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE</p>
<p>1. Are the review methods (for example, panel, ad hoc, site visits) appropriate?</p> <p>Comments: A major strength of the CMMI division is that there is strong evidence that consistent processes were followed to review submitted proposals, particularly considering the number of proposals submitted annually. Overall, the merit review process is working well and is largely effective. The review methods were found to be fair and adequate to establish the technical basis for proposal recommendations and the rationale for award-decline decisions. The majority of the jackets reviewed utilized panels, while the EAGER, workshop and supplements generally had ad hoc or internal reviews. The COV considers this an efficient and effective means of freeing resources for the panel reviews.</p> <p>For special solicitations, there was concern about the lack of clarity in the solicitation, the review analysis and context statements regarding the review process when a two stage review process was employed. The COV recommends that any Additional Solicitation Specific Review Criteria be included in reviewer and panel templates to facilitate specifically addressing these requirements.</p>	<p style="text-align: center;">YES</p>

<p>2. Are both merit review criteria addressed</p> <p>a) In individual reviews?</p> <p>b) In panel summaries?</p> <p>c) In Program Officer review analyses?</p> <p>Comments: The COV found that reviewers addressed both criteria, but in most cases, the intellectual merit was addressed in more detail and depth. In general, there is a lack of consistency in the attention paid to broadening impact. This is an area where the PI and the reviewers still have some lack of understanding. COV members recommended that the formatting of reviews with strengths and weaknesses for both criteria be strongly encouraged. In some instances, reviewers did not address program specific criteria for GOALI proposals, and in one jacket, these criteria were not addressed in the panel summary as well.</p>	<p>YES</p> <p>YES</p> <p>YES</p>
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<p>3. Do the individual reviewers giving written reviews provide substantive comments to explain their assessment of the proposals?</p> <p>Comments: The COV members reviewing jackets in different clusters found that, for the most part, the reviewers provided substantive comments to explain their assessment of the proposal. In a few cases, the level of detail was sparse or the reviewer did not address the criteria in a meaningful way. For some proposals, it appeared that either the reviewer did not have the right expertise or did not conduct a thorough review of the proposal. In most cases where this occurred, the panel discussions have rectified these situations. The COV again recommends that reviewers be instructed to provide justification for each of the strengths and weaknesses.</p>	<p>YES</p>
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<p>4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)?</p> <p>Comments: Overall, the panel summaries were excellent. They provided a comprehensive critique of the proposed work that was generally more informative than the individual reviewer comments. The advice of the panel regarding award-decline recommendations was clearly articulated for most of the panel summaries for unsolicited and CAREER proposals. In some cases, the panel summaries highlighted disparate views of the reviewers. The panel summaries provided the rationale for the panel consensus except in the few</p>	<p>YES</p>
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<p>cases where the panel recommendation seemed to be inconsistent with the summary. The COV found that some panel summaries included “Suggestions for Improvement” and supports the implementation of this section in the special solicitation reviews.</p>	
<p>5. Does the documentation in the jacket provide the rationale for the award/decline decision?</p> <p><i>[Note: Documentation in the jacket usually includes a context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.]</i></p> <p>Comments: The documentation in the jacket generally provides the rationale for the award/declination decision, and is clearly articulated for unsolicited and CAREER proposals. In regard to Program Officer decision process, it appears the Program Officers employ a variety of processes: making the decision based on individual and panel reviews, assessing program priorities, engaging other Program Officers in making the decision. Occasionally the decision statement was cursory, and in a few cases reviewed, the rationale was not adequately addressed. The COV found the use of the RA template wording was useful, but are concerned when specific details regarding a decision are not included. Occasionally the decision statement was cursory, and the rationale not adequately addressed or inconsistent. For instance, in one case reviewed the justification presented to recommend awarding a “do not consider” proposal appeared to be weak. In another jacket, the explanation used wording that did not clearly detail a complicated decision regarding a collaborative project. While not questioning the decisions made for proposals such as EAGER, the COV recommends providing sufficient detail regarding the rationale to justify each decision.</p> <p>From examination of the review analyses, the COV found that across programs it appears that the workload varies along with the size of the panels in terms of number of proposals/panelists. While the current structure is effective, review quality could be improved by balancing the workload.</p> <p>The COV recommends that final award decisions for large solicitations (e.g. LEAP-HI), be made (or reviewed) by at least two other program officers. This will reduce any bias or apparent bias of the Program Officer.</p>	<p>YES</p>
<p>6. Does the documentation to the PI provide the rationale for the award/decline decision?</p>	<p>YES</p>

