CORE QUESTIONS and REPORT TEMPLATE for FY 2006 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2006 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2006. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at <www.inside.nsf.gov/od/oia/cov>.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the results generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals.

Many of the Core Questions are derived from NSF performance goals and apply to the portfolio of activities represented in the program(s) under review. The program(s) under review may include several subactivities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the subactivities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may choose to add questions relevant to the activities under review. NSF staff should work with the COV members in advance of the meeting to provide them with the report template, organized background materials, and to identify questions/goals that apply to the program(s) under review.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in two primary areas: (A) the integrity and efficiency of the ***processes*** related to proposal review; and (B) the quality of the ***results*** of NSF's investments that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order to determine the likelihood that the portfolio will lead to the desired results in the future. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. *COV reports should not contain confidential material or specific information about declined proposals.* Discussions leading to answers for Part B of the Core Questions will involve study of non-confidential material such as results of NSF-funded projects. The reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements, and are made available to the public. Since material from COV reports is used in NSF performance reports, the COV report may be subject to an audit.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions. For past COV reports, please see http://www.nsf.gov/od/oia/activities/cov/covs.jsp.

FY 2006 REPORT TEMPLATE for
NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: March 6 and 7
Program/Cluster/Section: CTS
Division: CTS
Directorate: Engineering
Number of actions reviewed: Awards: 48 Declinations: 24 Other:
Total number of actions within Program/Cluster/Division during period under review: Awards: 491 Declinations: 2753 Other: Over the three fiscal years of interest, 2003, 2004, 2005, CTS made 491 new research grant awards, 66 new CAREER awards, and 116 new GOALI awards.
Manner in which reviewed actions were selected: Nine jackets for each of the eight programs were randomly selected by the Division Director and additional jackets were requested for review by COV members while at the NSF.

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.

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[1]
1. Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) Comments: As of fiscal year 2005, all program elements within the CTS shifted to using many more panels for the merit review of competitively funded proposals. NSF review panels	Yes

[1] If "Not Applicable" please explain why in the "Comments" section.

typically are composed of nine panelists and each proposal is reviewed in advance by four of the panelists. The resulting panel recommendation is most often a well-considered recommendation by the peer community regarding the quality of the proposed work. The panel review mechanism assures timely reviews, decisions, and feedback to PIs. Given the large number of proposals and the importance of keeping dwell time as low as possible, utilizing panel reviews is appropriate. Note that the time period spanned the transition from mail reviews to panel reviews. Both review mechanisms were deemed to have been used appropriately. We note that the 2003 COV had recommended the greater use of panel reviews and we commend the Division Director and Program Managers for making this transition.	
2. Is the review process efficient and effective? Comments: The panel review mechanism is efficient and for the most part, effective but the system as it exists is not perfect. Panel sessions have the advantage of promoting a dialog about proposals among reviewers, allowing substantive debates regarding the intellectual merit of the proposal, as well as serious consideration of the broader impacts of the work. The panel format also has the potential to be more favorable to interdisciplinary research since panelists from multiple related disciplines may be present. However, real concern was expressed that panel recommendations are sometimes perceived as being random. This may be due to the inherent generalist nature of panel reviewers in contrast to mail-based reviewers who had expertise aligned with an individual proposal's subject matter. Anecdotally, some resubmissions have not received consistent reviews although there was no evidence of this in the sample proposals. Some suggested mechanisms to be considered to address these concerns include: • Utilize a combination of ad-hoc mail reviews by experts along with panel reviewers to assure the viewpoints of experts are considered by the panels. • To increase continuity of panel recommendations, the CTS could consider an NIH-like model where panelists make a commitment to serve as a panelist for three years and each panel would then consist of members who would staggered and rotated (e.g. 1/3 new, 2/3 retained). While the panel review mechanism seems an efficient process for reviewing proposals, it may have been a factor that led to an increase in the number of proposals received by CTS. Between FY 2004 and FY2005, the number of proposals submitted to CTS increased from 966 to 1448 proposals, a nearly 50% increase. It is speculated that the increase could be the result of the fixed deadlines for proposal submission coupled with the prompt turnaround of decisions and feedback but this was not studied. We presume that the number of submissions will stabilize as the panel review process and submission windows are utilized consistently by CTS, but this needs to be watched carefully.	Yes
3. Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's	Yes

