REPORT OF THE 2016 COMMITTEE OF VISITORS
DIVISION OF MATHEMATICAL SCIENCES
NATIONAL SCIENCE FOUNDATION
September 19–21, 2016

Submitted on behalf of the Committee of Visitors by
Juan de Pablo, Chair of the MPS Advisory Committee

to

Fleming Crim
Assistant Director
Directorate of Mathematical and Physical Sciences

Introduction

After several weeks of preparatory study of data provided by the Division of Mathematical Sciences (DMS), the 2016 Division of Mathematical Sciences Committee of Visitors (CoV) met at the National Science Foundation (NSF) during September 19–21, 2016 to discuss the data and write reports on its findings concerning the operation and status of programs administered by the DMS. The committee formed six (overlapping) subcommittees, three to review operations of disciplinary research programs (Subcommittees A, B, and C) and three to review the management of the mathematical sciences research institutes program, the special research programs, and the workforce and infrastructure programs, respectively.

Each subcommittee submitted a report, and these form the bulk of this document. This introduction is meant to serve as an overall summary as well as to draw attention to specific findings or points of emphasis.

The subcommittees found that the DMS is generally doing an excellent job of administering the programs and distributing the available funding to support extremely high quality research in a wide range of disciplinary areas, though there was also unanimous agreement that DMS budgetary limitations made it inevitable that a large number of excellent proposals received every year could not be funded.

The reports of the Subcommittees A, B, and C (which evaluated the disciplinary programs) noted some common themes (along with specific comments for each program):

1. The panel system for evaluation, supplemented by mail reviews, is working very well. The review analyses were not uniformly thorough. Particularly when funding decisions deviate from the

panel orderings, the review analysis should contain as full an account as possible of the details that led to the final decision, including factors of which the panel was unaware and comparisons between specific proposals.

2. It would be useful to collect and analyze more data about the participation of women and minorities, both in proposals and awards. This may provide some guidance to help increase the number of proposals from underrepresented groups.

The CoV noted that the Research Institutes program is a major investment of the DMS (about 13–14% of its budget) and is of enormous importance to the mathematical community in the US, and a cost-effective way to support a large number of researchers in a productive environment. There was no competition for new Institutes in the period under review, but there was a renewal competition for some existing Institutes in 2014–5, and, as one result, two of the US institutes (the Institute for Mathematics and Its Applications (IMA) and the Mathematical Biosciences Institute (MBI)) were placed on a "ramp-down" trajectory to the discontinuation of core DMS support. A majority of the subcommittee on Research Institutes found that the process leading to these decisions was acceptable. The subcommittee did have some concerns about the effectiveness of communication between DMS and the Institute leaderships. It also recommended that the DMS take especial care to fully and clearly communicate its criteria for success in the future competitions for new and continuing institutes.

The subcommittee report on Special Research Programs noted that the DMS Focused Research Groups (FRG) program, while small, received exceptionally strong proposals, and they particularly lauded the DMS for its efforts to secure co-funding with other NSF divisions. The subcommittee felt that the FRG program could be usefully enlarged if funding were available, especially if minority participation could be increased. The other special research programs covered a wide range and were regarded as great successes in engaging mathematical scientists in interdisciplinary research.

The workforce and infrastructure programs currently involve about 13% of the DMS budget and the workforce program includes the Research Experiences for Undergraduates program (REU), the new Enhanced Doctoral Training program (EDT), the Mathematical Sciences Postdoctoral Research Fellowship program (MSPRF), and the Research Training Group program (RTG).

1. The DMS REU program continues to be a rousing success. The report made some suggestions about collecting data (particularly longitudinal data for long-running REU programs) that might be helpful in judging their effectiveness.
2. The EDT is a new program and potentially an important way to encourage doctoral programs to better prepare their students to thrive in the job market. It will be important to find good ways to judge the success of this program.

3. The MSPRF program was judged to be an outstanding success, though there were concerns about the current low funding rate of the applications. Some other suggestions were made about possibly increasing the flexibility of the awards.
4. The RTG program was generally seen as a successful and significant improvement over the previous Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE) program; it has been effective in attracting, training, and placing American undergraduates, graduate students, and postdoctoral fellows, as well as in improving mentoring. The report suggested that it would be desirable to put in place more rigorous mechanisms to evaluate the success of the RTG program as a whole.

The Broadening Participation Initiative (BPI), which provides additional funding for some regular research awards with a particularly strong diversity component, was introduced in response to the previous CoV report, and the subcommittee commends the DMS for instituting it.

The six subcommittee reports, a table of the Committee of Visitors membership, and the signature block are given below.

SUBCOMMITTEE A: Algebra and Number Theory, Combinatorics, and Computational Mathematics

SUBCOMMITTEE ROSTER:
Adebisi Agboola, UC Santa Barbara
Vyjayanthi Chari, UC Riverside
Jacob Fox, Stanford
Genetha Gray, Intel Corp
Robert Krasny, U. Michigan
Diane Maclagan, University of Warwick
Ali Pinar, Sandia Laboratories - Livermore (unable to attend, but provided written comments)
David Saltman, Center for Communications Research
James Sethian, UC Berkeley
Eitan Tadmor, U Maryland
Richard Taylor (Chair), Institute for Advanced Study
Prasad Tetali, Georgia Tech

The overall quality of the review process was seen as extremely high. Proposals are considered by a panel of highly qualified experts, who are, in the overwhelming majority of cases, able to have very substantive discussions of the proposals before them. Based on the panels' advice the program officers have created very impressive portfolio of investments that is both deep and diverse. The subcommittee congratulates the program officers on their work. We were, however,

very sorry to see the large number of excellent proposals that had to be rejected only because of budgetary constraints.

1) MERIT REVIEW PROCESS

The subcommittee strongly endorses the extensive use of panels. It was felt that, because these allow for discussion and the making of comparisons, they are much preferable to the old system of relying only on mail reviews.

In the panels examined by the subcommittee, the choice of panelists was excellent. They were very knowledgeable experts with a broad view of the subject area. They also came from a diverse set of institutions. The number of women on the panels was adequate, but the low number of underrepresented minorities on the panels continues to be a challenge. Despite initial concerns, we were pleased to receive data that panelists were not reused too often. There was concern that more than half of all those invited to serve on panels turn down the request to serve. The programs could experiment with methods to increase the acceptance rate. These could include remote panels and more but shorter panels, although these all have potential downsides. (It would have been useful if the CoV had been given a list of the membership of all panels over the last 3 years. Some subcommittee members had trouble even finding the lists of the members of panels we were examining in detail.)

Careful attention is paid to conflicts of interest, which are appropriately resolved.

Some members of the subcommittee were concerned that proposals in areas lying between two panels may not always get an appropriate hearing. The program officers were well aware of this and worked to correct it, for instance using mail reviews when appropriate. Panelists writing reviews and panels writing summaries could be asked to state their degree of confidence in their judgments, although this should not be shared with the PI. This might help identify those proposals that would benefit from additional mail reviews.