<p><i>[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 in the PO Comments field or emailed with a copy in the jacket, or telephoned with a diary note in the jacket) of the basis for a declination.]</i></p> <p>Comments: By and large, the program officer review explained the decision well. Particularly in the case where the proposal did not meet compliance and was returned without review, the program officers' notes were informative.</p> <p>The rationale for the proposal declination are typically based on the peer reviews/panel recommendation. However, in cases where the PO declines the proposal despite the panel recommendation, the documentation to the PI appears to be less informative.</p> <p>For special solicitations, the COV noticed some inconsistencies with the final Program Officer decisions and award notice to the applicant. In some awards, the final decisions and negotiations were not stated in the award notice (e.g. if partial funds were awarded to address a specific challenge). There were also inconsistencies in the information provided to the applicant (e.g. panel rankings, availability of context statements, etc.).</p> <p>The COV recommends that specific terms of the final award decision be included in the award notice (e.g. partial funds awarded for a specific challenge).</p>	
<p>7. Additional comments on the quality and effectiveness of the program's use of merit review process:</p> <p>In regard to proposal intake and return, the oversight over proposals not fulfilling the GPG requirements was strong. There was evidence in the jackets of proposals being returned without review because they were lacking specific sections and/or not responsive to the funding call. The COV commends the attention to compliance.</p> <p>When ad hoc reviews are used along with a panel review, the ad hoc reviews should be completed and available to the panel, unless there is a panel recommendation to seek specific expertise on a particular technical issue.</p>	

II. Questions concerning the selection of reviewers. Please answer the following questions about the selection of reviewers and provide comments or concerns in the space below the question.

SELECTION OF REVIEWERS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE
<p>1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments:</p> <p>Overall, the qualifications of the selected reviewers are very strong. Through a review of the jackets of the proposals and reviewer comments, as well as the Program Officers' analyses, it was confirmed that CMMI continues to recruit reviewers with high technical qualifications and maintains a rather costly but worthwhile structure of panel review process. The panels reviewed were composed of experienced and balanced reviewers. If more than one stage of the review was required (e.g., employing the Blue Ribbon Panel for the second review), the reviewers were selected to provide a balanced view of the proposed work. This is a strength and shows the strong efforts of the CMMI to review the proposals fairly and completely. An additional strength is that the interdisciplinary proposals had 5-6 or more reviewers. The COV commends the work of CMMI Program Officers in trying to ensure that the panels are balanced by gender and ethnic diversity.</p> <p>Through the review, the COV also found several issues and would like to make recommendations to further improvement. One of the issues is that the effort of the reviewers varied widely. Some made only cursory remarks, some answered the 5 questions for each merit criteria, and others organized by strengths/weaknesses. Although the panel discussion may be the process where the gaps between the individual reviews can be filled, having reviewers make their respective due efforts can benefit the review process. The COV recommends that the Program Officers pay attention to encouraging reviewers to make needed review comments by providing adequate review guidance.</p> <p>CMMI has made significant efforts to balance the review panels, partly as a response to the previous COV's recommendations. However, this COV still found room for further improvement. Many review panels in the Jackets were largely male, perhaps as a reflection of the available pool of reviewers in the discipline. The COV has noted that CMMI conducts an analysis regarding the diversity of reviewers annually, and recommends CMMI utilize those reviewer analytics to make continuous improvement in panel diversity. The COV also recommends that CMMI maintain a larger number and a more expansive set of</p>	YES

