Report of the

Committee of Visitors

for the

Division of Mathematical Sciences
National Science Foundation

February 11-13, 2004

Submitted on behalf of the Committee
by Robert J. Zimmer, Chair

to

Michael Turner
NSF Assistant Director for Mathematical and Physical Sciences

Contents:

1. Introduction

The Committee of Visitors (COV) for the Division of Mathematical Sciences (DMS) met at the National Science Foundation (NSF) on February 11-13, 2004. The committee was charged by Michael Turner, NSF Assistant Director for Mathematical and Physical Sciences (MPS) to address and prepare a report on:

- The integrity and efficacy of processes used to solicit, review, recommend, and document proposal actions
- The quality and significance of the results of DMS programmatic investments
- The relationship between award decisions, program goals, and Foundation wide programs and strategic goals
- DMS balance, priorities, and future directions
- The DMS response to the prior COV report of 2001
- Any other issues the COV feels relevant to the review

The COV core questions and reporting template were provided for use in addressing a number of these issues.

The COV members represented a broad diversity of perspectives from the extended mathematical sciences community. There was representation from public and private universities, research-intensive universities and small colleges focused on education, academia and the corporate community, other Federal agencies and national laboratories as well as scientists from abroad, and scientists who had received NSF funding in the past and those who had not. This breadth of perspective was very useful for the committee's work.

Prior to the meeting, the committee members were supplied with a variety of documents pertaining to DMS, including the COV reports from 1998 and 2001, DMS annual reports from 2001-03, and considerable data on divisional programs regarding award size, funding rates, methods of review, and finances. At the beginning of the meeting, William Rundell, Director of DMS, gave an overview of DMS programmatic activities and financial context, and program directors within DMS also gave brief presentations to subcommittees that were examining their program's activities. During the meeting, COV spent considerable time evaluating selected and requested proposals that had come to DMS. In addition, DMS staff was available and responsive to questions and requests for information that arose during the course of our discussions. The material supplied beforehand and at the meeting, the informational sessions during the meeting, and the responsiveness to requests for additional information and data enabled the committee to have the relevant information necessary to carry out its charge. Deborah Lockhart of DMS discussed conflict of interest rules with the committee, which governed committee members' participation in the committee's work, and both she and William Rundell were available for consultation on conflict of interest matters throughout the committee's visit.

The COV conducted some of its work as a whole, and some of its work by dividing into three groups. The latter were of particular importance in evaluating specific programs within the DMS where the expertise of particular committee members could be brought to bear. The COV met as whole to discuss overriding and cross-cutting issues.

At the conclusion of the COV work, the committee met with Judith Sunley, Executive Officer of MPS, representing Michael Turner, to present a summary of findings and answer questions.

2. Underlying assumptions

In evaluating the work of the DMS, it is important to articulate the underlying assumptions about the role of mathematical sciences in national science, social science, and technology efforts.

The underlying reason for Federal support of mathematical sciences is its contribution to the nation's welfare, prosperity, and security. This contribution is rich, multi-faceted, long-standing, and embedded across a vast expanse of science, engineering, and business. Both this current contribution and potential new contributions to emerging science and technology are growing rapidly. Dramatic expansion of connections to the life sciences, to the analysis of massive amounts of data from biological, physical, financial, and social sciences, and to emerging technologies has begun and will only accelerate.

Ensuring both the immediate and long term capacity of the nation in mathematical sciences to realize these benefits demands attention to three major domains:

i) continued and expanded strength of the nation in core mathematical sciences research;

ii) continued and expanded strength in connecting mathematical sciences to those other areas of natural science, technology, and social science where joint progress offers a major opportunity;

iii) expansion of the workforce in the mathematical sciences, and in particular ensuring the education and development of a diverse and broadly educated set of persons who can perform core mathematical science research, those who can make connections to other disciplines, and those who will teach the generations of the future.

The COV believes that the DMS is very attentive to all three of these domains, and that the underlying assumptions of the DMS are the appropriate ones to advance the contribution of the mathematical sciences to the nation's welfare.

3. **General comments**.

The DMS is in the midst of a period of significant change and development. The clear articulation of a strategic focus on the three major domains above, the increased resources

available to DMS, the energy, intelligence, and strategic focus that the leadership has brought to DMS, and the resulting set of new initiatives and programmatic directions hold great promise for making major strides in the DMS mission and its broader contribution to the Foundation's goals. COV commends not only DMS, but MPS and NSF more generally for supporting these initiatives which will enhance the ability of DMS to contribute to the NSF mission.

The COV is enthusiastic about the strategic focus of DMS on addressing all three major domains. There have been significant increases in funding for the disciplinary programs and new funding structures, such as Focused Research Groups (FRG), put in place within them, enhancing the core research effort. Connections of the mathematical sciences with other disciplines have been dramatically addressed in the establishment of new institutes and joint funding initiatives with other Divisions. Workforce issues have been addressed through VIGRE, and other major efforts. The COV believes that in recent years the DMS has vigorously and successfully addressed major strategic issues, and shown boldness and imagination in doing so.

With all these changes and initiatives, it is inevitable that concerns will emerge about how to modify new initiatives to better achieve their goals, and about the balance between various efforts, approaches, and resulting allocation of resources. Importantly, COV was impressed that DMS clearly understands (and in fact asserts) that in the midst of great innovation it is inevitable that adjustments will need to be made. The COV spent considerable time discussing these questions, and we shall report on these discussions in section 4 of this report. We reiterate, however, that these discussions took place in the context of broad enthusiasm and appreciation for the innovative work and productive flexibility of DMS.

There have also been significant changes in the processes employed by DMS. DMS has moved towards a greater use of panels rather than mail reviews, and the recent innovative programs have necessitated a major increase in site visits. We comment on these in Part II below.

4. Innovation and balance

There were a number of issues concerning priorities and balance that the COV discussed at some length. Some of these were responses to new initiatives, and some represent long standing issues within the community that were highlighted by the new initiatives.

Recent investment within the disciplinary programs has led DMS to award a significant number of single-PI grants with greater funding than in the past. Moreover, the FRG awards have also provided significant funding in a focused direction. Inevitably, both of these types of focused investments entail trade-offs against increasing the number of grant recipients. The committee discussed this at length, and supports DMS efforts to create a portfolio of levels of awards, with the guiding principle being that support should be appropriate to the nature of the work. Many proposals reflect work that requires significant funding to succeed, including (but not restricted to) work in areas that

increasingly require larger, sometimes multidisciplinary, teams to address problems. Others require less. The current evolving structure of the portfolio has made a major contribution to the ability of the mathematical sciences community to do its work. The COV also acknowledges that the tension that exists between focus and breadth in the portfolio of NSF awards will never be completely resolved, and that there will continue to be questions about the balance and composition of the portfolio.

The ubiquity of mathematical sciences and its potential productive interactions with other disciplines makes the current funding level for DMS inadequate to address the breadth of these potential connections. Recent increases in funding have made significant expansion of these connections possible, and we believe the DMS strategic vision and implementation in using these resources will have a broad and major impact. We believe such (anticipated) success should encourage additional NSF support, enabling DMS to support yet greater breadth through core mathematical sciences work, its connection to other disciplines, and the corresponding training of students.

The VIGRE program represents a major investment in the workforce, from undergraduates through postdoctorals. COV is enthusiastic about the attention to workforce issues that VIGRE represents. Because of the significant level of investment in this program, COV recommends DMS attention to developing an assessment mechanism for the VIGRE program at an appropriate time. The timing and nature of such evaluation needs careful thought because of the long term nature of the program. In addition to evaluating the success of this particular program, COV commends DMS in thinking about ways of modifying the new workforce program to make it more flexible and appropriate to a variety of situations. But as with the increase in funding to address specific research challenges, the increased attention to and resources for workforce development as represented by the VIGRE program is an essential contribution to the NSF mission.

DMS has greatly increased its support for institutes, both those that are NSF institutes, such as IPAM and MBI, and those that are not NSF-only institutes, such as AIM and Banff. This expansion has had several positive effects. It has enabled greater communication within mathematical sciences and of mathematical sciences with other disciplines. It has enhanced the connectivity to industry. It has provided new and sometimes defining experiences for young mathematical scientists. It entails contributions to all three of the major strategic domains. COV enthusiastically supports DMS efforts in this direction. There were however, three concerns voiced about the institute program that COV believes need attention.

First, given the increased number of institutes, COV supports a serious evaluation of whether other programs previously supporting conference type activity should be decreased to minimize unnecessary duplication of efforts and allow more strategic re-allocation of those resources.

Second, COV is concerned that core components of the mathematical sciences are not receiving adequate attention and resources in the overall work of the NSF institutes.

COV recommends that DMS carefully evaluate this question and actively respond if appropriate.

Third, given the increased number of institutes, DMS should regularly analyze how the strategic goals of the institute portfolio as a whole are being met. On one hand, this entails an analysis of the union of the programmatic activities of the institutes. On the other, while recognizing that investment in an institute is long term, this entails evaluating the individual institutes and their renewal in the context of the overall portfolio.

The institutes represent one approach to enhancing the connectivity of the mathematical sciences to other disciplines. COV strongly endorses investment in institutes as an effective component of this effort, and supports DMS in its efforts to foster these connections in other ways as well, in particular through the initiative for joint funding with other NSF divisions. The potential of joint funding with other Federal agencies, while perhaps administratively more cumbersome, would also be of great benefit to advancing the connectivity of mathematical sciences with other disciplines where dramatic advances might be made.

The abundance of innovation within DMS and the corresponding need for excellent staff also highlights long-standing staffing issues and makes progress on them yet more pressing. The integrity, energy, and commitment of the DMS staff were noted by the COV. However, COV is concerned that current DMS staffing does not represent an effective balance of permanent program officers and rotating program officers. The institutional memory and continuity provided by permanent program officers is essential, as is the fresh perspective and immediate connection to the community offered by rotators. The importance of mentoring rotators by permanent officers is evident. In particular, to develop an effective balance, COV recommends that there be at least one permanent program officer in each major programmatic domain. The recruitment of both excellent rotators and permanent officers has not been easy. While COV does not see a magic solution, we recommend that this issue be seen as one of high priority, that to aid recruitment NSF and DMS offer an enhanced infrastructure environment such as adequate space and funds for travel, and that whatever possible increased and appropriate flexibility be allowed to enable the Director of DMS to recruit an excellent and balanced staff.

The evolving portfolio of programs within the DMS also raised questions within COV about the nature of the COV review itself. The committee recognized that it is performing both an audit function and a strategic function. The newly more complicated DMS portfolio suggests a corresponding rethinking of what type of material should be given to COV in preparation for its meeting, particularly with regard to its strategic function. Namely, we suggest that a statement from the Director concerning the strategic directions that DMS has followed, together with budgetary and programmatic information organized around these strategic directions, be sent to COV prior to the meeting. Some material of this type was actually presented by the Director in his opening presentation, but it would be very useful for COV to have this and additional

such material beforehand. This is just one idea that would better enable COV understanding and discussion to reflect the changing nature of the DMS programs. We suggest the Director and the next Chair of COV devote additional thought to ensuring that the materials sent prior to the meeting provide appropriate background to both the strategic and audit discussion that will take place during the COV visit. While the strategic and audit functions of COV are not independent, a greater clarity of separating them in the charge to COV, materials sent to COV, and discussions at the meeting would be beneficial.

Part II of this report responds to the core questions within the reporting template, and as such addresses many of the processes for evaluating proposals and making awards. While we have many specific comments, in general the processes are highly effective with appropriate outcomes. There was one particular concern, however, that we felt deserved special mention, namely the question of "broader impact" that proposed investigators are required to address.