recommendation? Comments: For the most part, yes, reviewers did provide sufficient information to back up their recommendations, but this is highly dependent upon individual reviewers. However, of the proposals reviewed for this COV, rather few (less than 5%) of the reviewers provided insufficient information to the PI to explain the reviewer's recommendation.	
4. Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation? Comments: The COV believes that the panel summaries are thoughtfully crafted and provide useful information to the PI(s). Most notably, the panel summaries do a good job of synthesizing any disparate opinions among the individual reviewers and reflecting the consensus of the panel. The panel summaries are generally effective in providing guidance to PIs who wish to improve their proposals before resubmission. The COV expressed some concern that the level of detail provided under broader impacts was quite variable, and it is not clear that all reviewers fully understand and appreciate what constitutes the broader impact merit review criterion. This is addressed in more detail in A.2.	Yes
5. Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation? Comments: The program directors all thoroughly documented their decisions, and their decisions reflected the consensus of the mail reviews and/or panel reviews well. It is of concern that proposals which are highly recommended for funding are not being awarded. The COV applauded that fact that the context statements were candid about the tight budget constraints and the need to maintain programmatic balance in such lean funding times in the case of many of these proposals. However, this points to the ongoing problem of inadequate funding in the Engineering budget. The energy and creativity of the community far exceeds the capacity of the CTS budget.	Yes
6. Is the time to decision appropriate? Comments: The COV was impressed with the low dwell times overall in CTS (~75% in the 0-6 month window). This is particularly remarkable given the large increase in the number of proposals that has occurred over the last few years. It was noted that 1415 (Particulate and Multiphase Processes) had a significant percentage of proposals that had a dwell time over 12 months, although it was stated that this may be due to the desire to fund proposals in the following fiscal year. The COV also noted that 1406 (Thermal Transport and Thermal Processing) also had an increase in the dwell time in FY 05.	Yes

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

NSF and CTS in particular are exemplars in holding to a rigorous standard in conducting merit review processes.

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[2]
1. Have the individual reviews (either mail or panel) addressed both merit review criteria? Comments: Yes, the individual reviews consistently addressed both merit review criteria. Whereas all reviewers evaluated the intellectual merit of the proposed work using consistent measures, there was tremendous variability in application of the "broader impacts" criterion. Even in reviews of CAREER proposals, for which reviewers are explicitly instructed to evaluate the educational component and societal impact of the proposed work, broader impacts were not consistently considered. Examination of several (4) CAREER proposals, both funded and declined, reveals that roughly 1/3 of the reviewers provided a thoughtful review, roughly 1/3 mentioned the educational impacts only in passing, and roughly 1/3 either ignored the criterion completely or simply commented on the importance of the research. Such an analysis is more appropriate for the intellectual merit review. Reviews of core program proposals were substantially more scattered, with the majority of reviewers focusing on the broad "need" for research in a particular area, and others simply stating the obvious – that the proposed work would train students. Very few reviewers of core proposals actually provided a review of the educational or societal impacts. One proposal did not address broader impacts, which is directly counter to instructions in the NSF Grant Proposal Guide, yet 4 of the 7 reviewers commented on the "broader impact" of the research by again commenting on the need for the underlying science. Such inconsistency in the application of the broader impact criterion is fundamentally unfair to the proposers and raises real questions as to the value of this criterion as an evaluative tool. Similar criticism was voiced in the 2003 COV report but little change is apparent. It is recommended that over the next three year period this issue be monitored and	Yes

[2] In "Not Applicable" please explain why in the "Comments" section.