<p>reviewers that includes a wider diversity in various dimensions including gender, ethnicity, domain expertise, institution, academic/industry, and stakeholder.</p> <p>During the review process, the COV had questions about the role of each participant of the proposal review process, such as Program Officers, reviewers/panelists, CMMI Division Directors, in making final funding decisions. For each participant to have a clear idea about his/her role will help each one to be more effective in playing the role. The COV recommends that CMMI provide reviewers/panelists with clear information about the participants' roles in final funding decision-making.</p>	
<p>2. Did the program recognize and resolve conflicts of interest when appropriate?</p> <p>Comments:</p> <p>Through this review process, the COV sees the emphasis and clear handling of conflict of interest by CMMI Program Officers. However, there were instances when reviewers cited possible conflicts of interest at the time of review, but there was no documentation indicating how the COI was resolved. The COV recommends that the Program Officers document how any COI is managed prior to, during, and following the review.</p> <p>There was a single case where a panelist who is very familiar with the proposal topic provided the most negative and comprehensive review. This panelist had a similar proposal declined in the COV review jackets. Such a scenario could be considered as COI in terms of competing for scarce resources. The COV recommends CMMI review the COI policy to avoid such cases from happening again.</p>	<p>YES</p>
<p>3. Additional comments on reviewer selection:</p> <p>While examining the jackets for the handling of reviewer COIs, the COV noticed the need to avoid Program Officer conflict of interest as well. There is, however, no clear guidance stipulating this kind of COI. The COV recommends CMMI consider this issue and provide guidelines for the reviewers and for future COVs.</p>	<p>YES</p>

III. Questions concerning the management of the program under review. Please comment on the following:

MANAGEMENT OF THE PROGRAM UNDER REVIEW

1. Management of the program.

Comments:

The management of the programs appears to be very effective and efficient. NSF manages a broad range of basic research programs while maintaining high standards for evaluation. Most reviewers in the jackets provided substantial comments with significant technical depth. The COV was impressed by many specific comments provided by the reviewers and Program Officers for the cases of some of declined proposals as well as funded proposals. There has been continuous efforts to improve managing the diversity of the panels and CMMI should continue to work on this.

Broader impacts seem to be interpreted among the reviewers (and the proposers) differently from one another. The definition is still very broad—including research (scientific, technical, and potential commercial) impacts, educational impacts, and impacts to various groups (including undergraduate students, high schools, URM, women, etc.). Overall, there has been a maturation and improvement in the conceptualization and discussion of broader impacts within the proposals themselves, especially articulating the broader impacts of research to society and the fields of engineering. Over the years, CMMI has provided examples and more detailed guidance to reviewers, helping to clarify BI, as the previous COV suggested. There is still a non-uniformity in the ways in which reviewers evaluate broader impacts. Reviewers' assessments of broader impacts were very weak, with the notable exception of CAREER proposal reviews. Review statements in awarded proposals such as "Broader Impacts are acceptable" or "broader impacts are pro forma" highlight the dichotomy that persists between consideration of BI and IM by reviewers. Most of the COV members agreed that a successful proposal would never have a review that stated "Intellectual Merit is acceptable". COV members recognized that this is an ongoing issue across NSF, and as one measure to address the disparity between IM and BI, recommended that the formatting of reviews with strengths and weaknesses for both criteria be strongly encouraged, if not required.

There is an inconsistency in a number of reviews. Some jackets had five or six reviews, while others had only three. With more reviews, the influence of an outlier decreases (even with variability in the review quality). There is more confidence in the assessment when there are four reviews. The COV recommends CMMI consider four reviewers as the standard and increase the number when the scale of funding is larger, possibly using the mail-in reviewer program. CMMI should also consider innovative mechanisms to help solicit reviewers such as increasing the prestige of serving as a panel reviewer, assigning a title, stipend/honorarium in addition to per diem, the publication of "thanks to the following reviewers," etc.