COV certainly supports the notion that this is an important question in general. However, there is currently considerable uncertainty within the community about what constitutes an adequate response. This uncertainty finds its way into both proposals and reviews of proposals, and the lack of clarity makes for uneven (and hence arguably unfair) use of the criterion. The COV noted improvement in 2003 over the years 2001 and 2002, and understands that it takes some time for the responses of program officers to these issues to be digested by the community in proposals and reviews. However, because of the real potential for inequity caused by a lack of clarity, we recommend DMS immediately begin work with the community to accelerate this process, and be as explicit as possible about the appropriate interpretation of "broader impact" for various types of proposals. This will also encourage proposers to better plan activities that directly address the issue.

5. Introduction to Part II

Part II contains the COV responses to the NSF core questions and reporting template for visiting committees. Many address the detailed audit functions of the committee. The committee split into three groups, each taking responsibility for a set of programs and responding individually to the questions. The results are compiled in our responses in Part II. Some of the salient issues that arose in this work are in fact discussed in sections 2-4 above. However, the responses in Part II contain some further detail, as well as raising a number of other issues.

Overall, the COV believes that the processes of the DMS and their outcomes are excellent, but that improvements in selected areas can be made.

The subgroups:

Group 1: algebra, number theory, and combinatorics; applied mathematics; VIGRE; REU; Mathematical Sciences Postdoctoral Fellowships.

Group 2: analysis; computational mathematics; probability; DMS/NIGMS; CARGO; SCREMS; IGMS; professional societies; NAS; other educational activities

Group 3: geometric analysis, topology, and foundations; statistics; mathematical sciences institutes

6. **Appendix to Part I:**

Committee of Visitors for Division of Mathematical Sciences, 2004

Dr. Robert J. Zimmer (Chair of COV)
Provost, Brown University

Dr. Efraim P. Armendariz
Department of Mathematics, University of Texas at Austin

Dr. Suncica Canic
Department of Mathematics, University of Houston

Dr. Richard J. Cleary
Department of Mathematical Sciences, Bentley College

Dr. Carl C. Cowen
Department of Mathematics , Purdue University

Dr. Brenda L. Dietrich
Department Manager, Mathematical Sciences, IBM T.J. Watson Research Center

Dr. Dennis DeTurck
Department of Mathematics, University of Pennsylvania

Dr. Emmanuele DiBenedetto
Department of Mathematics, Vanderbilt University

Dr. Charles Doering
Department of Mathematics, University of Michigan, Ann Arbor

Dr. Paul Goerss
Department of Mathematics, Northwestern University

Dr. John Grove
Los Alamos National Laboratory

Dr. Katherine Heinrich
Vice President (Academic), University of Regina, Canada

Dr. Naresh Jain
Department of Mathematics, University of Minnesota

Dr. Raymond Johnson
Department of Mathematics, University of Maryland

Dr. Carlos Kenig
Department of Mathematics, University of Chicago

Dr. Jon R. Kettenring

Dr. Robert V. Kohn
Department of Mathematics, Courant Institute of Mathematical Sciences, NYU

Dr. Angela Kunoth
Institut für Angewandte Mathematik und Institut für Numerische Simulation
Universität Bonn, Germany

Dr. Barbara MacCluer
Department of Mathematics, University of Virginia

Dr. Wen Masters
Division of Mathematical, Computer, and Information Sciences, Office of Naval Research

Dr. Juan C. Meza
High Performance Computing Research Department
Lawrence Berkeley National Laboratory

Dr. Peter Monk
Department of Mathematical Sciences, University of Delaware

Dr. David R. Morrison
Department of Mathematics, Duke University

Dr. Tomasz Mrowka
Department of Mathematics, Massachusetts Institute of Technology

Dr. Claudia Neuhauser
Department of Ecology, Evolution and Behavior, University of Minnesota

Dr. Stephen Portnoy
Department of Statistics, University of Illinois at Urbana-Champaign

Dr. Robert Serfling
Department of Mathematical Sciences, University of Texas at Dallas

Dr. Michael Stob
Dean for the Contextual Disciplines and for the Natural Sciences and Mathematics
Department of Mathematics and Statistics, Calvin College

Dr. DeWitt L. Sumners
Department of Mathematics, Florida State University

Dr. Abigail Thompson
Department of Mathematics, University of California at Davis

Dr. Andrew Wiles
Department of Mathematics, Princeton University

Committee of Visitors for DMS
Report Part II

FY 2004 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)

Date of COV: February 11-13, 2004
Program/Cluster:
Division : Mathematical Sciences
Directorate: Mathematical and Physical Sciences
Number of actions reviewed by COV[1]: Awards: ~ 270 Declinations: ~ 240 Other:
Total number of actions within Program/Cluster/Division during period being reviewed by COV[2]: Awards: Declinations: Other:
Manner in which reviewed actions were selected: ~170 awards and ~ 160 declinations randomly chosen. Of remainder, ~80 awards and ~60 declinations were chosen by the program directors and the rest by request of the COV.

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

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged. Please do not take time to answer questions if they do not apply to the program.

A.1 Questions about the quality and effectiveness of the program's use of merit review procedures.

Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE
Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) **Group 1**: *ANTC/AM disciplinary programs:* The review process involving a combination of panels and external mail	YES

[1] To be provided by NSF staff.
[2] To be provided by NSF staff.

reviews is appropriate for two reasons:

(1) it involves a large segment of the target community in the process,
(2) it generates substantial feedback for the proposal submitters.

Panels have been used more extensively in recent years and there is the question of the balance between panel and mail reviews used in the process; we comment on this in the next section.

VIGRE/REU/Postdoc Infrastructure programs:
VIGRE: The use of both panel and site visit is appropriate; the site visit in fact is critical to the final decision.

Panels are particularly appropriate in all three areas

Group 2: Different disciplines rely on different combinations of mail, panel, and mail and panel. Considering that the mail reviews provide access to expertise and panels provide comparability, a mixed approach seems preferable.

Overall, panels are efficient and effective. In the certain instances in which there were some concerns raised, they were about the composition of panels, occasional dysfunctionality, and that strong characters might dominate a review process.

A panel of real experts in the field is used to review proposals to programs such as CARGO and NIGMS. These panels are balanced across the two disciplines, but there are a limited number of cross disciplinary experts to call on. Composition of panels was very good. Reviews well written and provided good information.

For very small awards, the peer review may be excessive and add delay and cost to the process. DMS may want to consider a level under which such proposals can be handled by a less cumbersome procedure.

Group 3: Our group felt this was a particular strength and the program directors are to be commended for their flexibility in designing and applying a variety of review mechanisms in considering individual and group proposals to disciplinary programs. We felt the use of the ranking panel in statistics was particularly valuable and may be useful in other programs, but we understand that some areas may not have the critical mass of applications to justify the expense of this method. The increased use of screening and ranking panels is an appropriate response to the recommendation of the previous COV. The program directors were especially good at dealing with disappointed researchers whose proposals were declined.

The combination of panel review and site visits provided appropriate guidance and information for program officers to make cogent decisions for the Mathematical Sciences Research Institute program.

The panel review was preceded by a largely unsuccessful attempt at soliciting *ad hoc* mail reviews (for some proposals, none of these were returned).	
Is the review process efficient and effective? **Group 1**: The process resulted in the selection of very high quality programs. *ANTC/AM disciplinary programs:* Efficiency: We believe panels are more efficient for the NSF than mail reviews, keeping in mind that it is important for panels to be assembled by program officers with an understanding of NSF's goals, broad familiarity with the field, and some "institutional memory" of past panels. Effectiveness: The entire review process is very good at selecting high quality proposals. The panel system provides a different kind of review than the old mail review process, and it is recognized that the dynamics of the panel process can generate some variability in the nature of the reviews. Panels are an efficient way to avoid "Balkanization" of a field by exposing proposals to a wider set of reviewers than might otherwise be possible. On the other hand one vocal reviewer on a panel can possibly be overly influential in the panel's recommendation for any particular proposal. This may lead to the suppression (at the panel level) of some more risky and innovative proposals, but the oversight of the experienced program officers can---and in some cases do---counteract that. Overall we observe that there are a significant number of high quality and deserving proposals that are not funded due to lack of resources. *VIGRE/REU/Postdoc Infrastructure programs:* VIGRE: The creation of an NSF staff position with full-time responsibilities for VIGRE was particularly valuable. POST DOC: Very comprehensive and effective process with well documented minutes at the meeting. **Group 2**: The process appears to be efficient and effective. Excellent and very poor proposals seem to receive less attention compared to borderline proposals; this is deemed appropriate. Decisions are typically reached quickly and correspondence between the PI and the corresponding program director seems to be thorough. **Group 3**: For the disciplinary programs, when the review process is not efficient, it is usually due to a particular set of reviewers not responding in a timely fashion; we discuss this further under "time to decision" below. For the institute program, the site visits are necessary and were conducted effectively and in a timely way. The panels were well chosen.	YES

Are reviews consistent with priorities and criteria stated in the program's solicitations, announcements, and guidelines? **Group 1**: *ANTC/AM disciplinary programs*: Panel and external reviews tend to focus more on the scientific merit of the proposal and the PI quality than other criteria, but that might be appropriate. The program officers augment those judgments enforcing other priorities and criteria. The broader impact criterion is more clearly articulated in recent proposals (to some extent) and panels and program officers are taking this into account to an increasing degree. **Group 2**: The reviews were consistent with the priorities of NSF and the directorate. The programs we observed seem to take care that proposals fit within the program's solicitation; some proposals were not funded because they did not fit the program or they spanned two programs and the other program was not interested in funding the proposal. Intellectual merit seems to be given more weight than broader impacts, and this seems appropriate for most programs. Most reviews, both panel and mail, inadequately address broader impacts, though this seems to vary with the programs somewhat and it has improved in later years. There is a large variance in the quality of mail reviews, from very short to quite detailed. Panel summaries are typically very short, but the discussion seems to be well captured by the program director's summary. Special programs, such as FRG or CAREER, are reviewed consistently more thoroughly. When panels are given more instructions such as in 2002 CARGO reviews, the priorities of the program are explicitly addressed. Also, for most of the CARGO proposals that were declined, specific shortcomings with respect to the criteria are given. **Group 3**: While the overall track record is good in the disciplinary programs, confusion over the role of the intellectual merit and broader impact criteria caused concern in our subcommittee. A lack of consistency in application of these criteria led to the belief that some investigators might misinterpret the reasons for a declination. We provide more details in our response to A2. We also believe that the proliferation of programs has muddied the waters somewhat in terms of proposers' and reviewers' understanding of program requirements and guidelines. We are also concerned that it is getting more difficult for investigators to tell precisely to what program interdisciplinary	YES

proposals should be directed. On the bright side, our subcommittee was pleased to see how frequently program directors were able to redirect applications to other announcements or programs that might be additional or alternative funding sources. According to NSF PR 02-56, "NSF established the Mathematical Sciences Research Institutes awards in 1980 to provide postdoctoral training and to stimulate research, collaboration and communication in the mathematical sciences. The activity promotes interdisciplinary research, team building and collaborations with industry, government laboratories and international colleagues; enriches and invigorates mathematics education at all levels; and expands opportunities in the field for underrepresented groups." The panelist reviews and panel summaries consistently rate the proposals on most or all of these aspects, in addition to addressing the usual Intellectual Merit and Broader Impacts criteria.	
Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's recommendation? **Group 1**: *ANTC/AM disciplinary programs* There is clearly a lot of effort put into collating reviews into a form that can assist PIs to understand the judgment and, if necessary, revise their proposal. *VIGRE/REU/Postdoc Infrastructure programs* VIGRE: Considerable effort is made to provide detailed feedback, notably when negative decisions are made. However, in one instance when funding was renewed there was no report from the 3-year site visit report, although it was indicated that the reviewers held differing opinions. We appreciate that this site visit took place early in the programs development and that at that time the program evaluation process was evolving. POST DOC: No rationale is provided to the candidate but we feel this is appropriate. REU: A considerable level of feedback is provided to the applicant. In several cases extensive comments have been provided to assist and encourage the applicant in making a future reapplication. **Group 2:** There seem to be differences between the different programs - some tend to have longer and more detailed reviews. There is a very large variance in the thoroughness of the individual reviews. Typically not much justification is given for excellent proposals or poor proposals. The panel reviews tend to be quite short.	MIXED