analyzed carefully in CAREER proposals and that NSF either provide explicit instructions to all reviewers as part of the review process and examine reviews for adherence, or eliminate this criterion in all but broad educational programs such as CAREER and Center proposals.	
2. Have the panel summaries addressed both merit review criteria? Comments: All the panel summaries inspected addressed both merit review criteria, although application of the "broader impact" criterion was more uniform in the panel summaries than in individual reviews. Here too some panel summaries focused on the importance of the research rather than the broader impact of the activity as defined in the GPG.	Yes
3. Have the *review analyses* (Form 7s) addressed both merit review criteria? Comments: Yes – the jackets included a review analysis by the Program Director that addressed both criteria. This was the case even for a few cases, particularly from FY 02, wherein the panel review included a discussion of "broader impacts" focused only on the relevance of the research to the community at large.	Yes

4. Additional comments with respect to implementation of NSF's merit review criteria:

Inconsistent application of the "broader impacts" criterion remains a problem. NSF needs to either take additional steps to ensure consistency in application of this criterion across all programs, or rethink the use of this criterion. Perhaps, it would be better to emphasize this criterion more heavily for programs that focus on the integration of research and education (such as CAREER, IGERT, and NIRT) and to weight its application more appropriately for other types of proposals.

Questions regarding the weighting of the "broader impact" criterion in reviews of core (unsolicited) proposals also need to be addressed by NSF. By moving to the panel review system for core proposals, there is concern that many proposals will be reviewed by non-experts, causing the reviewer to place disproportionate emphasis on the broader impact criterion, since that is more easily understood by the non-expert. Similarly, reviewers of core proposals who were expert in the subject and familiar with the work of the proposer's group appeared more likely to pay less attention to the "broader impact" criterion.

Reviews of core program renewal proposals were inconsistent, with some reviewers carefully evaluating the merits of the proposal as if it were a new stand-alone submission while other reviewers simply commented on the past track record of the group as a measure of likely future success. NSF should consider providing clear guidelines for evaluation of renewal proposals.

In reviewing NSF award statistics across CTS, two challenges are apparent. First, there needs to be a mechanism for reducing the number of proposals received by NSF. Second, PIs could be given better guidance on whether a resubmission is warranted; to do this, PIs would need some assurance that resubmission of a competitive proposal would be reviewed in the context of it being a solid effort that has been improved.

It is therefore suggested that NSF or CTS consider implementing a limited system to provide better panel review of resubmitted proposals, particularly for programs such as CAREER. This could be accomplished by establishing panels that include a mix of new reviewers and reviewers who have committed to spending 3 years on the same CAREER panel, thus providing some institutional memory when a proposal is revised and resubmitted. This could be accomplished by requiring CAREER recipients to serve on such panels beginning a few years after their grant has started. It is also recommended that panels be asked to make firm recommendations to some PIs that a particular proposal not be resubmitted. This will help encourage the investigator to develop a new idea for the next submission.

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**[3]
1. Did the program make use of an adequate number of reviewers? Comments: Of 72 randomly selected jackets, the number of reviewers for each proposal ranged from 3 to 8 and averaged 4.6. Among all the jackets reviewed few (~12%) had less than four reviewers. Four reviewers seemed to be the right number to provide sufficient expertise and diversity. In some cases the program officer requested additional reviews.	Yes
2. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The expertise of the reviewers was found to be appropriate. For example in 1401 (a chemically oriented program) of nine randomly selected jackets with 47 completed reviews, all but 2 were chemical engineers or chemists, and most had done work relevant to the proposal. Some of the selected reviewers were recommended by the PI. This finding was deemed representative of other programs.	Yes
3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups?[4]	No

[3] If "Not Applicable" please explain why in the "Comments" section.
[4] Please note that less than 35 percent of reviewers report their demographics last fiscal year, so the data may be limited.

Comments: Interestingly, for one program from the nine jackets selected at random there was disproportionate representation by reviewers from the midwest and east coast. Of 9 randomly selected jackets and 47 reviewers, 18 were from the midwest, 15 from the east coast, 10 from the south (including southwest) and 4 from the west coast. However, the overall statistics for CTS do NOT suggest geographical biasing of the reviewers. Similarly a compilation of the statistics for gender dispersion amongst reviewers would also be worth tracking. A predominance of the reviewers were from larger institutions. While representation by women closely matched that of the community, representation by minorities did not appear to be consistent with the community of potential reviewers. In fact, only a couple of the reviewers were recognized as ethnic minorities. Of the 47 reviewers, 8 (or 17%) were female.	
4. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Yes.	Insufficient Information
5. Additional comments on reviewer selection: In concurrence with the 2003 COV report we recommend that CTS staff continue to promote the recruitment of highly qualified reviewers from industry and national laboratories in order raise the numbers of women and minorities involved in the process. Although in 1407 (Combustion and Plasma Systems) good numbers (~20%) of industrial and national lab personnel were involved in the reviewing process (based on the jackets reviewed), for some programs the number was very small (close to zero) and in still other programs it was only about 10%. Efforts to increase these numbers should be encouraged.	