In general, reviewers make substantive comments, but the number of cases where this fails to happen is larger than desirable. This problem was already noted in the last CoV report. Program officers are aware of this and work to improve the situation. We commend the division for asking all panelists to submit their reviews at least 1 week before the panel so that the program officers can work with those whose reviews lack detail to improve them. We also support the pilot study of asynchronous panel reviews.

In general, the panel summaries are also very good, providing a good explanation of the panels' decisions. In some cases, the summaries could reflect more of the panel discussion. Panels should be made aware that their comments on all proposals in the "fund if possible category" are of particular importance because final funding decisions may not reflect the panel ordering.

The documentation in the panel summary usually provides a good rationale for award/decline decisions. Particularly when funding decisions deviate from the panel orderings, the review analysis should contain as full an account as possible of the details that led to the final decision, including factors of which the panel was unaware and comparisons between specific proposals. The subcommittee looked carefully at cases where the program officer's funding decisions deviated from the panel ordering. In many cases the reasons for this reordering were not made clear in the review analysis. Usually, but not always, the subcommittee could think of good reasons for the reordering and were happy with the outcome. In no case was the subcommittee unhappy with the outcome. However, we did feel that the reasoning should be better explained.

The documentation provided to the PI usually provides as much explanation as possible about the reasons for the final decision. In particular, the program officer comments are excellent. When appropriate, guidance is provided on how the PI could make a stronger proposal. It is highly desirable that this be done, whenever it is at all possible. This was already highlighted in the previous CoV report.

Both merit review criteria are discussed in individual reviews, panel summaries and review analyses. Often the discussion of intellectual merit is more detailed than the discussion of broader impact. The subcommittee felt that this was usually appropriate, as the broader impacts could often be described more succinctly.

2) AWARD PORTFOLIO

The subcommittee found that size and duration of awards was appropriate. Most mathematics is done by individual investigators or small groups of investigators, and the large number of individual or small group grants is highly appropriate, indeed essential for the continued success of the programs. There are certainly highly innovative and potentially transformative awards (a few examples are given below). The portfolio contains an appropriate balance of awards to those of all career stages, including early career researchers.

The subcommittee noted the very high success rate of applications for conference funding in some programs. We felt this was a good use of resources, because a relatively small investment in a conference can have a wide impact. Exposing a broad spectrum of young mathematicians to the highest level research can inspire them to raise their own goals. (Conversely, exposing young researchers to weak research can be misleading and counterproductive.) The program officers should continue to ensure that conference grants are primarily used to support mathematicians who do not have other funding for travel to conferences.

The data was insufficient for the subcommittee to determine whether the participation by underrepresented groups in the portfolio was reasonable. The

funding rates for women who applied are reasonable. The program officers are well aware of the need to promote diversity and the awards reflect this commitment. We encourage program officers to remain sensitive to bias issues that may arise in panel discussions.

Questions were raised about whether women were applying in sufficient numbers, or whether "self-selection" in applying for grants was disproportionately impacting them. The subcommittee did not have the data available to answer this question. We recommend the collection of data to compare the percentage of tenure track or tenured positions in mathematics held by women with the percentage of grant applications in DMS with a female PI. Data that specifically relates to the number of female applications in particular career stages would also be useful.

The number of applicants who did not give their gender was large and, in fact, comparable to the number of female applicants. This makes the data we did have difficult to interpret and may lead to erroneous conclusions. We urge the NSF to experiment with ways to encourage more applicants to state their gender, such as reminders or the better placement of the question on the website. We also urge the NSF to consider making its own estimate of the number of men and women in the "undeclared gender" category.

The portfolio includes projects that integrate research and training, although the subcommittee was disappointed by how few postdocs were funded through research grants. However, the subcommittee understands that it is expensive to fund a postdoc, so increasing the number of postdocs funded in this way may not be practical in the current funding environment.

3) ADMINISTRATIVE SUPPORT

The program officers expressed satisfaction with the administrative support they currently receive. They had particular praise for the substantial improvement in the IT systems available to them in the last few years, which they now describe as "excellent." The subcommittee commends the NSF for the provision of an extra program officer to DMS, which has made an important difference.

4) OVERALL PERFORMANCE

Overall the programs' use of merit review is seen as being highly successful. For example, over the last 3 years, PIs from the 3 programs we are examining have won a Fields Medal, a Wolf Prize, a Breakthrough Prize, two Shaw prizes and a National Medal of Science.

Algebra and Number Theory PI Ben Elias, together with Geordie Williamson, proved the Kazhdan-Lusztig conjecture in full generality and surprisingly used purely algebraic techniques. Algebra and Number Theory PIs Christopher Hacon and James

McKernan, together with Chenyang Xu, proved that all canonically polarized semi-log canonical pairs with fixed numerical invariants are of finitely many deformation types. Algebra and Number Theory PI Kevin Ford, with his coworkers, made the first improvement since 1938 in the order of growth of the maximal gap between two consecutive primes less than a given number.

Combinatorics PI Andrew Suk recently proved a new upper bound that determined the exponential constant in the famous "Happy Ending Problem" in geometric Ramsey theory, which goes back to the 1930s. Combinatorics PI Balog, with his collaborators, has developed the hypergraph container method and applied it to solve long-standing problems in graph theory, additive combinatorics, extremal set theory, and discrete geometry.

Computational Mathematics PI Malgorzata Peszynska has built computational models of methane hydrates, a substance which is of great interest in geophysics, climate studies, and energy engineering, because it can release methane, a powerful greenhouse gas and drilling hazard. With an excellent track record, novel computational methodologies and an ambitious research plan that involves experimentalists, this is an outstanding example of an interdisciplinary research program that brings together computational mathematics and current application. Computational Mathematics PIs Traian Iliescu and Zhu Wang are transforming Reduced Order Modeling into a robust and practical tool that can tackle the challenges raised by realistic noisy flows in engineering, geophysics, and medicine.

SUBCOMMITTEE B: Applied Mathematics, Foundations, Probability, Topology and Geometric Analysis

SUBCOMMITTEE ROSTER:
Alejandro Aceves**,** Southern Methodist University
Chad Topaz, Macalester College
Fern Hunt, National Institute of Science and Technology
Gail Ivanoff, University of Ottawa
Gloria Marí-Beffa, University of Wisconsin- Madison
Grigor Sargsyan, Rutgers University
Jacques Hurtubise, McGill University
Jan Philip Solovej (Chair), University of Copenhagen
José Iovino, University of Texas at San Antonio
Matthew Ando, University of Illinois
Robert Bryant, Duke University
Yuriko Renardy, Virginia Tech

The subcommittee was very impressed with the quality of the disciplinary programs under review. The programs receive a large number of proposals of outstanding scientific quality, many more than they can fund. Selecting the successful

applications is a painful and time-consuming task that we find is being done with great care. The Program Directors (PD) do an excellent job in forming panels, overseeing the review process, and finally selecting the proposal for award/declination. Their role is crucial in balancing the portfolio, and we found that, in particular, the equalization process was especially important. In the following answers to the template questions, we give a few suggestions for improvement.