For CARGO, they are very detailed, demonstrating a good understanding by the reviewers of the science and the application domain. We suggest that guidance and expectations for reviews should be communicated to reviewers and that the reviews include suggestions to the PI. **Group 3**: This is another strength of the merit review process in the disciplinary programs, since the reviews and the summary letters from program directors are usually quite detailed. Our subcommittee was concerned with the "grade inflation" seen in some fields (this is less pronounced in statistics than the other programs we studied, at least based upon our limited experience), and we encourage the program directors to include a sentence or two in their letters that describe this in detail. For example, one included a passage along the lines of, "This proposal received four overall grades of very good, and one excellent. However many proposals with even higher scores were not funded." We also encourage the practice that some of the long-term program officers have of keeping track of reviewers' grading tendencies. As noted above, many of the *ad hoc* mail reviews for institute proposals were not returned. Our group feels that it is probably unreasonable to solicit such reviews, give the size and complexity of the proposals and their interdisciplinary nature. We recommend that DMS consider asking *ad hoc* reviewers for more focused reviews that deal with specific aspects or criteria, so that "solo" reviewers can read the proposals with these specific questions in mind. On the other hand, we found the individual panelist reviews very helpful and informative.	
Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation? **Group 1**: *ANTC/AM disciplinary programs* There is clearly a lot of effort put into assembling panels' recommendation in a form that can assist PIs to understand the judgment and, if necessary, revise their proposal. *VIGRE/REU/Postdoc Infrastructure programs* VIGRE: Panel reports are reasonably informative; moreover for projects that get site visits they are supplemented by very detailed reports on those visits. POST DOC: There are no panel summaries but we feel this is appropriate. REU: Summaries are comprehensive and written to provide extensive	YES

information to applicants. **Group 2**: The panel summaries for individual research grants tend to be quite short. This is however remedied by the program director's summary that tend to be thorough and summarize both the panel's and the mail reviewers' opinions. Panelists should comment on how to improve the proposal if sufficiently highly ranked but not funded. They were generally good. **Group 3**: In the disciplinary programs there is sufficient information in general (particularly since the individual reviews of some panel members are included with the panel summary), although some of the decisions of screening panels are quite terse when proposals are rejected without further review. Generally the program directors have summarized these in a sensible fashion and this practice should continue. As with the panel summaries for disciplinary proposals, the institute panel reviews, taken together with the individual panelist reviews, provide complete and enlightening justification of the panel recommendation (for site visit or not).	
Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation? **Group 1**: *ANTC/AM disciplinary programs* The COV was impressed by the thoroughness with which funding decisions, both positive and negative, are documented. *VIGRE/REU/Postdoc Infrastructure programs* Thorough documentation is provided. **Group 2**: The jackets are all complete and show a considerable effort in keeping track of all the paperwork. Program officers do a consistent and outstanding job at providing information to the applicants, in particular when a declination was made. When a proposal is outstanding, reviews tend to be shorter. **Group 3**: Our previous two answers address this for disciplinary programs. We believe the program directors are doing very well in this regard. Subcommittee members gave several examples of wonderfully honest reviews, and we thought these were especially well done in the	YES

cases where proposals fell just short of the award/decline boundary. The Program Officer prepared the documentation of the ultimate decisions on institute proposals with exceptional care, and thoroughly documented both the panel's and the site visit committee's reasoning.	
Is the time to decision appropriate? **Group 1**: *ANTC/AM disciplinary programs* Over the years, the review process has been streamlined to a great degree without any sacrifice in quality. The implementation of panels seems to be a positive development in this regard. *VIGRE/REU/Postdoc Infrastructure programs* VIGRE: The timeline from application to decision is typically between 6 and 9 months and this seems appropriate given the need for a several site visits prior to a final decision. POST DOC: There is a very short time period between the meeting of the panel and the notification to the applicant **Group 2**: There were significant improvements made in 2003 of the proposals processed in six months or less. Before, processing percentages were under 50% while in 2003, they increased to over 70%. Computational Mathematics has made particularly noticeable improvements. For the infrastructure proposals, processing time was very good, but in some cases of small requests, the time may have been too long. **Group 3**: We are pleased with the overall percentage of disciplinary proposals handled within six months, but we recognize that frustrating delays remain in a significant minority of cases. The ad-hoc nature of the communication between program officers and reviewers evident in many jackets was a concern and we thought it could benefit from some structure. The call for institute proposals specified a timeline for submission, panel review and recommendation, site visit review and recommendation, and ultimate award decision. This seems to have been followed assiduously.	YES
Discuss issues identified by the COV concerning the quality and effectiveness of the program's use of merit review procedures: **Group 1**: *ANTC/AM disciplinary programs* It is important that programs have sufficient institutional memory (in the form of permanent program officers) to effectively implement the review process. Especially with the more extensive use of	

panels, the quality and dedication of the program officers is a crucial ingredient in the success of the process. In the processes of choosing panels and external reviewers, and then interpreting and utilizing their recommendations, program officers play a key role in the merit review procedure. That being said, the mix of panel and external mail reviews seems to be the best approach, especially for individual investigator grants where specialized technical familiarity with the proposal is necessary to produce the highest quality and most appropriately balanced portfolio.

VIGRE/REU/Postdoc Infrastructure programs
The procedures work well with respect to all three programs (VIGRE, POST-DOC, REU). This is especially important in the case of VIGRE, where due to the large grant sizes NSF's decisions have major consequences for the institutions involved.

Group 2: In almost all of the jackets reviewed, the decision was clear as to whether a project was funded or not. Documentation is generally better for the declines than for the accepts. In some instances where the program director goes against the panel's rankings, more explanation should be provided concerning the reasons for the decision. The FRG program is very competitive -- even proposals with excellent/very good ratings are not funded. Some panel members felt that the position of summer salaries in FRG's should be re-evaluated.

Panels should provide thorough summaries. We feel that the current panel review form does not encourage thorough reviews, in particular concerning the broader impact statements.

Group 3: No additional such issues were identified by our group.

A.2 Questions concerning the implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by reviewers and program officers. Provide comments in the space below the question. Discuss issues or concerns in the space provided.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	YES, NO, DATA NOT AVAILABLE or NOT APPLICABLE
Have the individual reviews (either mail or panel) addressed whether the proposal contributes to both merit review criteria? **Group 1:** *ANTC/AM disciplinary programs* In the past, many reviews have focused much more sharply on Intellectual Merit than on Broader Impact. Since Fall 2002 DMS has required all proposals to address, in the project summary as well as in the proposal body, how the project addresses each of the merit review criteria. This new DMS policy has been very effective in helping reviewers, panelists, and program managers identify and evaluate the projects' Broader Impact. *VIGRE/REU/Postdoc Infrastructure programs* Panel reviews are used for evaluation of REU proposals while both panels and site visits are used for VIGRE proposals. In both case, the COV was impressed with the substantive comments by individual reviews that adequately addressed both merit review criteria. **Group 2**: Individual reviews were good at addressing the Intellectual Merit criterion, but less uniformly successful at addressing the Broader Impact criterion. Many reviews either left this question blank or addressed it in only the most perfunctory way. The Broader Impact criterion was addressed most clearly by reviewers when it was clearly detailed in the proposal. Various interpretations were given by both PIs and reviewers as to the meaning of the Broader Impact criterion and its significance in the overall process. In general, there was improvement in later years addressing broader impact.	MIXED

Group 3: Not consistently for disciplinary programs; consistently, for the institute program. See further comments in the last question of A.2.	
Have the panel summary reviews addressed whether the proposal contributes to both merit review criteria? **Group 1:** *ANTC/AM disciplinary programs* While some reviews focus mainly on just one review criterion, the panel summaries systematically address both of them. This is no doubt a reflection of good management from the program managers who run the panels. *VIGRE/REU/Postdoc Infrastructure programs* It is this COV's observation that the panel summary reviews (both for REU and VIGRE) as well as VIGRE site-visit reports adequately addressed whether or not the proposal contributes to both merit review criteria. **Group 2**: Panel summaries tended to address the Broader Impact criterion in only a routine or "generic" way, unless there was something quite special to be noted. For NIGMS, the panel reviews tended to be very brief but did at least a perfunctory job of addressing both. For CARGO 2003, the panel reviews did a better job than most. Indeed, the panel reviews have shown steady improvement in addressing both merit criteria in the last three years **Group 3** Not consistently for disciplinary programs; consistently, for the institute program. See further comments in the last question of A.2.	MIXED
Have the *review analyses* (Form 7s) addressed whether the proposal contributes to both merit review criteria? **Group 1**: *ANTC/AM disciplinary programs* The COV panel was extremely impressed by the comprehensiveness, thoughtfulness, and fairness of the Form 7 "Review analyses". *VIGRE/REU/Postdoc Infrastructure programs* The review analyses for VIGRE and REU provide ample information addressing whether or not the proposal contributes to both merit review criteria.	MIXED

Group 2: In the disciplinary programs, the review analyses did a good job of addressing the issues. Boiler plate text was used to address broader impact in almost all of sample NIGMS jackets– regardless of whether rejected or accepted. This was handled slightly better in CARGO proposal jackets. **Group 3**: Not consistently for disciplinary programs; consistently, for the institute program. See further comments in the last question of A.2.	

Discuss any issues or concerns the COV has identified with respect to NSF's merit review system.

Group 1: *ANTC/AM disciplinary programs*
The practice of structuring the review process around two main criteria, Intellectual Merit and Broader Impact, is still relatively new. We were pleased to see that the community is making rapid progress in this area. The NSF is to be congratulated on its success in conveying the importance of both these criteria to the PI's and in using both of them in its assessment of the proposals.

VIGRE/REU/Postdoc Infrastructure programs
The COV wishes to congratulate the Program Officers of DMS for taking great efforts to maintain consistency of NSF's merit review outcome, particularly, given the scope of VIGRE proposals.

Group 2: There were concerns about the lack of clarity with regard to the meaning and significance of the Broader Impact criterion. There were questions as to whether this criterion is applied evenly in decision making.

It would be helpful if the directorate would provide guidance to reviewers and PIs, specific to mathematics, of various forms that "broader impact" might take. For example, COV panelists feel that an important aspect of broader impact is the way in which the proposal addresses discipline-wide concerns. Apparently, other disciplines, such as chemistry, have done so.

Group 3: In reviewing proposals in the disciplinary programs, reviewers, panels and program officers alike give careful attention to Criterion I (Intellectual Merit). For proposals from individual investigators, however, Criterion II (Broader Impacts) was applied only inconsistently. Indeed the understanding of the meaning and intent of this criterion varied a great deal from investigator to investigator, reviewer to reviewer, and even program officer to program officer. For proposals that earned very strong or relatively weak reviews based on Criterion I, the second criterion was often ignored entirely. Near the award/decline boundary, the Broader Impact criterion was applied only some of the time, although in a few cases it was apparently decisive. We say "apparently" because in some cases where Broader Impact was cited as a deciding

factor, it seemed that the proposal should (and would) have been declined on Intellectual Merit grounds alone. There was some concern among our group that this would propagate misinformation to proposers about just what are the weaknesses of their proposals. We did note that Criterion II seems to be being applied with increasing discrimination. The Broader Impact criterion seems to be more uniformly applied to group (i.e., FRG) proposals.