There were some jacket cases the COV found difficult to understand. Specifically, there was a case where the panel summary was "Not Approved" but the proposal was awarded. There was another case where the panel recommended funding and the award was not made without justifiable explanation within the review analysis. These irregular results are likely due to the discrepancies between the perspectives of the Program Officer and the panel in making recommendations and final decisions. The COV recommends that CMMI Program Officers provide justifications for this kind of irregular case to the Reviewers and PIs. Furthermore, the roles and responsibilities of the various types of personnel involved in the decision-making should be emphasized.

Some panels had too many proposals to review --- workload should be balanced across panels. Overall, the CMMI Program Officers appear to be overloaded. One example was a collaborative submission, with one collaborator being declined and the other awarded. The rationale for awarding/declined based on investigator workload did not agree with documented current/pending support. The lack of clear documentation in the jacket led to misinterpretation by the reviewing COV member, who thought this might be an instance of P.O. error. Further information provided by CMMI indicated that appropriate actions were taken, but not clearly documented.. The COV suggests CMMI consider reviewing the possibility of subdividing CMMI into more entities to better manage the workload and/or providing more resources to the CMMI programs.

The COV also recommends that CMMI provide information on the roles and responsibilities of the various types of personnel staffed in the division; details on number of division personnel and workload balance; and details on workload per Program Officer. During this COV review, the CMMI staff indicated such detailed information which was helpful for the COV review process. The COV recommends CMMI provide this information for future COV meetings. The variety of personnel involved in each jacket could explain some of the errors involved in the review, award management process.

A small number of the reviewed proposals within the different clusters raised "red flags" in terms of the overall process being followed that resulted in a well-documented decision. Examples of these red flags include funding proposals that were not discussed in panels and triaged as "do not consider," poorly-justified individual panelist reviews accompanied by poorly-written panel summaries and only template Review Analysis text. About half of the proposals had at least one individual review that was of poor quality. The COV recommends that NSF provide more guidance/requirements to panel members, e.g., a template for the review, or require the articulation of at least one strength and one weakness for IM, BI, and the summary. Reducing the heavy workload of for Program Officers may help to reduce "red flag" cases.

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

Comments:

Reorganizations, consolidation, and restructuring of programs appear to be an effective tool to remain nimble. Two specific recent actions have helped to make the program more responsive to emerging research and educational opportunities. The first is the merging of four manufacturing topic areas under the single heading of Advanced Manufacturing. The second is the plans for international collaborations. The COV recommends CMMI consider performing a self-assessment of

the effect of its reorganization and consolidations. International collaboration continues to be one way of addressing emerging research and providing unique educational opportunities. CMMI should continue to expand its participation in collaborative international research.

The increased responsiveness of NSF program to emerging research opportunities apparently motivated the EAGER (Early-concept Grants for Exploratory Research) funding mechanism ‘to support exploratory work in its early stages on untested – but potentially transformative – research ideas and/or approaches.’ Despite its high-minded start, the merit review process of EAGER program appears to be somewhat compromised or suffer inconsistency of evaluation metrics. The COV examined several cases of EAGER proposals. The evaluation metric ranged from no review, when a proposal is submitted directly to the PO as an EAGER proposal for funding consideration, to a panel discussion, to a formal evaluation by four external reviewers, presumably when a proposal submitted as a regular unsolicited was found by the panel or PO to be more suitable for an EAGER. This may raise the question of fairness. The COV recommends CMMI pay attention to the transparency and fairness of the EAGER review process.

The COV noticed that CMMI Program Officers have so much autonomy, which is the strength of NSF and supports abilities at NSF through good Program Officers to address emerging research and educational opportunities. In addition, the COV commented that rotators (IPAs) have the value of bringing new ideas and perspectives and to permit the portfolio to move into new directions.