I. Questions about the quality and effectiveness of the program's use of merit review process.

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

   The subcommittee felt that the review methods were excellent. Three reviewers are chosen to evaluate each proposal. This is done prior to the meeting of the panel. During the panel discussion, all members discuss each proposal and rank them into three categories, recommended for funding, fund if possible, and not recommended for funding. There is an equalization procedure that deals with borderline applications. The committee found that all these methods are appropriate.

2. Are both merit review criteria addressed
   a) In individual reviews?

      The criterion of intellectual merit is addressed in all reviews. The meaning of broader impacts seems unclear to some reviewers as well as some applicants. The subcommittee recommends that DMS provide the reviewers with examples of good and bad reviews on broader impact.

   b) In panel summaries?

      The panel summaries address both merit review criteria, broader impact and intellectual merit. As with the case of individual reviews, the portion addressing broader impact is not as clear as the portion addressing intellectual merit. The subcommittee found that panel summaries articulate the panel's opinion better than the individual reviews, as expected.

   c) In Program director review analyses?

      The program director's review analysis also addresses both merit criteria, often by referring to the panel summaries.

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

Good individual reviews are of tremendous value to the overall review process. They help proposers to understand the disposition of their proposals and, in the case of decline, how to improve their proposals for later submission. They help program directors to explain their decisions and to place proposals during equalization.

Many individual reviews are very good, but the quality varies substantially, and there are still too many that are not sufficiently informative. We encourage the DMS to continue to take all steps to ensure high quality individual reviews. Reviewers should be discouraged from merely summarizing proposals. Reviews that make specific and substantial reference to the proposal are more helpful than generalities about the proposers and their work. General comments are less helpful and can be subject to undesirable biases, even if not intended. Even comments about a proposer's track record can refer to the bio sketch or to the results of previous support. On the other hand, reviews should not refer to previous unfunded proposals. The DMS can assist reviewers by providing examples of reviews that are either more or less helpful (if allowable, these could be actual reviews, or else examples could be constructed).

We were distressed by cases in which one of three reviewers gave a grade of R, and explicitly reported that they lacked sufficient expertise. If the panel cannot supply three substantial reviews, then program directors should get mail reviews. This is particularly important for reviews that are brought to the equalization process and for those where there is no consensus between the other two reviewers.

To address issues with both the quality and number of reviews obtained, we wonder whether DMS should consider an overhaul of the timeline of the submission and review process. We had the impression from program directors that they are spread thin, trying to ensure quality of individual reviews during a very hectic three-day review panel. We recognize that reviewers themselves are strapped for time, but wonder if it would be possible to have reviews due quite far in advance of a panel, so that program directors would have time to reach out to reviewers whose reviews were too short, did not appropriately address intellectual merit and broader impacts, or had other issues.

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

   We commend the writers of panel summaries, many of which are exceedingly clear and well justified. We also recognize the important role program directors play in finalizing these summaries, a role they generally fulfill very well.

   However, we have also read panel summaries where there appeared to be insufficient information. These cases generally corresponded to either 1) proposals for which individual reviewers conflicted and perhaps included an "R" rating, or 2) proposals with high ratings from individual reviewers but that received a low ranking in the overall landscape of proposals. We also found cases of panel summaries that justify a low ranking simply by referring to stronger competition from other proposals. This does not provide sufficient information to the applicant. Finally, in cases where a proposal is sent to two panels, we hope there can be made some effort to harmonize or reconcile the summaries.

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

   The committee commends the program directors for their management of the reviewing and selection process. By and large, the reports clearly communicate the process and line of reasoning leading to the award/decline decision. However, the committee finds there are instances where more careful documentation is needed, for example, when there is strong disagreement in the assessment of a proposal that cannot be resolved before the panel review. This is especially important when one or more of the reviewers feels unqualified, so that the reviewer decision falls on two conflicting reports. We found proposals whose funding priorities were changed during the equalization process. The internal record of these proposals, such as the review analysis and the equalizations minutes, should give a more detailed account of the deliberation that led to such changes.

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

   Even though summaries PIs receive that are prepared by the PDs are good on details, when issues of concern as described in I.3, I.4 above arise, they are rarely addressed in the summary. When an excellent proposal is rejected due to insufficient funds, the applicant should be

encouraged to submit a revised proposal in a future competition. An effort should be made to offer concrete suggestions for improvement.

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

   The quality of the review process is particularly critical in strengthening further cross/interdisciplinary efforts. We believe that the DMS should pay special attention to proposals that might fall between the cracks of two panels within a program or two different programs, or even proposals that might receive co-funding outside DMS. It is very important to put in place mechanisms that allow such proposals to also be judged on their interdisciplinary qualities, and not only on their merits in the individual disciplines.

   The panels should be strongly encouraged to avoid ties in the ranking of applicants "recommended for funding".

   The Grant Proposal Guide calls for the Results of Prior Support to address Broader Impact. Reviewers should be asked to consider this aspect of proposals, to encourage follow-through on proposed activities with broader impact. This includes activities to increase the participation of minorities and women.

II. Questions concerning the selection of reviewers.

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

   The expertise of the reviewers was appropriate. When the panel lacked expertise, mail reviews were collected, or a proposal was evaluated by two panels. This was often the case in the Applied Mathematics program. Unfortunately, as mentioned in I.3 above, there were a very small number of unacceptable cases when one reviewer out of three declared a lack of expertise, and the PD did not seek further input even when the two reviewers disagreed on the merits of the proposal. In such cases, it is critical to ensure that a third qualified reviewer is found.

   DMS should pay special attention to make sure proposals from Primarily Undergraduate Institutions (PUIs) have at least one reviewer from a PUI. Understanding the nature of research at undergraduate institutions is a form of expertise, and Research in Undergraduate Institutions (RUI) proposals are required to include special documentation about the impact the grant would have on their institution.

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

   Based on the information available to us, conflicts of interest were carefully identified and dealt with in a completely adequate manner. The subject was brought up frequently, and even the very few cases that naturally escape a document search were later discovered through announcements. It is very clear that avoiding conflicts of interest is of fundamental importance to DMS.

3. Additional comments on reviewer selection:

   We have no further comments.

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

1. Management of the program.

   We were very impressed by the management of the individual programs in establishing panels and overseeing the review process. As already mentioned, the timeline of the review process could perhaps be improved to allow the PDs better control of the quality of individual reviews.

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

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

   Answer to questions III.2-3 above: We are very much in agreement with the bottom-up philosophy of the PDs to let the mathematics community define the trends and opportunities in research and education. The responsiveness of the programs to such trends is ensured through a flexible model for establishing panels.

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

   DMS has responded to the 2013 CoV call for continued efforts to improve diversity by introducing the Broadening Participation Initiative (BPI).

We still see insufficient internal documentation in the equalization process as a problem that should be addressed.

We retain an impression from the 2013 CoV report that broader impacts appear to play a much less significant role in the proposal review process than intellectual merit. For example, there was a sense that proposals with strong intellectual merit and weak broader impacts might still be funded. We hope that program directors will make sure that panel discussions devote significant, and not merely passing, time to discussing broader impacts.

Concerns about the uneven quality of reviews persist.