In the institute program, the panelists, site visitors and program officer gave careful analyses of the proposals' strengths and weaknesses in consideration of both the Intellectual Merit and Broader Impacts criteria. The second review criterion is easier to understand in this context than for disciplinary grants, and so the proposers and reviewers addressed this well. Additionally, significant attention was paid to the other review criteria specific to this program, such as the management and evaluation plans enunciated in the proposals.

A.3 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE
Did the program make use of an adequate number of reviewers for a balanced review? **Group 1**: *ANTC/AM disciplinary programs* The number of reviewers was certainly enough within the panel system. In the mail review system there was sometimes difficulty in getting enough responses. In this respect the panel system was superior. *VIGRE/REU/Postdoc Infrastructure programs* Every effort appears to have been made to have a sufficient number of reviewers for all of the programs. The committee did observe that some of the REU panels had a fewer number of members than on average. In addition, the committee would like to observe that a concerted effort has been made to match the breadth of the panel to the areas represented by the applicant pool in the selection of NSF postdocs. **Group 2**: In all cases, the number of reviewers was more than sufficient. In some cases of small proposals, the number of reviewers may have been too large. **Group 3**: Essentially all reviews in the disciplinary programs had at least three substantial reviews and/or were subject to panel review. Others had many more than three reviews. The size of the panel for the institute program was appropriate given the complexity and multi-disciplinary nature of the proposals. In fact, we were impressed that only ten people could have done the review so thoroughly. The size of the site visit teams was also appropriate.	YES

Did the program make use of reviewers having appropriate expertise and/or qualifications? **Group 1**: *ANTC/AM disciplinary programs* The panel felt that the presence of at least one member of the permanent staff as program officer made for much more successful choices. We would recommend this wherever possible. Without this institutional memory and experience of past reviews it is very hard to make appropriate judgments**.** *VIGRE/REU/Postdoc Infrastructure programs* All of the panels had reviewers who had excellent credentials in their respective fields and were eminently qualified to make sound decisions on the proposals **Group 2:** Where we could check (i.e. know the reviewers and areas), the reviewers were appropriate for the proposal content and type. Panel reviewers were particularly well chosen. Careful selection of referees seems to increase the return rate . Understaffed divisions may not been able to guarantee this. Increasing information on referees by including key words for their specific areas may help to better assign referees. In some disciplines, more international referees should be included into the data base for international visibility and comparability. **Group 3**: There is a conscientious and even exhaustive effort to find a balanced and broad selection of reviewers in the disciplinary programs. Reviewers were not shy to disqualify themselves and to make suggestions of alternatives, which were often followed by the program officers. The institute panelists needed and possessed expertise across a wide swath of mathematics and other disciplines to review the set of proposals that ran the gamut from geometry to broad-based core mathematics to computational science to statistics to applied and biomathematics. The site visit teams were equally impressive.	YES

Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups? **Group 1**: *ANTC/AM disciplinary programs* There was a successful attempt to reflect these characteristics while maintaining a high level of expertise. *VIGRE/REU/Postdoc Infrastructure programs* Most of the panels had an adequate balance with respect to geography, type of institution and underrepresented groups. In one instance, the REU panels, the small average size of the panels may have made it difficult to ensure geographical balance. **Group 2:** Yes, overall the choice of reviewers has been careful in this respect, as far as we tell, and this is a positive aspect of the process. **Group 3**: In the disciplinary programs, all the reviewers we saw were from academics. For some proposals, particularly in statistics, it may be appropriate to use reviewers from industry or government. To the extent possible, given the constraint of the expertise needed to review the submitted proposals, the institute panelists and site visitors were reasonably diverse.	YES
Did the program recognize and resolve conflicts of interest when appropriate? Comments: **Group 1**: *VIGRE/REU/Postdoc Infrastructure programs* The program has an excellent process for both recognizing and resolving conflicts of interest. **Group 2**: In all cases, this was handled very carefully and completely. **Group 3**: The programs seem extremely scrupulous about conflicts of interest.	YES

Discuss any concerns identified that are relevant to selection of reviewers.

Group 1: *ANTC/AM disciplinary programs*
The panel system works extremely well in theory. It also works extremely well in practice in the hands of high quality program officers.

VIGRE/REU/Postdoc Infrastructure programs
There were no overall concerns with the process for the selection of reviewers. The program officers appear to go to great lengths to ensure a fair and balanced set of reviewers for all of their programs.

Group 2: PIs whose grants are awarded could be requested on a systematic basis to serve as referees for other proposals. The pool of referees should be expanded to a more international group.

Group 3: No such concerns were identified by our group.

A.4 Questions concerning the resulting portfolio of awards under review.
Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE, OR DATA NOT AVAILABLE
Overall quality of the research and/or education projects supported by the program. **Group 1**: *ANTC/AM disciplinary programs* We found the quality of the science supported to be excellent. The overall review process clearly selects the best proposals from a pool that has many excellent submissions. *VIGRE/REU/Postdoc Infrastructure programs* The overall quality of the VIGRE, MSPRF and REU programs is appropriate. We note that the REU program is funding a large fraction of good projects from its proposal pool. (More on this in the last box of this question.) **Group 2**: In the disciplinary programs, the quality of the research and education projects is very high. Indeed, in the disciplinary programs, the quality is so high that more awards could be made without diminishing the overall quality of the programs. NIGMS and CARGO are both of very high quality. IGMS and SCREMS could benefit from a larger applicant pool. It would be desirable for more theoretical aspects to be included in NIGMS proposals in addition to the computational aspects. It was noted that funded NIGMS proposals generally had educational impact at the graduate and postdoctoral level but not at the undergraduate level. Some of the unfunded proposals came from smaller schools or four-year colleges and would potentially have had educational impact but were weaker on the science part. Partnering between research universities and four-year colleges might solve this problem. A similar comment applies to the other jackets: if broader impacts were more emphasized, the program could be expanded in scope. The overall quality of the Interdisciplinary Grants in the Mathematical Sciences is good.	APPROPRIATE

Group 3: The overall quality of funded disciplinary projects is indeed very high and arguably too high in that many excellent proposals are unfunded. Indeed, we believe that 50% more could be funded, if resources were available, without significant decrease in the overall quality. The institutes whose funding was renewed in the 2001 competition have an outstanding record of success. The new projects have great promise but it seems too soon to say for sure.	
Are awards appropriate in size and duration for the scope of the projects? **Group 1**: *ANTC/AM disciplinary programs* Given the overall DMS budget constraints, we found the award size and duration to be appropriate. We commend the DMS for its success in increasing the median size of the awards by means of funding students and postdocs, and in moving to 3-year grants as the norm. We encourage the DMS to keep moving in this direction, increasing mathematics grant sizes so that they become more commensurate with NSF MPS average grant sizes. We would also encourage the DMS to consider raising the percentage of 5-year grants as appropriate; new multidisciplinary projects usually require more than 3 years to reach their goals. *VIGRE/REU/Postdoc Infrastructure programs* The scope of the VIGRE program is extremely large with long term goals that will require more than even 5 year awards to realize. **Group 2:** In most disciplinary areas, the size and duration are appropriate. Some computational math proposals could benefit from either a higher funding level or longer duration, given the nature of the projects. In the infrastructure programs, awards are typically funded at or close to the requested level and for the time proposed. **Group 3:** The current process is attracting excellent disciplinary proposals with reasonable size and duration parameters. There is a general feeling, however, of the need to fund more people and more proposals, which would drive the average award size down without the addition of more resources. On the other hand, in statistics there is a growing need for larger, laboratory-like projects that involve substantial computing equipment and the development of very sophisticated	APPROPRIATE

software. To ignore this trend would impede the development of statistical science and the associated cross-disciplinary research (see the recent NSF report "Statistics: Challenges and Opportunities for the Twenty-First Century", edited by Bruce Lindsay, Jon Kettenring, and David Siegmund for more background). The cycle of institute evaluation at year 3 with renewal at year 5 and renewal in open competition in year 10 is appropriate. In general, the committee did not want to see automatic sunset clauses or a bias against long-term continuation of an institute. On the other hand, it seems reasonable that institutes with a specifically targeted focus will have a finite lifetime. In general, the size of the awards seems appropriate, as does the relative size of the institute program within the DMS enterprise taken as a whole.	
Does the program portfolio have an appropriate balance of: • High Risk Proposals? **Group 1**: *ANTC/AM disciplinary programs* The NSF program officers are very receptive to proposals that do not neatly fit into disciplinary boxes, and are very effective at getting these proposals expertly reviewed, often by panels and reviewers from outside the discipline. *VIGRE/REU/Postdoc Infrastructure programs* VIGRE awards involve a significant amount of risk given the ambitions of the program, which include cultural changes in the mathematical sciences community. High standards of rigorous review are certainly necessary for large scale projects like these. The (approximately) 15% non-continuation rate of VIGRE awards after three year reviews indicates the level of risk adopted in the initial award procedures **Group 2**: It was felt that the appropriate term should have been high risk, with high impact potential. It was also felt that maybe this kind of proposal should be evaluated by a different system. Some members of the group thought that the answer depends on the meaning of 'appropriate balance'. Among CARGO, NIGMS, and all the infrastructure proposals, the balance is appropriate. Some of the subprograms are more high risk than others. Evaluations reflect the level of risk of proposals. **Group 3**: There is a need to be more sensitive, if not more systematic across the programs, to the approach to identifying and funding high-risk, high-reward disciplinary proposals. It would seem inappropriate to look for particularly high risk in the institute program.	APPROPRIATE

Does the program portfolio have an appropriate balance of: • Multidisciplinary Proposals? **Group 1**: *ANTC/AM disciplinary programs* The DMS has leveraged its resources by encouraging and funding multidisciplinary proposals, and is to be commended for this. We commend the program officers in the core mathematics disciplines for their support of multidisciplinary initiatives, despite the conservative nature of some panels. *VIGRE/REU/Postdoc Infrastructure programs-not applicable* **Group 2:** The balance was felt to be appropriate in computational math and probability. In analysis there was discussion as to whether a perceived current move towards proposals more interdisciplinary in tone is cutting back the support on core research too much. It was felt that both modes of support are necessary in any program, but there was concern that the balance was tilting too much in the analysis program. **Group 3:** Multidisciplinary research is a strength of the DMS. It has been moving strongly in this direction with good results and improving processes. The record shows a very strong list of currently co-funded programs across the DMS with other divisions with NSF. One of the institutes is specifically targeted as multi-disciplined. The others that have an applied bent often run programs that are inherently multi-disciplinary. We feel it is important to monitor the balance between "core" and multi-disciplinary institute programs vigilantly.	APPROPRIATE
Does the program portfolio have an appropriate balance of: • Innovative Proposals? **Group 1**: *ANTC/AM disciplinary programs* We found the mix of highly innovative proposals to be appropriate. Although panel review may tend to be more scientifically conservative than individual mail reviews, on balance they do fund innovation, and avoid balkanization (disciplinary hegemony). **Group 2**: Appropriate **Group 3**: Appropriate	APPROPRIATE