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[5], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program.	Appropriate

[5] If "Not Appropriate" please explain why in the "Comments" section.

The overall quality of the research and educational projects is very high. Across all programs in CTS, awards have gone to those who have presented the highest quality research proposals. In many cases the faculty who have received funding also are well known and successful in their fields. For instance some PIs who have been supported were noted to have had substantial funding from a variety of agencies. At the same time the program managers are to be credited for their efforts to provide support for CAREER grants for those who are just entering their fields. In the event of a proposal with excellent recommendations with perhaps one "very good", CTS program managers might consider sending the criticisms to the PI for rebuttal. This sort of procedure can help make a better decision.	
2. Are awards appropriate in size and duration for the scope of the projects? Unsolicited proposals are frequently reduced in scope and in dollar value due to budget constraints. This has meant deletion of summer support for the PI, postponement of the purchase of a piece of equipment, a reduction in the number of graduate students that can be supported, and then a reduction in the overall scope of the project. For example, one of the jackets that was examined had both an experimental and a theoretical component, but in this case with the budget reduction, the theoretical component had to be dropped. A goal should be set to increase the level of support derived for the average CTS grant. It was the consensus opinion of the COV that this is as important a problem (or more so) than the problem of success rates.	Inappropriate
3. Does the program portfolio have an appropriate balance of: Innovative/high-risk projects?[6] Funding of innovative high risk projects could be increased. Greater use of SGER awards is one possibility. If we want to be "on the cutting edge" we must recognize that some of the risky research that is funded will fail. To increase the use of SGERs, Program Directors should be reassured by management that they will not suffer if they fund a risky proposal that subsequently fails. We are pleased to see that this activity will be enhanced by the formation of the Emerging Frontiers in Research & Innovation program.	Inappropriate
4. Does the program portfolio have an appropriate balance of: multidisciplinary projects? There were no overtly multidisciplinary grants in the random sample that was examined. One of 9 random jackets was a CAREER proposal that was funded and in which the proposed work involved colleagues from other disciplines. However, it was the consensus opinion of the COV that not enough data was in hand to properly evaluate this subject. We do recommend	No data available

[6] For examples and concepts of high risk and innovation, please see Appendix III, p. 66 of the Report of the Advisory Committee for GPRA Performance Assessment, available at <www.nsf.gov/about/performance/acgpa/reports.jsp>.

that this be studied, statistics compiled and that this be a subject of presentation by the PDs before the next COV.	
5. Does the program portfolio have an appropriate balance of: • Funding for centers, groups and awards to individuals? Comments: Unknown	No data available
6. Does the program portfolio have an appropriate balance of: • Awards to new investigators? We find that one Program Director tries to maintain CAREER acceptances at about 33 percent, but another funded only 5 of 33 applicants. Although new PI success rates overall were determined to be low compared to more senior proposers, the rate of funding for CAREER grants across CTS were above average. This is to be commended because it balances the effects of less seniority and stature early in a person's career.	Appropriate
7. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? A review of the multitude of funded projects appears to have a broad geographical distribution including Puerto Rico and Hawaii. The distribution (as expected) reflects the geographical concentration of major universities. The funding rate listed by state reveals a very reasonable distribution.	Appropriate
8. Does the program portfolio have an appropriate balance of: • Institutional types? There appears to be a broad diversity of institutions. It appears that non-PhD granting programs may be at a significant disadvantage in obtaining funding. There are obvious reasons for this relative to the review process and the inability to compete with large PhD granting institutions. CTS and NSF should be (and probably are) cognizant of the problem and should work to involve these institutions in the process as they are an important element of engineering and scientific education. The MRI program of NSF is designed to provide for this specific problem. The division is encouraged to be involved and to take advantage of that program as many of these institutions are important feeder institutions for the major graduate programs.	Appropriate
9. Does the program portfolio have an appropriate balance of: • Projects that integrate research and education? The grant proposals have sections that discuss broader impact which also relate or could be related to educational impacts including educational outreach projects. The	Appropriate

