Division of Mathematical Sciences
Annual Update to 2007 Committee of Visitors report
March 31, 2009

DMS received a 2.9% increase in FY 2008 almost all of which was specific to the new NSF-wide solicitation *Cyber-enabled Discovery and Innovation (CDI).* DMS made 678 awards for a funding rate of 31%, as compared with 769 awards for a funding rate of 35% in FY 2007. The median annualized award size remained constant at approximately $62K. The decline in award number and funding rate in FY 2008 is a reflection of flat budgets in all DMS programs other than CDI.

In the summary section of the Division's response to the Committee of Visitor's report, dated March 29, 2007, DMS undertook to provide annual updates in four areas of interest.

Improve the community's understanding of the Broader Impacts criterion
DMS continues the practices reported on in the previous update. To recap, the most important steps were publication of a Dear Colleague letter on the Broader Impacts criterion and introduction of the practice to instruct review panels to judge results of prior support not only on Intellectual Merit but also on Broader Impacts. Lack of reporting of broader impacts in results of prior support is supposed to be noted in panel summaries. Over the course of a three year funding cycle, this practice should alert the research community to the importance NSF attaches to this review criterion. Every panel briefing speaks to this issue and DMS intends to develop common briefing materials for all panels so that the Broader Impacts criterion will be presented in a consistent fashion. Finally, Program Officer comments to the Principal Investigator consistently point out cases where the Broader Impacts criterion was addressed incorrectly and give references to the relevant documents.

Assess the breadth and scope of institute programs
Successive Committees of Visitors have commended DMS for its Institutes activity, which the Division interprets as strong endorsement of the Institutes investment by the mathematical sciences community. Still there are community concerns that this investment be carefully managed and subjected to appropriate scrutiny. This concern is clearly reflected in the COV's recommendations.

The 2007 COV report recommends that DMS undertake an analysis of activities in the Institutes portfolio and the relationship of those activities to the rest of the Division's programs. Specifically, quoting from the bottom of page 6 of the report, COV recommends a study of:

1. how these [institute] activities are related to DMS's research portfolio;
2. whether institute activities appropriately express the dynamic balance among core and emerging areas in the mathematical sciences;

3. how well institute activities reflect emerging research opportunities at both the interfaces between core areas of mathematics and the interfaces of mathematics with other disciplines;
4. the balance of short-term workshops/conferences with longer (one-semester or one-year) programs.

Further, COV recommends (1) that an analysis be completed before the next Institutes competition and (2) that DMS report the results to the mathematical sciences community. DMS has begun to act these recommendations and this update describes our first steps.

Question 1 refers to the overall structure of the Division's investments and is relatively straightforward to answer. Questions 2, 3, and 4 refer to dynamic portfolio balance along three specific dimensions: established areas versus emerging areas of research; opportunities at intra-disciplinary versus extra-disciplinary interfaces, and programs of short versus long duration. Clearly, balance along these three dimensions is important to DMS but the Division does not manage the Institutes portfolio with some ideal or optimal balance in mind. Rather, balance is achieved as the result of active management of the Institutes as a whole, within in the context of the Division's total portfolio of investments.

Question 1: How are Institutes activities related to the DMS research portfolio?
The DMS portfolio includes three major components: Individual Investigator Awards (IIA), Mathematical Sciences Research Institutes, and Workforce training grants.

IIAs comprise roughly 70% of DMS spending. They support disciplinary research projects in all areas of the mathematical sciences and support multidisciplinary groups of researchers to attack problems of mathematical depth and scientific importance.

The portfolio of Mathematical Sciences Research Institutes, historically, has comprised roughly 10% of the DMS budget. Funded on a competitive basis in 10-year cycles, the Institutes serve as incubators for new ideas, new research directions and new research communities.

Workforce awards comprise roughly 15% of annual spending. Awards made through such programs as *Enhancing the Mathematical Sciences Workforce in the 21st Century (EMSW21), Mathematical Sciences Postdoctoral Research Fellowships (MSPRF*) and *Proactive Recruitment in Introductory Science and Mathematics (PRISM)* support mentoring and research training activities aimed at increasing the number of U.S. students who pursue careers in the mathematical sciences and other STEM disciplines.

DMS provides core support for five Institutes: the Institute for Mathematics and its Applications (IMA), the Institute for Pure and Applied Mathematics (IPAM), the Mathematical Biosciences Institute (MBI), the Mathematical Sciences Research Institute (MSRI), and the Statistical and Applied Mathematical Sciences Research Institute (SAMSI) as well as major support for an additional two Institutes: the American Institute of Mathematics Research Conference Center (ARCC) and the Institute for Advanced Study (IAS). DMS also provides partial support, at significantly lower levels, to four

other institutes or centers: the Banff International Research Station (BIRS), the Institute des Hautes Études Scientifiques (IHES), the Mathematisches Forshungsinstitut Oberwolfach (MFO), and the National Institute for Mathematical and Biological Synthesis (NIMBioS). Of these, only BIRS is relevant to this update.

Institutes are critical pieces of infrastructure that advance research in the mathematical sciences, increase the impact of the mathematical sciences in other disciplines, enable the mathematical sciences to respond to national needs, broaden participation and expand the talent base engaged in mathematical research in the United States. They support valuable activities that cannot be supported by IIAs and Workforce awards, either separately or in combination.