Does the program portfolio have an appropriate balance of: • Funding for centers, groups and awards to individuals? **Group 1**: appropriate **Group 2**: There was a desire to see an increase in the number of individual grants in analysis and probability, in exchange for a decrease in the size of large grants. **Group 3**: The institute program is clearly targeted to large groups. A concern voiced by our group involves the proliferation of programs that aggregate funding under the control of a single investigator, or a small group of investigators (e.g., VIGRE in its current and coming incarnations, FRGs, and the tendency toward larger awards). As these programs multiply, it is essential that there be overall oversight and monitoring of these funding patterns taken as a whole.	APPROPRIATE
Does the program portfolio have an appropriate balance of: • Awards to new investigators? **Group 1**: *ANTC/AM disciplinary programs* The awards to new investigators are appropriate as indicated by the data provided, in particular the graph depicting the accumulated PI Phd age distribution. This graph is concave down, which indicates preferential funding of young (PhD age) investigators. For example, the median DMS PI PhD age is less than 15 years. **Group 2:** Multi-investigator awards typically include a good balance. Single-investigator awards were balanced across the portfolio. **Group 3:** The disciplinary programs in DMS are doing an excellent job, really the best they reasonably can. This is a clear area of strength in the current process. The continuation of the successful MSRI and IMA institutes, and the addition of the other new institutes, seems right on the mark.	APPROPRIATE

Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: **Group 1**: *ANTC/AM disciplinary programs* After normalization by the regional research mathematics population density, the awards are distributed evenly with no apparent preference to any region **Group 2**: Awards are spread across the country with no visible bias. **Group 3:** The data we were given on the disciplinary programs indicate that this is the case. Given the constraint that the process began with a relatively small number of proposals, the institute program was quite sensitive to the issue of geographic diversity and has achieved it to a reasonable degree.	APPROPRIATE

Does the program portfolio have an appropriate balance of: • Institutional types? **Group 1**: *ANTC/AM disciplinary programs* A broad range of institutional types are represented in the awards, private and public institutions, institutions representing a wide range of the extended mathematical community in mathematics research and training activity. *VIGRE/REU/Postdoc Infrastructure programs* We note that the VIGRE program's goals are being addressed by an evolving set of programs in EMSW21 with the aim of achieving a broader representation across institutional types. We note that REU projects appear to be underrepresented among R1 institutions, but this is likely the result of the distribution in the proposal pool. **Group 2:** In general, there is an appropriate balance among institution types. Some members of the panel feel that an increase in funding opportunities to non-Ph.D. granting institutions would help pipeline issues. For infrastructure programs, awards are made to a variety of institutions **Group 3:** Disciplinary grants appear to be awarded solely on merit, without regard to location or institution type. This results in broad representation on both the geographical and institutional type fronts. The institutes are, to a greater or lesser degree, stand-alone entities attached to a larger permanent institution. Thus, one should expect a certain size-homogeneity among the hosts.	APPROPRIATE

Does the program portfolio have an appropriate balance of: • Projects that integrate research and education? **Group 3** : Disciplinary grants typically impact graduate education in natural ways; through direct support and through collaborative projects. If more integration of research and education in these grants is an NSF priority, this point should be made more clearly to the PI's and reviewers (see also A2). The integration of research and education at all levels was a primary mission of the institute program (see A1 above). Proposers were encouraged to address this goal carefully, and existing institutes have been encouraged to expand their efforts to do so. This has been one of the great strengths of the program.	APPROPRIATE
Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity and of emerging opportunities? **Group 1**: *ANTC/AM disciplinary programs* DMS program officers are very successfully leveraging DMS resources by supporting multidisciplinary projects involving mathematics. These DMS multidisciplinary projects cut across a large proportion of the NSF directorates, and we find the panels which review these projects (within and outside of the DMS) exhibit little or no turf protection, and have a refreshing willingness to learn and benefit from contact with other sciences. **Group 3:** This is a real strength of the flexible peer review process in the disciplinary programs. Identification of exciting emerging research areas is done informally but swiftly and effectively by the reviewers, and reinforced by the actions of program officers. The disciplines and sub-disciplines seem well-represented in the programs we studied. Addressing many sub-disciplines, applications and connections within and beyond mathematics was a primary purpose of the institute program.	APPROPRIATE

Does the program portfolio have appropriate participation of underrepresented groups? **Group 1**: *ANTC/AM disciplinary programs* We find that the participation of underrepresented groups is consistent with representation in the mathematics community; admittedly, their overall representation in the community needs to be increased. Drawing firm conclusions from very few data points can be risky, but where appropriate we encourage the DMS to increase the percentage of funded proposals by minority PI's. *VIGRE/REU/Postdoc Infrastructure programs* By design, the VIGRE program directly addresses participation of underrepresented groups. The REU program also appropriately addresses this issue. We have no data for the MSPRF program in this regard **Group 2**: Continuing emphasis needs to be placed on increasing funding opportunities for the participation of underrepresented groups. It should be noted, however, that the pipeline problem starts at the high school level or even before, which is outside of DMS's control. Particularly NIGMS funds a higher proportion of women than other DMS programs. Some of the other infrastructure proposals specifically fund African Americans. **Group 3**: Once applications are submitted to disciplinary programs, the process (and hence the outcomes) seem eminently fair. However, encouraging applications from women and minorities, even in programs that specifically target underrepresented groups, remains a continuing challenge. We feel that the Foundation can do a better job of promoting these programs. The record on this issue varies from institute to institute. MSRI provided a great deal of data that demonstrate a serious commitment to this. Participation of underrepresented groups at all levels in some institutes (boards, staff and participants) is exemplary. Others are less so. There are two issues that should be monitored carefully by the program: First, does the actual participation represent a balance and second, are deliberate efforts made to achieve balance (say by including underrepresented groups in advisory boards and decision-making groups). Especially with respect to the latter, there are some institutes that are better than others in this regard.	MIXED

Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports. **Group 1**: *ANTC/AM disciplinary programs* The DMS is very cognizant of national priorities, the NSF mission, and the birth of new scientific fields which have a strong mathematical component. **Group 2**: NIGMS covers a priority area and CARGO is explicitly funded as a national priority. **Group 3**: The U.S. Commission on National Security strongly endorses more funding for both basic and cross-disciplinary research. In the recent Hart-Rudman Commision report "Roadmap for National Security: Imperative for Change" they say: "In particular, we need to fund more basic research and technology development. As is clear to all, private sector investments in R&D have increased vastly in recent years. That is good, but private R&D tends to be more development-oriented than research oriented. It is from investment in basic science, however, that the most valuable long-run dividends are realized." The full report is at: http://www.nssg.gov/PhaseIIIFR.pdf A good summary is on the American Institue of Physics web page at: http://www.aip.org/enews/fyi/2001/023.html Insofar as a strong scientific infrastructure is a national priority, and is the mission of the NSF, the disciplinary and institute programs are of direct relevance. The especially interdisciplinary nature of statistics makes its support relevant to other national and scientific priorities that rely on the organization and analysis of large amounts of data (e.g., bioinformatics, computing and security issues). Geometry and topology play important roles in imaging and in the analysis of large-scale networks. Logic and foundations fundamentally inform the study of programming languages and semantics.	APPROPRIATE
Discuss any concerns identified that are relevant to the quality of the projects or the balance of the portfolio. **Group 1**: *VIGRE/REU/Postdoc Infrastructure programs* The quality of proposals funded in the REU program reflects the quality of the proposal pool. However the research quality could be improved. This is an issue that the community must	

address, especially at the R1 institution level.
Groups 2&3: discussed above

A.5 Management of the program under review. Please comment on:

Management of the program.

Group 1*: ANTC/AM disciplinary programs*
The Applied Mathematics program has been consistently very well run. ANTC is benefiting significantly from the involvement of a permanent NSF staff member, and is currently very well run.

The balance between rotators and permanent staff is a significant management issue. At present, there is a large number of rotators with quite rapid turnover in some areas, and this leads to not enough institutional memory in some circumstances.

Workload is another management issue. The increased number of proposals which can be expected in light of the Mathematical Sciences Priority Area will surely increase the workload for Division staff.

VIGRE/REU/Postdoc Infrastructure programs
The REU and MSPRF are well managed. This is especially commendable in view of the high financial management required relative to the average size of awards. There is evidence of consistency in decision making in the VIGRE program resulting from the assignment of a fulltime program officer.

Group 2: The programs appear to be well managed.
Documentation of decisions was easily found in the jackets.

However, COV members noted isolated deficiencies in certain programs in management such as some choices of reviewers for particular proposals, some of the annual reports reviewed by the Committee of Visitors were not well written (entire segments copied from one report to
another), and there were many short, uninformative reviews. The Committee recognizes that the Foundation is understaffed and program directors are trying hard in a difficult situation.

The management of the infrastructure programs such as NIGMS, CARGO, and similar kinds of efforts of the DMS is very efficient and effective.

Group 3: There is clearly an enormous workload in the disciplinary programs that is admirably handled with remarkable efficiency and success, and with great care and sympathy for both reviewers and proposers. There seems to be an overly large reliance on short-term rotating officers. Although this provides great flexibility and (over time) an extremely broad range of outlook and subject-area knowledge, it does mean that substantial time is spent on the learning curve (as is apparent in the review summaries). Additional

staffing is essential to alleviate the problem of a large and increasing workload. Having a somewhat larger percentage of permanent (as opposed to rotating) officers would also help.

The review and continuation process for the individual institute projects is carried out very well. However, we identified an issue concerning the coordination of the programs of the institutes, in particular how much coordination is necessary among the institutes, whether it happens as much as is necessary, and to what extent the NSF should facilitate this coordination.

There is also an issue concerning how the institute program as a whole is evaluated. What are the clearly identified goals for the institute program as a whole? To what extent are they being achieved? Certainly the starting point for such an evaluation will be the evaluation materials provided by the individual institutes, but the program must undertake (or outsource) a program of summary and summative evaluation for the entire program.

Responsiveness of the program to emerging research and education trends.

Group 1*: ANTC/AM disciplinary programs*
The applied mathematics program seems very sensitive to emerging trends, and is willing to invest in them as part of its portfolio. In the Algebra, Number Theory, and Combinatorics program, we note an experimentation a few years back with a new panel in Quantum Algebra, in response to an emerging research trend.

VIGRE/REU/Postdoc Infrastructure programs
A major societal concern is enhancing the workforce by enlarging the pool of technologically sophisticated citizens. VIGRE, REU and MSPRF are programs that are designed to address these needs at all levels of postsecondary education and beyond

Group 2: The Division of Mathematical Sciences has been very responsive to research and education issues with programs such as VIGRE. The disciplinary programs are very responsive to research trends.

Most of the infrastructure programs have been created to respond to the emerging research and education trends and they are doing so effectively.

Group 3: The disciplinary programs rely heavily on the broad-based review process to identify and evaluate new ideas and "hot" topics. The program officers are extremely responsive to such identifications, via informal but systematic consultation with other disciplines, using them in proposal decisions and in the development on new initiatives. The new initiative on multidisciplinary proposals is a good example of response to the increasingly multidisciplinary nature of modern science.

The very nature of the institutes, which host a variety of programs of varying length, lends itself particularly to respond to emerging research areas as well as trends in education (especially graduate and postdoctoral education). For instance, AIM's March 2003 program on "Future Directions in Algebraic Number Theory" was a rapid response to the 2002 announcement of Agrawal, Sayal and Saxena of an unconditional, deterministic, polynomial-time primality-testing algorithm.

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

Group 1: *ANTC/AM disciplinary programs*
We have almost no data about the program planning which led to the decisions we could see in the proposals we reviewed. There was an occasional indication of the kind of priority-balancing which is done by the program officers, particularly for proposals which were taken to the Equalization Meetings. The direct comparisons between proposals which appear in the minutes of those meetings reflect careful consideration of many factors which were used to ensure that the portfolio was well balanced.

VIGRE/REU/Postdoc Infrastructure programs
REU and MSPRF are traditional ongoing programs that have evolved as a result of perceived workforce development needs within the mathematical community. VIGRE is a relatively recent program that evolved from earlier programs such as the Group Infrastructure Grants through with support from an external advisory group. An evolving set of programs associated with VIGRE in EMSW21 provides clear evidence of program planning.