CAREER proposals have required educational statements and comprise the important grants which more clearly integrate research and education. The CTS division has noted emphasis on maintaining CAREER awards even with budget pressures. The review panel believes the division has appropriately addressed this issue. A number of monetary awards have been observed in support of conferences, travel funds and workshops. This is an important educational component supported by the division. The discussion of educational and outreach parts of the proposal review involved with the broader impacts is often dealt with in a cursory fashion if even noted at all. The proposals often discussed the educational impact as an afterthought.	
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity and of emerging opportunities? The division has supported projects from non-engineering disciplines (e.g. chemistry, biological sciences, and physics). A basic concern was noted where the physical and biological science disciplines within NSF may not support engineering disciplines within their specific technology areas to the same degree. For those proposals which have a truly multidisciplinary approach that deserve funding, a mechanism should be in place where the engineering divisions and the scientific divisions can share costs.	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups? Overall, NSF has had a strong commitment to diversity and the division management reflects that commitment. The review process and panel members are chosen to involve a diverse slate of participants. The CTS data on underrepresented groups show that women and minorities are experiencing success rates (female 19-22%, minority 10-21%) that are comparable to or higher than those for majority proposers. The panel notes that some program directors are making an effort to increase the number of proposals from women and minorities by hosting workshops on proposal preparation and submission for faculty from such groups. All due effort should continue to be made to develop the research capacity of minority and women faculty. *The committee felt that it was hard to know what is deemed appropriate.	Appropriate*
12. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports. One key mission of CTS and of NSF at large is in providing the support and expertise for funding graduate level research to assure the education of our future engineers and scientists. This is mission number one and necessary to maintain the competitive technology edge the country has enjoyed over the last several decades. The CTS programs excel in these areas and have worked hard to maximize them despite reduced funding during the past three years.	Appropriate

The projects noted in the various areas of the CTS fit into the areas of emerging engineering and technology including those specifically related to nanotechnology, biotechnology, homeland security. The specific areas of the division appear to encourage project support in emerging technology and breakthrough "higher risk" projects.	

13. Additional comments on the quality of the projects or the balance of the portfolio:

The quality of the projects is very high. The review process has become much more competitive in the past several years at least partly due to the limited funds available and the large increase in proposals. The stagnant and reduced funding in some cases has not allowed for the diversity in projects that might be desired. When targeted areas of R & D are the result of a "mandate" in times such as these, which are marked by reduced budgets, or low growth, then fencing of funds for these programs takes funding away from other needed and important areas of research.

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

1. Management of the program.
Comments:

There are management issues that spring from inadequacy of the whole of Engineering's budget. However, the operational efficiency is quite good when considered in the light of this problem.

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

The following observation varies by program, but for many CTS programs, it was difficult to be responsive to emerging opportunities in FY2005 because of the combined effect of smallish budgets and paring down of out-year commitments (reducing the mortgages). One program (1415) had zero standard-size awards (e.g. at the level of $90K/yr) from unsolicited proposals in FY2005. But in years when the budgets constraints were less severe, the CTS portfolio exhibited responsiveness to emerging opportunities (e.g. the emergence of the biocatalysis, nanotechnology and investments in ITR collaborations to leverage co-funding).

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

The CTS staff has made a conscientious effort to balance the portfolio across a broad range of topics while retaining the flexibility to place emphasis in sub-areas that reflect timeliness. CTS is commended for operating with a mix of permanent staff and rotators to bring in fresh ideas from the outside.