The COV were concerned whether NHERI equipment sites are being fully exploited. It would be interesting to compare equipment usage across NHERI versus other equipment programs (e.g., ships, polar facility)

The proposal reviewers provided good perspectives on the novelty of specific educational activities. Although this is part of the NSF review criteria, there was not strong evidence of breakthrough educational activities. CMMI programs are responsive and proactive to emerging research particularly through EAGER and RAPID, these research activities could better influence educational opportunities through an emphasis on sustainable higher education initiatives within the broader impact.

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

Comments:

It remains a challenge to review proposals that fall between the silos of structure (i.e. CMMI and other Divisions/Directorates). Cross-cutting proposals may still face multiple reviews in multiple programs. These types of proposals will still be a challenge to review, however, within manufacturing the reduction of silos should be a benefit. Program Officers should have a mechanism to be creative in the interpretation of their portfolio scope when it comes to these cases of cross-cutting proposals. Opportunities in these cross-cutting areas should also be better disseminated to the PIs. Interdisciplinary proposals should be reviewed by only one panel. It may be too soon to determine (since it occurred in August of 2018), but the consolidation of Cybermanufacturing Systems (CMS), Manufacturing Machines and Equipment (MME), Materials Engineering and Processing (MEP), and

Nanomanufacturing (NM) into a single program under Advanced Manufacturing (AM) could help make the program to be more responsive to emerging research and educational opportunities.

Due to the limited sample of proposals provided, it is difficult to accurately assess planning and prioritization without a better overview. Reviewing numbers of proposals, awards, and funding rates is not enough to understand program planning or prioritization, because the final funding portfolio is not clear. The COV recommends more transparent on variability on budget size, otherwise, it will be hard to comment on portfolio planning. It is recommended that CMMI undertake an internal evaluation to compare plans and execution using all data at their disposal.

The special solicitations promoted by CMMI have significant overlapping interests. It is not clear how these initiatives provide unique contributions to the portfolio balance. It appears the Program Officers managing the special solicitations often prioritized infrastructure building rather than potential future application impact.

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

Comments:

Based on specific areas addressed in 2015 report, CMMI has done a reasonable job at addressing a number of recommendations. The provided year-to-year update indicates continuous improvement and we have seen clear evidence of these improvements in the Jackets examined. The COV commends CMMI's effort in making continuous improvements, as well as producing the report that addresses the prior COV's recommendations point-by point with a new annotation made annually. This is extremely valuable for self-assessment of CMMI.

The clarity of how to evaluate broader impacts—i.e. instruction to reviewers—was mentioned in the prior COV. It is also a concern for this COV. Since broader impacts are considered by NSF to be an important part of the program, proposal and evaluation criteria, a clear definition of it should be made.

The COV recommends CMMI provide the new materials developed as a result of the previous COV – Broader Impacts review process, new review analysis and PO recommendation templates, declination templates, etc. In addition, the COV also recommends CMMI provide Workshop funding data since workshops are so important for exploring new directions and portfolio development.

Relative to some of the structural changes that CMMI has implemented, this COV's limited sample and short-term perspective would benefit from a more long-term view of their impact. The COV recommends CMMI benchmark between different programs and with other NSF divisions. The resulting data will be useful for the next COV.

IV. Questions about Portfolio. Please answer the following about the portfolio of awards made by the program under review.

CMMI is the largest division in the Engineering Directorate and one of the largest at the National Science Foundation. In the four-year span (FY2015-2018) that the COV reviewed, just over 14,000 proposals were submitted to the division. The majority of these were competitive proposals subject to the merit review process, including unsolicited and CAREER proposals for early faculty development. EAGER (Early-concept grants for exploratory research) and RAPID (Rapid Response Research) proposals were also considered for funding by the programs.