Group 2: The planning and prioritization are, for the most part, internal responses to generalized concerns from the outside or continuation of successful programs with ongoing need (such as SCREMS). In general, this planning was well targeted and resulted in innovative responses to these concerns.

Group 3: Prioritization in the disciplinary programs is highly influenced by the broad-based review process. Priorities identified by the scientific communities were capably developed into new programs. External influences also produce priorities that require programmatic implementation. Some of these (e.g., the use of the "broader impact" criterion, see A2) take some time to develop.

Planning for new initiatives appears to be very effective, but it might be useful to make the process more transparent. For example, few committee members had any idea how important recent initiatives were developed and implemented (e.g., the VIGRE program). On the other hand, the institute program was developed at least in part as a response to a perceived need identified by the mathematics and statistics communities to the NSF, in particular by the 2001 COV.

Discuss any concerns identified that are relevant to the management of the program.

Group 1: *ANTC/AM disciplinary programs*
The institutional memory which derives from having permanent program officers as part of the process is extremely important. We noticed that the management of the programs we reviewed was particularly effective when the staff of program officers included one of the permanent staffers.

VIGRE/REU/Postdoc Infrastructure programs
As always, having experienced program officers ensures continuity and consistency in evaluation and management. Recognizing that there are many factors that may mitigate against having such individuals, we still urge continual monitoring as well as encouraging and supporting innovative efforts that ensure their presence.

Group 2: There are issues of broader impact and increasing participation of under-represented groups in all of these programs and further actions are encouraged. Two issues that should be addressed are an inconsistency in production of annual reports by principal investigators, and the need for programs to produce well written annual program reports to feed into the NSF process for producing its annual report.

Group 3: None were identified by the group beyond those discussed above.

PART B. RESULTS : OUTPUTS AND OUTCOMES OF NSF INVESTMENTS

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

B.1 OUTCOME GOAL for PEOPLE: Developing "a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens."

Group 1:
There has been a dramatic increase in the number of postdoctoral associates, graduate and undergraduate students that are supported by DMS in FY 2001-FY2003 as evidenced by the table below:

	FY 01	FY02	FY03
Postdocs	319	322	457
Graduates	1403	2105	2050
Undergraduates	539	734	1079

We believe this increase is a direct result from the implementation of DMS strategic goals, and particularly from initiatives that address workforce issues.

a. The VIGRE program: A total of 39 VIGRE awards have been made to academic programs. These awards are designed to enhance the educational experience of students and postdoctoral associates, as well as motivate more students to pursue education in the mathematical sciences. A hallmark of successful VIGRE programs is the expansion of multidisciplinary experiences.

b. The REU Program: A specific example is the summer REU site supported under DMS-0137611 under the direction of Joseph A. Gallian at the University of Minnesota-Duluth. Twenty one prior summer programs, each having 6-10 participants, have been supported by NSF with additional support by NSA. The record of subsequent accomplishments by undergraduate participants is impressive. Seventy-four of the 90 participants who received Bachelor's degrees have gone on to graduate school, almost all at top-ranked institutions, with 47 now having received the PH.D. Graduates of the program are now contributing mathematicians, themselves involved in workforce development.

Group 2: In general the DMS does a very good job in encouraging PI's to include significant support for postdoctoral and graduate student support in the proposals submitted to its programs.
Especially in some programs, such as Computational Mathematics, there are increases in

inclusion of graduate students, postdocs and junior investigators in proposals. However, within some programs there is still room for improvement.

The question of diversity for the individuals supported by the NSF is difficult, but it is clear that the agency takes this question very seriously and is devoted to improving opportunities for women and minorities to gain access to government -sponsored research. A good example of minority outreach is provided by the RUI grant to SUNY New Paltz (DMS-0201430), an analysis project that includes an innovative use of symbolic computing (Mathematica)
to enlist undergraduates in the projects research. Ultimately the problem of the representation of minorities in science and engineering is a pipeline issue that requires increasing the exposure of young people at the elementary and secondary education level into the benefits of pursuing careers in mathematics and science. This problem is beyond the scope of the NSF to solve by itself, but the foundation should pursue cooperation with the department of education in increasing exposure of young people to real science. Certainly the NSF strongly encourages outreach to high schools by its investigators, and should be commended for this effort.

The focused research group grants are also an important mechanism to enlist students and junior research people into new and exciting projects. The NSF centers are expanding opportunities for graduate students and for major institutions to provide increased exposure to mathematics and its applications.

IGMS**:** Development of human resources is one of the key components of the IGMS program. This program is unique in the sense that that it is designed to expand the abilities of the projects participants across disciplinary boundaries, both by enlisting mathematicians to study new fields and applications and by broadening the appreciation of the value of mathematical analysis by researches in other fields. Although diversity was not generally an explicit component of the projects reviewed here, all were seeking to broaden the pool of mathematical researchers, which would in turn benefit the creation of a more diverse mathematical workforce.

Group 3:

The NSF program officers in the disciplinary programs are very actively promoting the training of junior researchers and career development at all levels. There are many indicators of this effort and of its success. These include:

- Postdoctoral programs. For example, support of NCAR's training of postdoctoral visitors in an interdisciplinary research environment through its Geophysical Statistics Project.
- CAREER awards.
- Substantial funding of recent (within 5 years) Ph.D.s (for example, 8 in Statistics/Probability in FY2001).

- Graduate student support in most proposals.
- Undergraduate research experience supported via REU's and RUI's.
- Efforts to increase the diversity (gender, ethnicity, disability, geographical) of the workforce.
- Special Workshops aimed at New Researchers, Women Researchers, e.g. IAS/Park City programs for women; and the New Researchers Conference and the "Pathways to the Future Workshop" prior to the Joint Statistical Meetings in 2001, 2002 and 2003, which included travel support funds targeted to members of underrepresented groups.
- Visits to leading professional conferences to contact researchers and prospective researchers.
- Contacts with other agencies, such as NSA, NIH.
- Honors and Awards to many funded researchers.

These activities and results are indicative of the continuous development of a diverse, competitive and globally engaged workforce of scientists, engineers, technologists and well-prepared citizens. Five examples that illustrate the dimensions and creativity of this process are as follows.

- Grant DMS-0312442 (Roberts, Washington University) studies hyperbolic 3-manifolds and their connections to geometry, dynamics and even combinatorics. Roberts has a strong record of mentoring undergraduate and graduate students from underrepresented groups, and proposes to continue to do so.
- Grant DMS-0104129 (West, Duke University) centers on a Bayesian approach to create new mathematical models for representation of complex structure of increasingly large data sets. Applications are diverse, for example, functional genomics, finance, and communications engineering. This 5-year grant includes support for 1 graduate student per year, REU support each year, and is co-funded by the MMS program in SBE.
- Grant DMS-0306211 (Adams, Williams College) supports an RUI devoted to an undergraduate research program that has engaged 50 students so far. Research papers have been generated. Adams also serves as a public speaker in mathematics and has given over 200 off-campus talks.
- Grants DMS-0103889 (Goldman, U Maryland) and DMS-0072607 (Schwartz, Maryland) support an Experimental Geometry Lab, which involves graduate students in the lab and includes outreach to prospective math students and the public in general.

- Neeman's CAREER Award (UCLA) includes support for graduate students in other departments to be visitors in training in the Math Department to study topics not available in other departments

It is clear from reviewing program decisions that increasing attention is being devoted to the goal of developing a suitable workforce. While the quality of a research project clearly remains the determining criterion, aspects relating to diversity, training of undergraduate and graduate students, and support of junior faculty and postdoctoral appointees are being given explicit consideration in ranking research proposals. The efforts are not uniform across programs and some attention should be given to making them more systematic.

In projects of an interdisciplinary nature, the actual specifics of how the collaborations and interactions will be conducted are receiving increasing scrutiny and are being used as a factor in evaluating the potential of such projects. Such discriminating evaluation of project components and plans is effective and will definitely contribute enormously toward the goal of an effective workforce in the long run. Along with this, it is necessary to go to greater lengths to inform and motivate the senior research community to assume stronger and stronger roles in this process.

The institute program is one of the most effective ways to provide research and educational opportunities for a wide range of people. Graduate students, underrepresented groups, postdoctoral workers are all well represented as participants in institute programs. The institutes' summer programs are particularly useful for undergraduate students, high-school teachers, and others

B.2 OUTCOME GOAL for IDEAS: Enabling "discovery across the frontier of science and engineering, connected to learning, innovation, and service to society."

Group 1: The most famous problem in ANTC is the Riemann Hypothesis, which concerns the distribution of prime numbers. A new and exciting development has been the use of ideas from random matrix theory, mostly the domain of physicists, to study and make predictions concerning the Riemann Hypothesis and related problems. DMS has supported initiatives in this area both in individual grants and through conferences and research grants.

The Applied Mathematics program supports an impressive array of wide ranging research that impacts nearly every component of science, medicine and engineering. Particular examples from just the last three years are

(1) DMS-9972210, co-funded by Physical Oceanography, has supported the development of a wave basin (an experimental facility) at Penn State University to study deep water wave patterns. The experimental results are compared with modern theoretical predictions and numerical simulations to increase understanding of physical phenomena like ocean waves.
(2) DEB-9981552, an award from Systemic and Population Biology that is co-funded by Applied Mathematics, has lead to the development of a mathematical model used to identify improved control tactics for a public health problem. For a disease that

cannot be adequately treated by drugs or vaccination, the model provided an effective--and ethical--way to explore prevention strategies in computer simulations without putting human subjects at risk.

(3) DMS-0109086, co-funded with Computational Mathematics, supports a young theoretical physicist who has taken ideas from risk-management in finance and economics to develop and evaluate management strategies for natural systems (e.g. forestry).

(4) DMS-0074049, co-funded by the Office of Naval Research, led to the application of methods from mathematical fluid dynamics to problems in computer vision and image analysis. This has produced a new algorithm for "inpainting" and resolution enhancement for digital images.

Group 2: DMS has successfully fostered advancing knowledge across the frontiers of science.
Within Analysis itself, noteworthy is the solution of the Kato problem in 2001 (Lacy and S. Hoffman). Across other disciplines the whole issue of notion of diffusion across scales, and interaction of particle systems has had an impact. In particular the work of R. Williams DMS 0305272 and Y. Peres DMS 0305272 are noteworthy.

The "cultural impact" of mathematical biology has been good overall, especially through the Biodynamics center at BU, especially in signal transduction and pattern formation.

The Computational and Algorithmic Representations of Geometric Objects (CARGO) projects provide an excellent opportunity to cross-fertilize efforts in geometry and related fields to provide new methods and tools that are indeed at the cutting edge of mathematical science. Such projects do indeed enhance learning and innovation and are of great service to society.

NIGMS provides a real service to the scientific community by being responsive to emerging needs in blending mathematics and life sciences. In this sense, it is at the forefront of the modern notion of scholarship. All of the projects reviewed were new, so nuggets of progress were not available at the time of this report.

Group 3: Virtually every proposal we reviewed contained high-quality ideas. Especially noteworthy were the many proposals that made connections among various mathematical sub-disciplines and to other disciplines. A few examples include:

- Mykland 0204639: a five-year award co-funded with MMS develops ideas and results in statistics arising from options trading.
- Hirschfaldt 0200469, a 1999 Ph.D. applies ideas of computability to model theory algebra and combinatorics and also investigates notions of effective randomness.
- The FRG led by Henson 0100979 at Illinois is a project in model theory that emphasizes connections to other areas of mathematics especially number theory and algebra and aims to disseminate the methods of model theory to researchers in those

areas.

- Hopkins 0306519 is an outstanding homotopy theorist whose work unifies several areas of topology, number theory and algebraic geometry. The group at MIT has had great success in training Ph.Ds and has broad influence on the field of homotopy theory.