Question 2: Do Institute activities express an appropriate dynamic balance between established areas versus emerging areas of research?
This question is most subtle of the three. Both established and emerging areas of research are appropriate for Institutes activities and both areas are well represented by those activities, as even a casual glance at the Math Institutes website www.mathinstitutes.org will reveal. The main argument for periodic revisiting of established areas is that, after a period of time has passed, exciting new developments warrant a fresh look by experts and a new articulation of the research agenda. The main argument for focusing on emerging areas is that they explore new intellectual territory, make new connections and stimulate the creation of new mathematics and new mathematical communities. The observation that, within the 25 year span of the Institutes, at least some currently established areas of research were once emerging areas that were identified and developed by an Institute program illustrates the appropriateness of tipping the balance in favor of emerging areas.

Question 3: Do Institute activities express an appropriate dynamic balance between opportunities at intra-disciplinary versus extra-disciplinary interfaces?
Given their charge to identify and push intellectual boundaries and to form new research communities, the balance Institutes have struck with respect to intra- versus extra-disciplinary interfaces is appropriate since it is essentially scale-invariant, being largely a function of their total programmatic capacity.

Question 4: Do Institute activities express an appropriate dynamic balance between programs of short versus long duration?
Given that the business model of some Institutes is essentially the short duration workshop and given that most Institutes have some quick response “Hot Topics” mechanism driven by community input, DMS considers that balance of program duration is appropriate.

Broader participation by women, under-represented minorities and institution-type
A succinct way to report on broader participation is to provide funding data for research awards in categories tracked by NSF.

Underrepresented Minority Groups are defined as American Indian or Alaska Native, Black or African American, Hispanic or Latino, Native Hawaiian or Other Pacific

Islander, as indicated on the NSF information request form for Principal Investigators. Please note that PIs may choose not to declare their gender, race or ethnicity; hence the data cannot be understood to represent fully and accurately the funding rate for women and underrepresented minorities. For comparison purposes, we also included data for all PIs and for PIs who choose not to declare their status. The reported percentage is the number of awards divided by the number of actions in each category while the number in parenthesis is the actual number of awards.

Funding Rate	**FY 2006**	**FY 2007**	**FY 2008**
All	30% (685)	35% (769)	31% (678)
Women	25% (79)	34% (102)	32% (90)
Underrepresented Minority	28% (34)	23% (34)	26% (30)
Minority Status Undeclared	21% (39)	35% (67)	26% (52)

One notes a decline in the number of awards in each category but an improvement in the funding rate for underrepresented minorities. While funding rates for both All and Women declined from the previous year, the funding rate for Women was higher than the funding rate for All in FY 2008.

NSF also tracks award data for the Research in Undergraduate Institutions program (RUI) which is one measure of institutional diversity. PIs from non-PhD granting institutions are eligible to submit proposals with an RUI designation as are PIs from PhD granting institutions, if the PI's department does not have a doctoral program and meets certain additional requirements. As above, PIs eligible to submit under RUI may choose not to do so; hence the data cannot be understood to represent fully and accurately the funding rate for PIs from non-PhD granting institutions.

RUI/FY 2006	**RUI/FY 2007**	**RUI/FY 2008**
24% (17)	27% (17)	20% (15)

The significant drop in funding rate is due to a slight decrease in awards made and a sizable increase in proposals received.

Support of graduate students, post-docs and junior researchers

NSF collects data on graduate student stipend support, postdoctoral stipend support and also the number of such individuals supported on NSF awards. The dollar amount reported below is the total spending on stipends in a given category and the number in parenthesis is the total number of individuals supported. The dollar amounts are stipends only and do not reflect fringe benefits, tuition, and indirect costs. Please note that since individuals may receive differing amounts of support, and be supported for differing lengths of time on different awards, no inference can be made from the data reported here about full time equivalent (FTE) number of individuals supported.

Funding	**FY 2006**	**FY 2007**	**FY 2008**
Graduate student	$26.60M (1941)	$27.76M (2133)	$27.21M (2054)
Post-doc	$12.22M (318)	$13.20M (351)	$15.01M (368)

One notes an increase in total support for graduate students and post-docs of over $1M in a relatively flat budget year. Post-doc spending and head counts improved relative to those for graduate students.

A succinct way to report on support for junior researchers, and to put such support in context, is via a table of funding rates on research awards by PhD age:

FY 2008

Years past degree	Awards	Proposals	Funding Rate
1-5	117	399	27%
6-10	126	459	27%
11-15	98	309	32%
16-20	94	281	33%
21-25	62	184	34%
26-30	58	141	41%
31-35	43	129	33%
36-40	26	88	30%
41-45	16	31	52%
>45	5	15	33%

FY 2007

Years past degree	Awards	Proposals	Funding Rate
1-5	129	440	29%
6-10	156	489	32%
11-15	114	318	36%
16-20	89	264	34%
21-25	81	200	41%
26-30	67	176	38%
31-35	55	117	47%
36-40	37	92	40%
41-45	13	34	38%
>45	5	21	24%

FY 2006

Years past degree	Awards	Proposals	Funding Rate
1-5	110	421	26%
6-10	150	547	27%
11-15	92	290	32%
16-20	87	268	32%
21-25	67	195	34%
26-30	51	132	39%
31-35	45	113	40%
36-40	33	87	38%
41-45	10	27	37%
>45	3	17	18%

One notes a decrease in number of awards made and a decrease in the funding rate for all but the most senior researchers as defined, say, as those researchers more that 25 years past the PhD. On the other hand, of the 678 awards made, 243, or roughly 36% of the total, were made to junior researchers within 10 years of the PhD. However, funding rates for these researchers are below the overall funding rate of 31% for the division while funding rates for more senior researchers are above that figure.