Balancing across the division:

Just prior to the 2015 COV, the division underwent a restructuring with programs distributed into four clusters, Advanced Manufacturing (AM); Mechanics and Engineering Materials (MEM); Operations, Design, and Dynamic Systems (ODDS); and Resilient and Sustainable Infrastructure (RSI). Each of the clusters manages a significant number of awards of all types in their portfolios, and is responsible for the review of proposals and recommendations for award. This 2019 COV is the first review of the quality and integrity of the NSF merit review process within CMMI subsequent to the major changes creating these clusters. During the interval, a number of program realignments have been made that also have an impact on the balance of the award portfolios across the clusters, including the formation of the Special Programs and Solicitations cluster.

Data was provided to the COV panel on the distribution of the proposals and awards across types, disciplines, and subdisciplines, as well as information concerning reviewer and panel demographics. In addition to these data, randomly selected proposals from across the research proposal types (unsolicited, CAREER, EAGER, CRISP, LEAP-HI, workshops and others) were provided to each COV member for each cluster. These sets of proposals included awards and declinations and the COV had access to the ejacket that included reviews, panel summary, rating, program officer review analysis, context statement and diary notes.

The COV noted that the demographic and institutional type data is tracked by CMMI, and commended the division on the addition of analysts to the staff to assist in data management.

Across the division, the representation of women and underrepresented minorities (URM) submitters and awardees is nearly equal. COV members were concerned whether these awardees were PIs or co-Pis, as this can impact recognition of effort, responsibility and fiscal authority. The COV was pleased with the clarifying information that the analysts quickly produced that women and URM are lead PIs on awards at essentially the same proportion as their proposal submission.

COV members expressed concern with the size of the CMMI program portfolios, with such large numbers of proposals requiring panel review and the subsequent documentation needed for the award/declination decisions for ejacket. CMMI indicated that they expect a small decline in annual proposal submissions now that the division is accepting proposals at any time, no longer having the deadlines except for special solicitations and CAREER proposals. CMMI is also encouraging the submission of proposals to programs such as Leading Engineering for America's Prosperity, Health, and Infrastructure (LEAP-HI), a division initiative to move researchers towards more integrative projects and larger awards.

The COV commends CMMI on its efforts to reduce or balance portfolio load across the division but is concerned that overall proposal load, and subsequent management of programs, will still be an issue.

The COV recommends that CMMI investigate measures to continue to reduce proposal load impact as well as the actual proposal load. This could include realigning responsibilities of staff, using clusters to limit multiple proposal submissions by encouraging EAGER submissions followed by larger/longer awards, or other management initiatives. For example, data indicates that the average award during FY15-FY18 was just under \$350,000 for just over 3 years duration. Perhaps the impact of moving towards \$500,000 for 4 – 5 years for the typical core program award could be investigated.

To improve the presentation of the portfolio balance, we recommend tracking and presenting information from the CMMI in a larger context. For example, the number of CRISP proposals considered by CMMI was answered in the materials provided to the COV, but it was not clear if this was a proportional share of the proposals submitted to the NSF at large. If there are some special programs that are received in more abundance by CMMI than other NSF program areas, this could help shape the strategic mission of the CMMI in the next 5-10 years. Similarly, information on the age, gender, and ethnic background of CMMI grantees is useful, but it does not provide any comparison to the NSF at large. If the CMMI is receiving a larger or smaller share of proposals from investigators of different backgrounds, this could help the CMMI develop a strategic plan for the future.

Portfolio balance for early-career faculty:

The CMMI programs provide appropriate review of the CAREER proposals. The CAREER award is for 5 years at \$500,000 and the funding of early faculty through this solicitation is well balanced within the program portfolios.