- Taubes et al (0104196) is an outstanding geometric analysis award that promises and has delivered new developments in 4-manifold theory arising from Seiberg-Witten theory. There are strong connections with mathematical physics.

- Hofer (0102298) has made profound advances in the development of symplectic field theory, further extending the connections between this part of geometry and physics.

Ozsvath (0234311) and Szabo (0107792) have made tremendous advances in three-manifold topology using their Heegaard-Floer homology. This work combines ideas from symplectic topology and mathematical physics so problems in low-dimensional topology.

B.3 <u>OUTCOME GOAL for TOOLS:</u> Providing "broadly accessible, state-of-the-art S&E facilities, tools and other infrastructure that enable discovery, learning and innovation."

Group 1: There are numerous outstanding examples where DMS has provided state-of-the-art S&E facilities, tools and other infrastructure that have enabled discovery, learning and innovation. Of these we would like to mention three representative examples:

1) Michael Rubinstein (DMS-0138597) is investigating the statistical properties of zeros of L-functions, and will develop a software package for computing L-functions. The software and the data it generates will be released to the public for use by other mathematicians

2) Campbell (DMS-980229) and some of his collaborators have developed an optimization software toolkit that can be applied to a wide range of design problems in industry and has been used in manufacturing processes. This is one of many examples where new mathematical algorithms have been implemented in software widely used by the broader community.

3)Several students under an REU grant led by Vernescu (DMS-0097469) worked on developing models for monitoring vapor return equipment in gasoline stations and for identifying their failure. This is an excellent example of providing students a research experience with far-reaching consequences.

Group 2: For core areas (ANTC, Analysis, Geometry, and some subareas of Applied Math and Statistics & Probability) the NSF funded centers, Focused Research Groups, and supported conferences help to provide the connections necessary to further discovery, learning, and innovation.

For computational mathematics, some sub-areas of applied mathematics, and statistics and probability, additional emphasis needs to be placed on standards and tools for computational methods and data representations. In general, the answer to this question is largely dependent on the definition of tools and infrastructure. For tools such as published algorithms and mathematical analysis the situation is quite good. Papers published based on DMS sponsored research are usually of high quality and provide an important service to the scientific community. A major short coming, however is in the development of sharable software tools that implement the ideas and algorithms developed under these projects in ways the can be shared with people outside the immediate projects. Here the situation could be enormously improved, as illustrated by the success of computer science and engineering in providing useful software tools that can be downloaded from the internet.

CARGO**:** Traditionally the strong point for mathematical modeling has been the development and communication of algorithms, but these would not be generally recognized as being broadly accessible to persons outside of the immediate field. The DMS recognizes this problem and is attempting to provide mechanisms to improve this.

In the case of the NIGMS, the facilities and tools are in the process of being developed.

Group 3: Institutes by their very nature develop connections that are the tools of mathematics. A striking example of this was the discovery of the Jones polynomial in knot theory, which is attributed in part to the juxtaposition of programs in operator theory and topology at MSRI.

At a recent BIRS conference, in response to a question of Olga Plamenskya, student of Peter Kronheimer, Yakov Eliashberg (0204603 and FRG) proved the final missing step of the program of Kronheimer and Mrowka (0206485 and FRG) to prove the Bing-Martin Property P conjecture, a special case of the Poincare conjecture.

Jack Xin of the University of Texas and Yingyong Qi of Qualcomm, Inc., who worked on modeling the nonlinear aspects of human hearing, after discussions with Li Deng of Microsoft at an IMA workshop, collaborated to discover a new approach to coupling auditory neural feedback to their mechanically based models which recently led to a breakthrough in the numerical modeling of multitone auditory responses. This 2003 work may lead to significant applications in voice processing systems and to audio compression methods.

B.4 OUTCOME GOAL for ORGANIZATIONAL EXCELLENCE: Providing "an agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices."

Group 1: The DMS does an outstanding job in constant improvement of older procedures and programs, and in designing and implementing new procedures and programs to service the needs of the national mathematics community**.**

The DMS has dramatically shortened the time-to-decision for proposals, doubling in the last

3 years the percentage of proposals processed within 6 months of receipt to a directorate average above 70%. This improvement in processing speed happened at a time when the number of proposals received increased by about 30%. This improvement in processing speed was no doubt enhanced by increasing the role of panel review in proposal evaluation procedure, and somewhat diminishing the role of individual mail reviews. We find the panel method overall to be excellent; panels can infrequently be a bit conservative, but on balance panels are willing to fund new and innovative projects. The DMS leadership is agile and dynamic in its willingness to design new directions and broaden its mandate, responding to NRC reports and national needs. The DMS is very pro-active, designing and implementing midcourse corrections to major initiatives, like the transformation of the VIGRE program to the EMSW21 program. In its efforts to renew the discipline via enhancing the workforce, the DMS has successfully increased the median size of research grants in the last 3 years from a median of about $38,000 per year to a median of about $57,000 per year. The increase is intended to support students and postdocs, and all of the new and continuing DMS initiatives (for example EMSW21), contain substantial training components, or are entirely dedicated to training activities (for example (UBM, REU, RUI).

Group 2: DMS is able to quickly develop new programs to address areas of increasing importance; a good example is the development of the Undergraduate Mathematical Biology program in the last year.

To ensure that DMS maintains state of the art business practices, NSF should consider periodically benchmarking with other government agencies, academic institutions, and private sector organizations. As the boundaries of the various areas within Mathematical Sciences shift, for example due to external priorities, it should consider refactoring its areas so that focus is clear and inefficiencies caused by cross-area interaction are minimized.

The role of the annual program reports was not clear. Who is the intended audience, how are they distributed, and what role do they serve in internal and external communications? It is clear that considerable effort is expended in creating the reports. If they are intended for broad distribution, quality should be improved; if they are used for narrow reporting purposes, the volume of information and level of technical detail may be excessive.

The Ohio State Mathematical Biosciences Institute and the joint program with the NIH are providing efficient organizational structures that permit bridges between mathematics and the life sciences. It is worth noticing that they are making a serious effort to work efficiently between several government agencies.

Group 3: The existence of the COV itself is a fine example of the innovative practices used at the NSF to insure the quality of its grants and awards. The program directors' flexible and judicious use of review panels, screening panels and mail reviews is commendable, and results in resources (human and monetary) being used effectively. This allows the essentially entrepreneurial activities represented by individual research grants to flourish with a minimum of accompanying administration.

We would like more information on how the overall DMS budget is constructed. Specifically,

how have decisions been made regarding broad allocations, e.g., VIGREs vs. REUs vs individual investigator grants?

PART C. OTHER TOPICS

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

Group 2: Perhaps the Mathematics Programs should encourage development of software tools and standards to encourage their use by large numbers of scientists

C.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.

Group 2: The DMS should continue its efforts in encouraging the contributions that can be made by the nation's colleges and universities that do not have PhD programs to pipeline and educational issues

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

Group 1: We congratulate DMS for its strong efforts to draw people into the pipeline and keep them there. These efforts naturally focus mainly on undergraduates, graduate students, and postdocs. But the pipeline issue arises for younger students too. It is important that talented high school students be drawn into mathematics and the sciences -- and that we nurture the intellectual development of students already interested in these areas. There are some successful programs of this type in the mathematics community, for example at OSU and BU. The COV panel finds it surprising that NSF does not support such activities.

Group 2: There continue to be staffing issues: the load that DMS program directors need to bear appears to be excessive and the balance between permanent and rotating staff positions appears to be too much tilted toward rotating staffers.

Mail reviews and panel summaries could be improved to help investigators understand why their proposals were rejected and how to improve them (although it was felt the review process was adequate to make the decisions.

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

See the discussion is sections 2-4 of this report.

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

Group 1: For international COV members, it would be useful to provide information prior to the meeting concerning DMS's various programs (their acronyms, their goals, and a brief summary of how they work).

Group 2: It would be helpful if the materials provided to the panel were better organized and explained. For example, it would be helpful for an NSF officer to go over the jackets so that we can understand the structure of the jacket quickly. Also a crib sheet for the
acronyms commonly used in the jackets would be helpful.

A short description of the request for proposals for the infrastructure grants should be provided with the collections of jackets – not all COV members are knowledgeable about the details of all the programs and it would make this part of the review more efficient. We are missing useful data about the sizes of approved proposals, and summaries of declined proposals program by program would be helpful. Also, the way the data about acceptances and declinations in the infrastructure programs is presented to the COV makes it difficult to use because this data is not organized by program, rather all programs are mixed together in the same list. It would have been helpful if the materials for the review that were mailed to members of COV would have arrived earlier. The handling of the electronic draft files in the COV subcommittees was very difficult because there was no easy way for the files produced on different machines to be combined. In particular, a computer for each COV panelist and an LCD projector in each room would be useful for the discussions.

SIGNATURE BLOCK:

_____

For the [Replace with Name of COV]
[Name of Chair of COV]
Chair

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

THE UNIVERSITY OF ARIZONA®
TUCSON ARIZONA

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

June 24, 2004

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

Dear Michael:

I am pleased to inform you of the formal acceptance of the Report of the Committee of Visitors (COV) for the Division of Mathematical Sciences (DMS). Dr. David Morrison of the MPS Advisory Committee (MPSAC), and a member of the DMS COV, presented the Report to the MPSAC at its April 22-23, 2004 meeting in the absence of Dr. Robert J. Zimmer, Chair of the COV. The Report strongly endorsed the work of the Division of Mathematical Sciences and enthusiastically noted the enhanced strategic focus of DMS in the three major domains of: 1) continued and expanded strength of the nation in core mathematical sciences research, 2) continued and expanded strength in connecting mathematical sciences to other areas of natural science, technology, and social science, and 3) expansion of the workforce in the mathematical sciences. The Report cites the "boldness and imagination" of DMS in "vigorously and successfully [addressing these] major strategic issues" and expressed "broad enthusiasm and appreciation for the innovative work and productive flexibility of DMS."

The Report articulates several issues that the MPSAC believes should receive attention. Specifically, the COV suggested that DMS develop a formal assessment plan for the effectiveness of the VIGRE program in light of the significant commitment of resources that this program commands. In addition, in light of the increasing support of and role of institutes in the DMS portfolio, the COV questioned whether other programs supporting conference activities are now somewhat redundant and whether certain areas of core mathematics are adequately represented in the institute portfolio. The MPSAC recommends that these questions be carefully considered by DMS as it implements its vision for future activities.

Finally, the COV Report indicated that there is "considerable uncertainty within the community about what constitutes an adequate response" to the "Broader Impact" criterion. The COV Report suggests greater community education on this issue and further recommends that "DMS immediately begin work with the community to accelerate this process, and be as explicit as possible about the appropriate interpretation

of ‘broader impact’ for various types of proposals.” The MPSAC strongly endorses actions to educate and engage the community on this issue.

We are grateful to the COV and its Chair for the excellent, in-depth review of the Division of Mathematical Sciences, and to the DMS staff for their thorough preparations for this COV review and for their commendable work.

Sincerely,

Jeanne E. Pemberton
Chair, MPS Advisory Committee

cc: R.J. Zimmer, W. Rundell, M. Aizenman

NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

OFFICE OF THE
ASSISTANT DIRECTOR
FOR MATHEMATICAL AND
PHYSICAL SCIENCES

October 27, 2003

NATIONAL SCIENCE FOUNDATION
4201 Wilson Boulevard, Arlington, Virginia 22230

Office of the Assistant Director
Mathematical and Physical Sciences
January xx, 2004
Dr. xxx

Dear Dr. xxx,

Thank you for agreeing to serve on the FY 2004 Committee of Visitors (COV) for the Division of Mathematical Sciences (DMS). The COV Review will take place at the NSF in Arlington, Virginia, on Wednesday through Friday, February 11-13, 2004; we expect to begin early Wendesday morning and conclude by late-afternoon Friday.