IV. Questions about the portfolio of awards.

1. Does the program portfolio have an appropriate balance of awards across disciplines and subdisciplines of the activity?

   A substantial effort is being made, in particular, in the equalization process to achieve this.

2. Are awards appropriate in size and duration for the scope of the projects?

   Yes

3. Does the program portfolio include awards for projects that are innovative or potentially transformative?

   We found an impressive fraction of successful projects that were innovative and potentially transformative. The program directors seem to be very attentive to this issue, e.g., in the equalization process. Moreover, we saw examples of potentially transformative proposals that, although they were turned down, received sufficiently constructive feedback to be successful in subsequent applications.

4. Does the program portfolio include appropriate multi-disciplinary projects and projects relevant to national priorities, agency mission, and other constituent needs?

   Mathematical Sciences are increasingly multidisciplinary, and this is reflected in a large number of multidisciplinary proposals and awards in all the areas that we reviewed (Applied Mathematics, Foundations, Probability, and Topology and Geometric Analysis).

5. Does the program portfolio have an appropriate balance of awards to new and early-career investigators?

   Early-career researchers are being recognized and are prioritized in the equalization process.

   The number of funded proposals is relatively small, and it is therefore difficult to ascertain a general trend, but early-career investigators have funding rates similar to that of more senior researchers. There is a steady drop in the total number of applications with increasing PhD age.

6. Does the program portfolio include projects that integrate research and training?

   Across the disciplines that this subcommittee looked at, the funding for graduate students made up in the range of 10–20% of the total budget of proposals. Unfortunately, graduate students are becoming increasingly expensive, and this is posing a real threat to the investment made in training. The funding for postdocs in the proposals is rather low.

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

   Although the success rate for proposals from persons from underrepresented groups appears to be comparable to the success rate overall, the pool of submissions from underrepresented investigators is distressingly small. The DMS should find ways to encourage more submissions from these populations.

   Possible strategies include:
   - DMS should liaise with professional societies to develop strategies to mentor applicants in preparing their proposals.
   - DMS should recognize the mentorship of women and members of underrepresented groups in grant writing as a broader impact activity.
   - PDs should make a particular effort to contact strong but unfunded applicants from underrepresented groups to encourage future submissions.

8. Does the program portfolio reflect an appropriate balance among (a) individual-investigator and small group awards, (b) workforce and infrastructure awards, and (c) research institutes?

   N/A

V. Other Topics

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

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.

   Overall, we think that, within the budgetary reality, the program's performance is very good. We were dismayed by the high number of excellent proposals for which there were insufficient funds.

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

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

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

   While CoV16 appreciated the Webinar and early access to the NSF websites, serving on two subcommittees in three days proved extremely stressful for many CoV participants.

SUBCOMMITTEE C: Analysis, Statistics, Mathematical Biology, and NIGMS

Berhanu, Shiferaw, Temple University
Doerge, Rebecca, Carnegie Mellon University
Ebenfelt, Peter, UC San Diego
Edelstein-Keshet, Leah, University of British Columbia
Huzurbazar, Aparna, Los Alamos National Laboratory
Keen, Linda, CUNY Lehman College
Pavlovic, Natasa, University of Texas - Austin
Pipher, Jill (Chair), Brown University
Rojo, Javier, University of Nevada-Reno

Thompson, Elizabeth, University of Washington
Whitaker, Nathaniel, University of Massachusetts Amherst
Williams, Talithia, Harvey Mudd College

This subcommittee reviewed the disciplinary programs Analysis, Statistics, Mathematical Biology (MB), and one DMS-NIH collaboration, the National Institute of General Medical Sciences (NIGMS), which we found to be functioning very well, with strong proposals and a good review process.

It is clear that DMS Program Officers (POs) are, overall, doing an extraordinary job of identifying the most excellent proposals from a much larger pool of excellence than can be funded.

Analysis is a healthy program, with junior PIs identified among the top of the Competitive range. The data showed that the Analysis Program supports a broad spectrum of research directions in this vibrant and foundational area of mathematics: breakthrough developments in harmonic analysis, PDE, general relativity, random matrix theory and operator algebra, as well as emerging connections with probability, dynamical systems, and geometry. This success is reflected in the awarded individual grants, including CAREER awards, and to some extent in FRG awards, which attracts highly competitive proposals in this field. We are impressed by the efforts of POs in supporting underrepresented minority and female researchers.

The committee felt that MB is a very well run program, with good panelists, good constructive reviews, excellent panel summaries, and good review analyses. MB often seeks co-funding with one of the following divisions within NSF: Molecular & Cellular Biosciences, Integrative Organismal Systems, and Environmental Biology in BIO, and Bio-engineering in ENG. DMS/NIGMS is an inter-agency program supporting research teams of mathematicians and biologists. In short, MB has made commendable use of leveraged funds to support researchers in mathematical biology.

Statistics is a field that is playing an increasingly central role in the mathematical sciences as well as in other disciplines, such as biology, engineering, and computer science. The panel jackets examined by our committee did not give a complete picture of the support throughout the foundation for statistics, especially since the core program has a focus on theoretical and methodological developments in the field. As we learned, statisticians are supported in DMS co-funded special programs such as Big Data, CDS&E, and NIGMS. This committee was pleased to learn that there has been a recent increase in proposals to Statistics focusing on "hot areas" or emerging areas such as those at the interface with topology, geometry, tensors, shape analysis, graphs and networks. We were encouraged to hear that, in order to enhance evaluation of such proposals, POs strived to include panelists from outside traditional pools (previously funded academic researchers), including industry

researchers and junior researchers. We commend the POs for their efforts with regard to panel composition.

Individual and panel reviews of proposals vary within a program, and even across programs. Some panelists provided detailed information, but others gave no reasons for their assessment. The Program Officers' "review analyses" (RAs) also varied, ranging from reiterating the panel summaries to a very detailed and thoughtful summary of the decision process. The rationale for "not recommended for funding" in all programs was typically clear and detailed in the RA. However, the details of the rationale for funding decisions in the RAs for "competitive" but "declined" category were more variable. This committee appreciated the difficulty of the decisions by POs for proposals in this category, and we had ample evidence that tremendous thought and consultation occurred in this process. We recommend that the documentation of the POs internal process be uniformly complete. Finally, the committee was extremely impressed with certain RAs in Analysis and MB. DMS might consider sharing model RA documents across programs.

The panel review process is, overall, working very well; all the panels we examined had, for the most part, sufficient expertise, and panelists did take both criteria (merit and broader impacts) into consideration in their evaluations. The weighting of these two criteria for a given proposal is left to the reviewer, which seems appropriate on balance. We were impressed by some of the broader impacts plans and discussions in some proposals and, in at least one case, noted that consideration of this criterion pushed a proposal at the margins into the Award zone. In the Analysis program, the panels appeared to have both sufficient expertise and diversity. Panel composition appears to be more challenging in those program that have an interdisciplinary aspect, such as Statistics and MB. MB uses very few ad hoc reviews, and there seemed to be sufficient breadth of expertise, with a good mix of junior and more senior panel members and good geographic diversity. Statistics makes greater use of ad hoc reviews; this appears to be the most feasible means of getting feedback from industry researchers who often cannot participate in 3-day panels.