One area of concern, however, was the relatively low number of awards to new and early-career faculty, outside of the CAREER program. There appears to be a bias towards more experienced faculty, with some reviewers even negatively commenting that someone was at the start of their career. During the review of the jackets, COV members found that some investigators seem to be extraordinarily successful in achieving funding. As an example, none of the awards in the MEM ejacket portfolio (including CAREER awards) were the first NSF awards for the PI. For one proposal, the panel expressed concern regarding whether the PI, who already had multiple awards, would be able to complete the work. The proposal was funded anyway. While the COV realizes that the jackets reviewed were a very small percentage of the overall portfolio for each cluster, there appeared to be some bias towards proposals from PIs who could demonstrate advances with prior support.

There was also concern discussed by the COV regarding the distribution of CAREER awards, with few being made to non-high R1 institutions. This has been noted in earlier COV reports, and continues to be an ongoing concern. It was recognized that a PI at an undergraduate or masters-degree granting institution who receives a CAREER award often relocates to a research institution. This may advance the PI's research career path, but does little for the educational plans at the institution.

The COV recommends that CMMI consider additional funding mechanisms for early career/unfunded faculty.

Portfolio balance for transformative and/or innovative research:

There was insufficient information on the transformative/innovative projects sponsored by the CMMI for the COV to be able to discern how well the portfolios were balanced or attaining goals. How is proposed research viewed or judged as transformative and/or innovative?

The COV recommends that CMMI develop a more proactive approach, working with the research community and/or across NSF to develop metrics that can be used to judge the transformative impact of the proposed research. Tracking the status of proposals identified as being transformative and/or innovative submitted by a broad background of investigators from across the division, evaluating the relative success, and considering how to grow a cohort of investigators would enhance this aspect of CMMI portfolios.

Portfolio balance for risk:

CMMI is to be commended for the high acceptance rate for the EAGER and RAPID proposals. The internal review mechanism may be a factor in making decisions regarding the higher risk proposals in the EAGER program. One of the COV members noted that some of the reviewed EAGER awards were made to extremely well-funded more senior investigators. This raised the question whether there is a belief (bias) that there has to be a strong, demonstrated research background to be able to pursue more high risk research. There may be some correlation between this concern and that regarding newer or less well funded PIs.

OTHER TOPICS

1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

n/a

2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

The COV noted that while the average number of reviews per proposal was just above three, some proposals had significantly more reviews. This happened either within the same panel, by the addition of ad hoc reviews, or due to being assigned to two different panels. It appeared to the COV members that proposals that had larger numbers of reviews (other than Special Solicitations) were more often declined. This inconsistency is a concern regarding the perception of fairness and/or bias in the merit review process. Program officers should address reasons for any outliers in the number of reviews for a proposal in the review analysis or context statement.

3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

Large gaps in PO staffing for a specific program has a significant impact on program leadership and research community. The COV recognizes the difficulty in attracting POs to serve as rotators, particularly when it appears that the effort needed to process proposals far outweighs the other responsibilities such as award management, involvement with cross-cutting activities, and interactions with the research community. CMMI had been proactive in developing both training documents for new program officers, addressing compliance (RWR), and streamlining some processes with templates and guidelines. The COV recommends that NSF recognize the need for additional resources for CMMI to meet all of its responsibilities while maintaining the high level of productivity with proposal merit review. Additional resources are needed to reduce the workload for POs and review panels.

4. Please provide comments on any other issues the COV feels are relevant.

One member of the COV expressed his concern that the research community is generally unaware of the bounds on the PO's authority to recommend proposals that have not been recommended by the review panel or have not been reviewed by any panels. It would be very helpful for the community to know the extent of the PO's role in the award making process.

5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

The availability of eJacket to COV members prior to the meeting works much better than old paper jackets (allows pre-work). Reviewing the merit review process by cluster provided COV members more time to discuss the findings in their reviews of the 320 jackets (21 – 23 jackets per member) for this large division. The framework, format, and oversight were effective. With the specific charge to the committee focused on the merit review process, providing budget

information to the COV would help panel better assess program planning, prioritization, and portfolio development.

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For the 2019 CMMI COV
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