The COV is an ad hoc subcommittee of the Mathematical and Physical Sciences Advisory Committee (MPSAC). Your appointment to the COV commences February 1, 2004 and ends with the presentation of the COV report to the MPSAC on April 2, 2004.

By NSF policy, each program that awards grants and cooperative agreements must be reviewed at three-year intervals by a COV comprised of qualified external experts. The COV is charged to address and prepare a report on:

* the integrity and efficacy of processes used to solicit, review, recommend, and document proposal actions;
* the quality and significance of the results of the Division's programmatic investments;
* the relationship between award decisions, program goals, and Foundation-wide programs and strategic goals;
* the Division's balance, priorities, and future directions;
* the Division's response to the prior COV report of 2001
* any other issues that the COV feels are relevant to the review.

A more complete description of the charge to the COV is provided as an attachment. The COV report is made available to the public to ensure openness to the research and education community served by the Foundation.

Decisions to award or decline proposals are ultimately based on the informed judgment of NSF staff, using evaluations by qualified reviewers who reflect the breadth and diversity of the proposed activities and the community. Systematic examination by the COV of a wide range of funding decisions provides an independent mechanism for monitoring and evaluating the overall quality of the Division's decisions on proposals, program management and processes, and results.

The review will assess operations of individual programs in DMS as well as the Division as a whole for three fiscal years: FY 2001, FY 2002, and FY 2003. The DMS programs under review include:

- o Analysis
- o Algebra, Number Theory and Combinatorics
- o Geometry, Topology and Foundations
- o Applied Mathematics
- o Computational Mathematics
- o Probability and Statistics
- o Infrastructure: which includes our institutes, pipeline/workforce as well as our outreach projects.

The general outline of the meeting will be an introductory session in which the Division Director, William Rundell , will present an overview of the Division's activities and plans, a brief overview of each program, and a review of statistical information and procedures. Following this session, the COV will break into subpanels for each program to examine program documentation and results and to prepare program-level review reports. This is expected to require about half of the meeting time. The remaining time will be spent on a review of the Division as a whole and preparation of a Division-level report, based on the program-level reports and other material as appropriate.

Drafts of the program-level reports and the Division-level report will be completed during the COV meeting. The Chair of the COV will finalize and submit the full report by February 28 to allow time for comment and distribution of the report to the full MPSAC prior to their meeting on April 1-2, 2004.

Bill Rundell (703-292-4850, wrundell@nsf.gov) will send you an agenda and background information to assist you in conducting this review 2 weeks prior to the meeting. Please feel free to contact Bill or Debbie Lockhart, DMS Acting Executive Officer, (703-292-4858, dlockhar@nsf.gov) if you have questions about the review.

The DMS Division Secretary, Jennifer Connell (703 - 292-5301, jconnell@nsf.gov), will contact you shortly with information about making travel and hotel arrangements.

Thank you again for your willingness to participate in this important activity.

Sincerely,

Michael S. Turner
Assistant Director

cc: Jeanne Pemberton, Chair, MPSAC

The COV Core Questions and Reporting Template will be applied to the program portfolio and will address the proposal review process used by the program, program management, and the results of NSF investments. Specific questions to be addressed and reported on are:

a) the integrity and efficiency of processes used to solicit, review, recommend and document proposal actions, including such factors as:
(1) selection of an adequate number of highly qualified reviewers who are free from bias and/or conflicts of interest;
(2) appropriate use of NSF merit review criteria;
(3) documentation related to program officer decisions regarding awards and declines, and the scope, duration and size of projects;
(4) balance of awards in terms of subject matter; emerging opportunities; high risk and innovation; size versus number of awards; new investigators; diversity of underrepresented groups; geographic distribution of principal investigators; and
(5) overall technical management of the program.

b) the relationships between award decisions, program goals, and Foundation-wide programs and goals;

c) results, in the forms of outputs and outcomes of NSF investments for the relevant fiscal years, as they relate to the Foundation's current strategic goals and annual performance goals.

d) the significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when these investments were made.
Examples might include new products or processes, or new fields of research whose creation can be traced to the outputs and outcomes of NSF-supported projects over an extended period of time.

e) response of the program(s) under review to recommendations of the previous COV review.

Sincerely yours,

Michael Turner
Assistant Director

MEMORANDUM

TO: Morris Aizenman, O/AD MPS

FROM: Deborah Lockhart/DMS

SUBJ: Division of Mathematical Sciences Committee of Visitors (COV)

DATE: March 17, 2004

The Division of Mathematical Sciences held its triennial COV on February 11-13, 2004. The COV was composed of 31 members from the scientific community chosen for their scientific expertise, awareness of developments in their respective fields of the mathematical sciences, as well as a sense of issues, perspective, and balance across the mathematical sciences. The 31 COV members composed a diverse committee with geographic, institutional, gender, ethnicity, age, private sector, and scientific representation. The following table describes the main features of the COV with respect to these issues:

Category	Number
Member of MPS Advisory Committee	4
Academic Institutional Type	
Research	21
Comprehensive	1
4-year	2
Public	13
Private	11
Industry	2
National Laboratory	2
Government Agency	1
Outside of US	2
Location	
Northeast	7
East	5
Southeast	3
Midwest	8
Southwest	4
West Coast	2
International	2
Female	8
Minority	3
No NSF Proposal in Five Years	8

It should be noted that Suncica Canic, who was appointed to the COV, did not attend the meeting due to illness.

The COV was briefed on issues of Conflict of Interest for the purpose of one of the COV's statutory responsibilities, namely the reading of proposals, reviews, and recommendations and commenting on the handling of actions and the appropriateness of recommendations.

Each COV member completed a NSF Conflicts of Interest form. Proposals and files were not available to COV members in those cases where the member had a conflict of interest. Furthermore, the COV members were instructed to leave the room during discussion of such actions. None of the COV members was involved in the review of a program in which he or she had a pending proposal. COV member Michael Stob, who was a co-PI on a proposal (from which he would personally receive no benefit) in the IGMS program, did not participate in any review or discussion of proposals in that program. However, he did participate in the discussion of other programs in Infrastructure. I believe that his comments were entirely free of bias and absolutely fair.

William Rundell and Deborah Lockhart were available at all times during the COV meeting to answer questions and resolve issues regarding conflicts of interest.

The Division of Mathematical Sciences believed that the efforts of the COV and the COV Chair, Dr. Robert Zimmer, were outstanding in all respects. The Division staff detected no situations in which conflicts of interest were not handled properly.

OFFICE OF THE ASSISTANT DIRECTOR FOR
MATHEMATICAL AND PHYSICAL SCIENCES
ADVISORY COMMITTEE MEMBERSHIP LIST
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Effective Date: October 1, 2003

Term Expires 10/01/04

Dr. Thomas W. Appelquist
Department of Physics
Yale University
New Haven, CT 06520
203-432-6969
203-432-5419 (FAX)
email: thomas.appelquist@yale.edu

Dr. Roger D. Blandford
Division of Physics, Mathematics, and Astronomy
California Institute of Technology
Pasadena, CA 91125
626-395-4200
626-796-5675 (FAX)
email: rdb@caltech.edu

Dr. Robert C. Hilborn
Department of Physics
Amherst College
Amherst MA 01002-5000
413-542-2062
413-542-5821 (FAX)
rchilborn@amherst.edu

Dr. Jeanne E. Pemberton **(Chair)**
Department of Chemistry
University of Arizona
1306 E. University Boulevard
Tucson, Arizona 85721-0041
520-621-8245
520-621-8248 (FAX)
pembertn@u.arizona.edu

Dr. William R. Pulleyblank
Director, Mathematical Sciences and
Director, Deep Computing Institute
T. J. Watson Research Center
914-945-3323
914-945-4206 (FAX)
pblk@us.ibm.com

Dr. Joseph Salah
Massachusetts Institute of Technology
Haystack Observatory,
Route 40
Westford, Massachusetts 01886
781-981-5407
781-981-0590 (FAX)
jsalah@haystack.mit.edu

Term Expires 10/01/05

Dr. Shenda Baker
Department of Chemistry
Harvey Mudd College
301 E 12th Street
Claremont, CA 91711
909-621-8011
909-621-8465 (FAX)
shenda_baker@hmc.edu

Dr. David R. Morrison
Department of Mathematics
Duke University
213 Physics Building
Durham, NC 27708-0320
919-660-2862
919-660-2821 (FAX)
drm@math.duke.edu

Dr. Peter F. Green
Department of Chemical Engineering
University of Texas Austin
Austin, TX 78712-1062
512-471-3188
512-471-7681 (FAX)
green@che.utexas.edu

Dr. Claudia Neuhauser
Professor and Director of Graduate Studies
Ecology, Evolution and Behavior
University of Minnesota
1987 Upper Buford Circle
St. Paul, MN 55108
612-624-6790
612-624-6777 (FAX)
CNeuhaus@biosci.cbs.umn.edu

Dr. Jean H. Futrell
Director
Pacific Northwest National Laboratory
P.O. Box 999, K8-84
Richland, WA 99352
509-372-4140
509-376-6742 (FAX)
Jean.Futrell@pnl.gov

Dr. Gary Sanders
LIGO Laboratory
California Institute of Technology
MS 18-34
Pasadena, CA 91125
626-395-2997
626-304-9834 (FAX)
sanders_g@ligo.caltech.edu

Term Expires 10/01/06

Dr. Janet M. Conrad
Department of Physics
Columbia University
716 Pupin Hall
New York, NY 10027-6902
212-854-5506
212-854-3379 (Fax)
conrad@nevis.columbia.edu

Dr. Luis Echegoyen (MPSAC/CEOSE Liaison through January 31, 2006)
Department of Chemistry
Clemson University
519 Hunter Laboratories
PO Box 340973
Clemson, SC 29634
864-656-5017
864-656-6613 (FAX)
luis@clemson.edu

Dr. Mostafa El-Sayed
School of Chemistry and Biochemistry
Georgia Institute of Technology
770 State Street
Atlanta, GA 30332-0400
404-894-0292
404-894-0294 (FAX)
mostafa.el-sayed @chemistry.gatech.edu

Dr. Frances Hellman
Department of Physics
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0319
858-534-5533
858-534-0173 (FAX)
fhellman@ucsd.edu

Dr. John Huchra
Harvard-Smithsonian, CfA
60 Garden St., MS-20
Cambridge, MA 02138
617-495-7375
617-495-7467 (FAX)
huchra@cfa.harvard.edu

Dr. Lucy Fortson
Adler Planetarium
Department of Astronomy
1300 South Lakeshore Drive
Chicago, IL 60605
312 322-0338/0323
312-322-2257 (FAX)
lucy@cygnus.uchicago.edu

Dr. Raymond L. Johnson
CMPS-Mathematics
2107 Mathematics Building
University of Maryland
College Park, MD 20742-4015
301 405 7061
301-314-0827 (FAX)
rlj@umd.edu

Dr. Jon R. Kettenring
Telcordia Technologies
One Telcordia Drive
Piscataway, NJ 08854-4157
973-829-4398
973-829-2645 (FAX)
jon@research.telcordia.com

Dr. W. Carl Lineberger
Department of Chemistry and Biochemistry
Joint Institute for Laboratory Astrophysics
University of Colorado at Boulder
UCB 440
Boulder, CO 80309-0440
303-492-7834
303-792-5894 (FAX)
wcl@jila.colorado.edu

Dr. Venkatesh Narayanamurti
Division of Engineering and Applied Sciences
Harvard University
Pierce Hall 217A
29 Oxford Street
Cambridge, MA 02138
617-495-5829
617-496-5264 (FAX)
venky@harvard.edu