In general, the communication from POs to PIs regarding strengths and weaknesses ranged from adequate to excellent. The committee would like to encourage further communication with declined PIs in the "Competitive" category to encourage future submissions.

We have a very positive impression of the overall efforts of DMS in increasing participation in underrepresented (UR) groups: Every program we reviewed had made use of the (new) internal Broadening Participation Initiative. There are areas requiring further efforts in diversity, as the data show. Indeed, with the vast amount of data provided, we were able to take a closer look at outcomes in individual programs. Our committee calculated application rates of women and UR minorities in each program and compared that with (the already provided) funding rates of women and UR minorities. We found for example that in Analysis 12% of

applications were Female (F), while F's had a 38% funding rate (higher than the overall funding rate of 30% in this program). Statistics had a 19% application rate from F's, and an 18% funding rate (lower than the overall rate of 25% in this program). MB had a higher than average application rate of proposals from UR minorities than other programs, but the funding rate was 13%, lower than this program's overall funding rate of 20%. However, the funding rate of 25% for women in MB was higher than the overall funding rate for women of 20%.

The committee finds that DMS has an "as-yet unrealized opportunity" to extract information from its own data, information that could be used internally, as well as for future COV meetings.

SUBCOMMITTEE ON MATHEMATICAL SCIENCES RESEARCH INSTITUTES

SUBCOMMITTEE ROSTER:

Ali Pinar, Sandia Laboratories – Livermore
David Saltman, Center for Communications Research
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Genetha Gray, Intel Corporation
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Jan Philip Solovej (Chair), University of Copenhagen
Linda Keen, CUNY Lehman College
Shiferaw Berhanu, Temple University
Vyjayanthi Chari, UC Riverside

RESEARCH INSTITUTES

The Research Institutes program is a major investment of DMS (13-14% of the total budget) and of enormous importance to the mathematical community in the US. They function to bring together many mathematicians and other scientists working on the subjects at the forefront of current research. They are a cost effective way to support a large number of people in an environment conducive to productive work.

The CoV2016 subcommittee on Research Institutes was charged with reviewing the DMS program on the Research Institutes in the fiscal years 2013–15. These are the national Institutes - the American Institute of Mathematics (AIM), the Institute for Advanced Study (IAS), the Institute for Computational and Experimental Research in Mathematics (ICERM), the Institute for Mathematics and its Applications (IMA), the Institute for Pure and Applied Mathematics (IPAM), the Mathematical Biosciences Institute (MBI), the Mathematical Sciences Research Institute (MSRI), the Statistical and Applied Mathematical Sciences Institute (SAMSI) and the foreign Institutes –the

Banff International Research Station (BIRS), the Fields Institute for Research in Mathematical Sciences (Fields), the Institut des Hautes Études Scientifiques (IHES), and the Mathematisches Forschungsinstitut Oberwolfach (MFO). Among the foreign Institutes, DMS is significantly more involved in BIRS than the others, which only receive relatively small grants to cover participation for US based participants. BIRS was conceived of as a North American resource and has a large constituency of US participants.

THE REVIEW PROCESS

During the period 2013–15 the Institutes BIRS, ICERM, IMA, IPAM, MBI, and MSRI underwent a non-competitive review in 2014, and the Institutes AIM, IAS, and SAMSI had midterm site visit reviews in 2015. The subcommittee examined these reviews. There were no open competitions during 2013–15.

In response to the CoV2013, the DMS has changed the cycle of reviews for the Institutes so that they are now all on a synchronized 5-year cycle of open competitions. The next open competition will be in 2019. Moving forward, the review process will change due to the competition between established centers and new applicants. It is important that DMS considers this with care and communicates it clearly to the community.

The CoV recommends that DMS clarify their selection criteria and procedures for investing in foreign Institutes.

The reviews in 2014 were very thorough and appropriate. The review process occurred in three stages: panel review; site visit; and evaluation by an Institute Management Team of the DMS. The Fields institute proposal was submitted as a conference/workshop proposal and was reviewed by mail.

The same panel reviewed all the Institutes. It was charged with deciding whether to recommend a site visit that would consider a list of questions it formulated. In 2014, the panel recommended site visits for all the Institutes. All the non-conflicted members of the panel wrote reviews that were very substantial. They clearly addressed both general review criteria, i.e., the intellectual merit and the broader impact, as well as solicitation-specific review criteria relevant to the research Institutes. The detailed panel summary described the strengths and weaknesses and formulated questions for the site visit. The panel members were well chosen and had appropriate collective expertise.

The site visit teams consisted of external reviewers and representatives of DMS. The reviewers were mostly mathematicians, complemented by well chosen representatives from relevant academic environments, e.g., biological sciences for MBI. The CoV would have liked to see more industrial representatives, e.g., in the IMA site visit team.

The final review analysis contains an analysis of the site visit report, the panel summary, the institute management team analysis, and its recommendations. A redacted version is sent to the PI. In all cases, the CoV found that the information sent to the PI contained the rationale for the decline/award decision. All Institutes received an award, but for IMA and MBI this was as a staged discontinuation award. We will discuss the process that led to this decision below when addressing the management of the program. The subcommittee found that the mid-term site visits were detailed and useful and were explicit in their recommendations.

MANAGEMENT OF THE RESEARCH INSTITUTES PORTFOLIO

The Institutes serve a broader community than the individual grants. Our subcommittee was impressed by the innovative and transformative qualities of many of the programs at the Institutes as well as the balance of pure and applied mathematics including interdisciplinary fields. They all integrated research and training very well.

The directors play a crucial role in the success of the Institutes. The CoV feels that, in its communications with the Institutes, the DMS should continue to stress the importance of their leadership. The CoV feels that the regular meetings of the Institute Directors are an important aspect of the management of the institute portfolio. The breadth of representation of research fields among the scientists on the Institutes' Advisory Boards is another important part of their administration. The DMS should continue to pay attention to the make-up of these boards.

DMS should pay close attention to the obligation of the Institutes to support minorities, women, and unfunded researchers. This can be done through the annual reports of the Institutes and also through site visits. Funding meant for a broad audience should go to a broad audience.

The CoV commends the DMS efforts to have the Institutes provide data on participants, including Ph.D. age, whether they are US or foreign participants, women or underrepresented minorities, NSF funded or not. Much of this material was collected in the DMS Participant Study from 2014. There is not uniform data on the outcomes of the programs. The CoV recommends the DMS work with the Institutes to provide data that can be used to better evaluate the effectiveness of their activities. For example, knowing only the number of women who participated does not, in itself, indicate how effective the program was for them. Rather, some measure of the scientific benefit of the program after some period would be more telling. Another example is data on the future productivity of those supported by the Institutes but not by other NSF funds.

The CoV2013 report concluded that

"Without substantial future increase in the DMS budget, the potentially painful decision to ramp down and not continue the funding of an existing institute must be considered in the mix along with the possibility of new ones."

In light of this and as a result of the 2014 non-competitive review of the Institutes, DMS recommended a staged discontinuation of IMA and MBI. These are very serious decisions with long lasting consequences. The CoV subcommittee on Research Institutes therefore spent a considerable amount of time discussing the process and rationale for the decisions.

The CoV subcommittee considered in detail the 2009 and 2014 DMS reviews of the IMA and found that these raised serious concerns about the operation of the institute. The subcommittee was not unanimous about whether DMS gave IMA sufficient feedback about the seriousness of the problems and, in particular, enough time to remedy the situation. A majority of the subcommittee found that the process leading DMS to discontinue IMA was acceptable, whereas a minority thought that clearer signals should have been sent to the institute, and that DMS should have acknowledged that IMA was making attempts to improve the situation.

In the case of MBI, the 2009 review pointed out problems with a core mission of the institute: the involvement of biological scientists. The midterm site visit review in 2012 reiterated this concern and the situation was still critical at the time of the 2014 review. Some members of the subcommittee were again concerned whether DMS had been clear enough in its feedback to the institute, but the committee as a whole agreed that the process leading to the discontinuation of core DMS support of MBI was acceptable.

Going forward, DMS should continue to articulate clearly and unambiguously their expectations for their Institutes to be in line with their missions. DMS should emphasize the importance of long term host institution commitment and include this among the selection criteria in future open competitions.

In general the CoV is concerned with the effectiveness of communication between DMS and the Institute leaderships. If problems emerge in site visits, they should be addressed in later annual reports. If they are serious enough, a plan of action should be drawn up by the Institute leadership and DMS to address the problems in a timely manner.

The CoV finds the loss of the postdoc program at IMA to be a particularly serious issue. The DMS would be well advised to find ways of filling that gap and ensure that such a training program is an important component in the future.

The CoV strongly recommends that DMS in the future keeps the same substantial investment in research Institutes as they have up to now.

SUBCOMMITTEE ON SPECIAL RESEARCH PROGRAMS

Aceves, Alejandro, Southern Methodist University
Ando, Matthew, University of Illinois, Urbana-Champaign
Ebenfelt, Peter, University of California, San Diego
Fox, Jacob, Stanford University
Hurtubise, Jacques, McGill University
Huzurbazar, Aparna, Los Alamos National Laboratory
Pavlovic, Natasa, University of Texas, Austin
Pipher, Jill (Chair), Brown University
Sethian, James, University of California, Berkeley
Tadmor, Eitan, University of Maryland
Thompson, Elizabeth, University of Washington
Whitaker, Nathaniel, University of Massachusetts, Amherst

This committee reviewed special research programs, with the exception of NIGMS, which was reviewed along with the MB program. The FRG program is a DMS initiative, while the rest constitute an impressive variety of collaborations and partnerships with other federal agencies, other MPS divisions, and NSF directorates.

FRG is one of the most competitive programs within DMS, with a funding rate of no more than 20%. The proposals here are exceptionally strong. Evaluation of proposals appeared to pay close attention to intellectual merit and broader impacts, as well as the additional criteria justifying the collaboration. The decisions to fund are made by the management team following a panel screening and subsequent input from mail reviews and Program Officers in the appropriate disciplines. The meeting notes did not always provide a great deal of detail on the decision rationales. On the other hand, we did find detailed evidence of efforts by the FRG management team to secure co-funding for some excellent proposals. One Applied Math proposal received substantial co-funding from the Fluid Dynamics program of the Division of Chemical Bioengineering, Environmental, and Transport Systems and from OMA. These successes in finding co-funding are undoubtedly fostered by a spirit of collaboration that is reinforced by investments of DMS in other divisions and directorates.

The small number of proposals in FRG awarded each year (4) makes it challenging to create a balanced distribution among fields and to support diversity in this portfolio. The two largest groups of applicants are in Algebra and Number Theory (ANT) and Applied Math, while 2/4 awards in each year went to ANT. We noted that Comp. Math received only one award in three years. In 2013, there were no female PIs or co-PIs on any of the awarded FRG grants. In 2015, there were only four female PIs or co-PIs on the awarded FRGs. Minority representation among PIs is low. Our committee felt that this program should make stronger efforts in diversity. This criticism notwithstanding, we were in agreement that this program should be a very high priority for additional funding, if such funding is available.

The committee was impressed with the range of special research programs: the DMS/NIGMS and the Computational and Data-Enabled Science and Engineering in Mathematical and Statistical Sciences (CDS&E-MSS) were viewed as great successes, attracting strong proposals with mathematical scientists as PIs or co-PIs. We were pleased to learn during the course of this meeting that the NIGMS Council had approved continuation in FY18-21 of the DMS/NIGMS program, following a full review by NIH.

Big Data is an NSF-wide program to which DMS contributes: DMS jointly funds a number of collaborations that include mathematicians and statisticians – the return on investment seems high.

The Designing Materials to Revolutionize and Engineer our Future (DMREF) program appears to attract strong proposals from interdisciplinary groups. Some members of our committee were concerned about the disparities between the evaluations of proposals by the DMR and the DMS panels. Similar disparities were observed in the COV 2013 report, and it is perhaps the case that any review process involving non-interacting disciplinary panels will result in significant assessment differences. We concur with the recommendation made in COV 2013 that mathematical scientists participate in those DMR panels evaluating DMREF proposals.

The Mathematical Sciences Innovation Incubator (MSII) program is a new (2014) activity that co-funds projects managed by other parts of NSF. The committee saw a number of proposals that were co-funded with support from this program and had a positive impression of its impact so far.

The rate of success in attracting strong proposals is quite variable among the non-DMS special research programs, but our committee found examples of excellent proposals in each of the programs we examined, including the Algorithms for Threat Detection (ATD), DMREF, Big Data, Software Institutes, and others. We understand that DMS has used "workshops" in advance of, or during, calls for proposals to help to generate greater awareness and more contributions from the math community. We think this is a good strategy.

SUBCOMMITTEE ON WORKFORCE AND INFRASTRUCTURE PROGRAMS

SUBCOMMITTEE ROSTER
Adebisi Agboola, UC Santa Barbara
Robert Bryant, Duke University
Rebecca Doerge, Carnegie Mellon University

Leah Edelstein-Keshet, UBC
Jose Iovino, UT San Antonio
Robert Krasny, U Michigan
Diane Maclagan, University of Warwick
Yuriko Renardy, Virginia Tech
Javier Rojo, U Nevada Reno
Richard Taylor (Chair), Institute for Advanced Study
Prasad Tetali, Georgia Tech
Chad Topaz Macalester College
Talithia Williams, Harvey Mudd College

Workforce and infrastructure programs involve about 13% of DMS's budget. They play a vital role in ensuring the long-term vitality of the research community in mathematics and statistics in the USA. Whereas some of the projects are long-standing success stories, others have undergone significant changes in the last 3 years, partly in response to the last CoV report. Although it is too early to judge the impact of these changes, our impression is that they have been very positive. The overall structure of the portfolio of programs has been usefully simplified. The subcommittee hopes that the structure of these programs will begin to stabilize.

RESEARCH EXPERIENCE FOR UNDERGRADUATES (REU)

The REU program continues to be a rousing success within the NSF.

Merit review. As appropriate, reviewers generally concentrated more on the broader impacts of the program than the intellectual merit (insofar as intellectual merit is interpreted as original research). We have two primary suggestions. The first pertains to the multiple ways in which an REU may achieve success. Reviewers must be directed to evaluate proposals in light of the specific route to success that is sought. For example, it strikes us that a proposal that aims to involve research students with less preparation should not be evaluated according to the number of publications the program produces. Second, for any proposals that constitute renewals of ongoing REU programs, reviewers must be encouraged to address the success of the prior REU awards.

Selection of reviewers. We note a diverse and highly-qualified pool of reviewers. Though it is difficult to be certain, we have the impression that some proposals have no primary reviewers who themselves conduct research with undergraduates. We fully understand the difficulty of obtaining reviewers but hope an effort can be made to have at least one such reviewer as a primary reviewer on every proposal.

Management of the program. The 2013 CoV report recommended, "We recalled in discussion with some NSF program directors that there are other REU programs within NSF and that the program directors will sometimes meet to discuss the different programs. We suggest that this might be a good opportunity to both share

and document best practices among all of the REU programs." In the 2015 Update to the 2013 Response to the CoV, the NSF has taken action. They report "The Division led the formation of an external REU PI Group that meets regularly to share best practices and develop materials of common interest. The group has implemented a pilot assessment project using the Undergraduate Research Student Self-Assessment (URSSA) tool. A common group assessment was used by ten DMS-supported REU sites during the summer of 2014. The group repeated the assessment activity during the summer of 2015." We commend this action.

We have several suggestions.

There were a few proposals from minority- and women-serving institutions that did not receive funding. As noted in the previous CoV 2013 report, "Care is needed to nurture promising underrepresented students and researchers as they move along the pipeline, with special attention to seeing that they are recruited to the next step in their careers while in each DMS program." We recommend that special care be taken by program directors to give copious feedback and encourage resubmission as a way of broadening the pool.

Many of the REU sites have been re-funded a number of times, and it would be helpful to have a tabulation of the longitudinal data (years in existence, number of students, total investment, and so forth) in comparing the programs. For the benefit of future CoVs and for NSF internally, it would be beneficial to have this data compiled. Some committee members share a concern that students participating in multiple REUs might detract from the goal of increasing the number of students brought into mathematical research. It would be extremely helpful to have data on the number of students who complete multiple REUs.

Portfolio of awards. We have one concern related to award size and scope of projects. The program solicitation states "many NSF units consider up to one month of salary for the PI, or distributed among the PI and other research mentors, to be appropriate for time spent administering and coordinating the REU Site, training mentors, and similar operational activities. (NSF expects that research mentors will be supported with appropriate salary for their research activities, though not necessarily through the REU grant.)" It appears that most awarded grants conform to this language. However, it strikes us that administering sites and advising research projects is substantive labor that should be compensated. We note that the language in the solicitation does not exclude the possibility of DMS exercising its discretion to fully fund REU site leadership (PIs and mentors), and we believe they should use this discretion. This will enable REU sites to maximally attract enthusiastic and qualified mentors.

The subcommittee felt that it would be very useful to have data to validate (or otherwise evaluate) the REU program. Some subcommittee members suggested that all participants be surveyed at the start of their REU as to their career intentions and that this data be compared to their actual career trajectories.

ENHANCED DOCTORAL TRAINING (EDT)

This is a new, relatively small, but potentially important program to encourage doctoral programs in mathematics to better prepare their students to thrive in the job market, where most PhDs do not end up working in academia. The program is too young to yet judge its success. However, we urge DMS to consider how it will, in the longer term, measure the success of this program.

Merit review. The review methods were appropriate and by and large well implemented. The Program directors were able to explain their decisions to the panel in person, but this information was not provided in the jacket. In general, the panel feels that the reasons for the actions taken by the Program Directors should be fully documented in the jacket.

Both the panel and a majority of the proposers appeared to have interpreted the program solicitation more narrowly than intended. This resulted in a significant divergence between the recommendations of the panel and the final decisions of the program directors. The committee was pleased to learn from the program director that changes have already been made in an effort to address this issue.

MATHEMATICAL SCIENCES POSTDOCTORAL RESEARCH FELLOWSHIPS (MSPRF)

This is a longstanding and outstanding program that has had a very great impact on the development of the mathematical workforce.

Merit review. We find the use of review panels to be very appropriate. In order to maintain the very high level of the MSPRFs, we believe that it is crucial that DMS collect letters of reference on the candidates. The subcommittee also thought it was important that several members of a panel had themselves mentored MSPRFs or similar postdocs. We commend the DMS for following the advice of the last CoV and replacing one large panel by three smaller panels based on subject areas.

The previous CoV urged DMS to take care that panel bias concerning subject area does not play a role in the selection of MSPRFs. We have no reason to believe such bias exists, but we reiterate this caution.

The subcommittee feels that, because of the reliance on confidential letters of reference in the decision process, it is impossible to give detailed feedback on each proposal. In addition, each panelist has to review an unusually large number of proposals, which would make the writing of reviews difficult. Nonetheless it is very helpful for those declined but in the "fund if possible" category to be informed that they narrowly missed a fellowship, so that they may feel encouraged to re-apply. DMS has apparently already started providing such feedback, a move that we endorse. In response to the last CoV report, DMS has also started giving very limited

feedback to all applicants—just the ratings and panel placement. This CoV felt that this may be worse than nothing. Given the variability from panelist to panelist in the assignment of ratings, the subcommittee doubted that this information was very useful and worried that without context it could be discouraging.

The documentation in the jacket was not always sufficient to reconstruct the reasons for the decisions taken by the program directors. For the applicants in the "fund if possible" range it would be very useful to the CoV if the review analysis contained an explanation for the final funding decision, particularly when that decision differed from the panel recommendation.

Award Portfolio. The subcommittee has an extremely positive impression of the effectiveness of this program. It notes that the funding rate is at historic lows. For 30 years or so, the funding rate fluctuated between 20% and 40%. In 2010 it fell to 16% and in 2011 was 17%. We don't know the funding rate since then, but for the 2015 panel we were given access to the rate, which was less than 20%. Such a low funding rate for such a successful program is a serious concern. We urge the NSF to try to correct this.

The subcommittee concurs with the previous CoV that it is important to back this up with data. DMS were able to provide us with some useful and impressive data from 2011 concerning the percentage of MSPRF awardees who went on to win other NSF grants. This percentage was about 60–80% in the period 1980–2000, which provides a strong endorsement of the program. We note that this percentage has fallen off in recent years, but we are uncertain about the reason. Is there a time lag between finishing a MSPRF and winning your first NSF grant? Are NSF grants becoming more competitive? Are recent MSPRFs weaker? We recommend that DMS collect such data on a regular basis, which might help clarify the explanation. In addition, data might be collected on the employment of MSPRFs 3 and 10 years after the completion of their fellowships, which would also help to evaluate the success of the MSPRF program.

We note that although the choice of mentor and host institution forms part of the application for a MSPRF, DMS allows awardees with a good reason to change mentor and institution after one year. We believe this flexibility is very important in a small number of cases. We commend DMS for extending this flexibility to fellows in their first year who wish to attend a special program at one of the mathematical institutes. We are aware of a number of unfortunate cases where this was previously not allowed. The subcommittee feels it would be useful, when there are extenuating circumstances, and with the approval of the program director, if MSPRFs could move their fellowship to a different institution with a different mentor, even before the start of their fellowship. (For instance this might be helpful for applicants trying to solve two-body problems. We know of a case in which an MSPRF award was turned down for this reason.) The new mentor should provide a mentoring plan. We expect that only a very few MSPRFs would take advantage of this increased flexibility, but that, for these fellows, it could be very important. We

recognize that if many MSPRFs chose to do this, it might adversely affect the geographic diversity of the program. If this were to happen, DMS would have to think again about such a change.

RESEARCH TRAINING GROUPS (RTG)

The program is generally seen as a successful initiative and is also seen as a significant improvement over the previous VIGRE program. Smaller-size awards allow for a greater number of institutions to take part in the program. The focused-theme nature of these seems to allow for identifying concrete objectives and for overall effective management. The RTGs have been very effective in attracting, training, and placing American undergraduates, graduate students, and postdoctoral fellows, as well as in improving mentoring.

We felt that the program, as devised by the NSF, was excellent. However, we had some concerns, many of which relate to how the implementation has drifted from the original program solicitation:

- The criteria for the program do not seem to have always been communicated clearly to the panel. In particular, the program solicitation states, "The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified." However, at times, the panel seemed to penalize well-run and well-documented programs for not being innovative, despite their already using best practices.
- The program solicitation states, "The RTG program is intended to help stimulate and implement permanent positive changes in research training within the mathematical sciences in the U.S." This seems to suggest that preference be given to newer initiatives rather than renewals of existing ones, however successful. If this is indeed the case, then it should be made clear to the community and the panels.

The subcommittee would like to see more rigorous mechanisms put in place to evaluate the success of the RTG program as a whole. Some subcommittee members felt that it was important to try to measure the difference between the career paths of students and postdocs who were in the group before and after the award.

BROADENING PARTICIPATION INITIATIVE (BPI)

We commend DMS for introducing the BPI initiative in response to the previous CoV report. This scheme provides additional funding for some regular research grant applications with a particularly strong diversity component.

INFRASTRUCTURE PROGRAMS

The infrastructure program funds unsolicited proposals to develop the infrastructure and workforce in the mathematical sciences. The subcommittee believes it is extremely important to keep this pathway open, both for crucially important projects that don't easily fit under any other program and for the occasional extremely innovative idea. Such projects as the ICM travel grants, the AMS mathematical research communities, and the PRIMES program for high school students, to name but a few, are held in very high regard by the community.

The portfolio is particularly diverse, which naturally poses some problems for the evaluation of proposals. Panels are only suitable for a few of the proposals. As a result, there is significant reliance on mail reviews, which makes consistency a challenge. The use of asynchronous reviews could perhaps aid in improving the quality and consistency of these reviews.

SUMMARY

In our evaluation of workforce and infrastructure programs, certain themes recurred:

- It is very hard for the subcommittee to evaluate the diversity of the workforce programs because the NSF does not have suitable demographic data. We strongly suggest that NSF compile figures for the percentages of participants (undergraduates, graduates and postdocs, not PIs) in each workforce program who are female or come from an underrepresented group. This would be helpful for DMS and for the next CoV. We were able to compile such figures ourselves for the MSPRF program. About 20% of MSPRF awardees are female, which is comparable to the percentage of women postdocs at Group I universities, but could be improved. We urge the DMS to try to raise this percentage. About 5% of MSPRF awardees are from underrepresented minorities. While very low, this is probably better than the corresponding percentage for postdocs at Group I universities.

- The documentation in the jacket was not always sufficient to reconstruct the reasons for the decisions taken by the program directors. Particularly when the funding decision of the program directors deviates from the panel recommendation, we feel that it is very important that as full an explanation as possible appear in the review analysis. This could include factors of which the panel was unaware and comparisons between specific proposals. This goes for all the programs reviewed by our subcommittee. This point was raised by the previous CoV.

- We urge DMS to collect data to judge the effectiveness of its various workforce programs. We feel that it is practical to collect such data that could be used to validate (or not) the various programs and to determine which approaches best achieve the stated goals. This has become both more

important and less daunting in view of the increased amount of expertise available in the age of big data.

- The terms of some of the solicitations are complicated and not entirely clear. They may not have been consistently applied by panels. (The terms of the EDT solicitation were construed more narrowly than intended by many applicants and panelists. Some RTG proposals were criticized for a lack of innovation, when the solicitation said innovation was not necessary. In the REU program there were different ways to be excellent, and the panels seemed to sometimes apply the standards of one version to a proposal coming from the other mode.) The subcommittee would like to see workforce solicitations simplified and clarified. We would also like to see panels urged to consistently apply the specified criteria.

COV Membership

	Name	Affiliation
COV Chair and Subcommittee Co-Chairs:	**Peter W. Jones, Chair** **Jan Philip Solovej** **Richard Taylor** **Jill Pipher**	**Yale University** **University of Copenhagen** **Institute for Advanced Study** **Brown University**
COV Members:	**Alejandro Aceves** **Adebisi Agboola** **Matthew Ando** **Shiferaw Berhanu** **Robert Bryant** **Vyjayanthi Chari** **Rebecca Doerge** **Peter Ebenfelt** **Leah Edelstein-Keshet** **Jacob Fox** **Genetha Gray** **Fern Hunt** **Jacques Hurtubise** **Aparna Huzurbazar** **José Iovino** **Gail Ivanoff** **Linda Keen** **Robert Krasny** **Diane Maclagan** **Gloria Marí-Beffa** **Natasa Pavlović** **Ali Pinar *** **Yuriko Renardy** **Javier Rojo** **David Saltman** **Grigor Sargsyan** **James Sethian** **Eitan Tadmor** **Prasad Tetali** **Elizabeth Thompson** **Chad Topaz** **Nathaniel Whitaker** **Talithia Williams** *** Remote participation only**	**Southern Methodist University** **University of California, Santa Barbara** **University of Illinois, Urbana-Champaign** **Temple University** **Duke University** **University of California, Riverside** **Carnegie Mellon University** **University of California, San Diego** **University of British Columbia** **Stanford University** **Intel Corporation** **National Institute of Standards & Tech.** **McGill University** **Los Alamos National Laboratory** **University of Texas, San Antonio** **University of Ottawa** **City University of New York Lehman College** **University of Michigan** **University of Warwick** **University of Wisconsin** **University of Texas, Austin** **Sandia National Laboratories, Livermore** **Virginia Polytechnic Institute & State Univ.** **University of Nevada, Reno** **Center for Communications Research** **Rutgers University** **University of California, Berkeley** **University of Maryland** **Georgia Institute of Technology** **University of Washington** **Macalester College** **University of Massachusetts, Amherst** **Harvey Mudd College**

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