The portfolio also includes a significant fraction of PIs who are outside of Engineering (e.g. physicists and chemists) adding commendable diversity to the portfolio. To the extent that the ENG directorate is perceived as supporting engineering research when the budget is requested, either the budget process

should be modified or controls placed to insure that high-level policy decisions (re: relative amounts of support for each discipline) are respected.

4. Additional comments on program management:

In the merger of CTS with BES, there will be an aggregation effect that could have the unintended consequence of diminishing important components of current programs. At the same time the COV concurs that a realignment of the directorate's programs was timely and since it is aimed at making Engineering more flexible and effective in promoting innovation, the goals driving the change are considered positive.

PART 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."
Comments:

Over the three fiscal years of interest, 2003, 2004, 2005, CTS made 491 new research grant awards, 66 new CAREER awards, and 116 new GOALI awards. Overall, the number of new research grants, continuing increments and supplements was 1151. Of these various proposals, 593 proposals were received from members of under-represented groups. These numbers are impressive measures of the number of principal investigators who were impacted by support from the CTS division. In addition to principal investigators, the grants supported a number of other people: 248 post-doctoral students (223 in the previous three years), 2148 graduate students (1742 in the previous three years) and 475 undergraduates (315 in the previous three years).

While the number of grants have been maintained or increased relative to the previous three years, the funding per grant has decreased. Low funding rates per grant indicate failure of budgets to meet demand for support. The number of proposals received is considered to be one measure of intellectual activity in a field. So long as the students are finding jobs, it is also an indicator of the need to educate people in these areas to meet workforce demands. Therefore, at given funding levels, the NSF is not meeting inherent needs for workforce development in this area. Funding per grant should be more closely aligned with overall NSF averages.

International Competitiveness: Excellent selection of leading edge topics for funding maintains competitive edge of USA. Strongest aspect of the programs is the intelligent and informed guidance of intellectual disciplinary development through consistent selection of good research directions for funding. Students supported by NSF grants generally receive excellent educations, making them competitive with the best in the world. The number of students being educated in Engineering, CTS being typical, does not, however, compare well with the numbers in other countries. This is a strong function of the funding level.
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Global Engagement: Researchers supported by NSF grants customarily make themselves aware of developments in their fields worldwide, as evidenced by the wide-ranging and thorough list of references in their proposals. Researchers regularly attend international conferences and interact with international colleagues. The engagement of international students who return to their home countries establishes strong ties between USA researchers and leading research institutions internationally.

Summary: CTS is supporting the development of a diverse, internationally competitive, globally engaged workforce to the extent allowed by its budget.

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

The intellectual foundations on which CTS rests are drawn ultimately from chemistry and physics, and they involve a distinctive combination of atomistic and continuum concepts. This mix of ideas varies between CTS programs, with Catalysis and Biocatalysis Program at the atomistic end of the spectrum and Fluid Dynamics and Hydraulics at the continuum end, and the programs involving processing and transport lying between. But, in all of the programs there is an increasingly strong cross-disciplinary

weave that makes them important and relevant to a wide range of engineering applications and scientific topics such as atmospheric science, oceanography, geophysics, biology, and medicine. Increasing emphasis on nano-scale engineering has shifted the center more towards ideas deriving from atomistic issues, but some of the most interesting investigations still involve continuum concepts. Thus, the subject of multi-scale physics, which currently excites researchers in many disciplines, falls squarely in the realm of CTS. Concepts and strategies from continuum processing and transport often lead to new, cost-effective methods of forming nano-structured materials. Conversely, implementation of nano-structured materials such as particles in fluids can produce new and useful bulk behavior, such as increased transport of heat in fluids and remarkable decreased transport of heat in insulating solids (aerogels).

Interesting ideas developed or proposed in the current three years are exemplified by:

1. Flow structure interaction and bed erosion by vortices. Flow structures such as pilings shed vortices that create significant and characteristic erosion patterns in the flow bed downstream. Extensive knowledge of the dynamics of eddy-shedding and vortex formation by bluff bodies, combined with experimental investigation of three-dimensional shedding in laboratory scale experiments are leading to new insights and methods of controlling erosion.

2. New polymer membrane materials for separating gases. Membranes constructed from safe, inexpensive polymers offer a new method of separating hydrogen and isolating it from contaminants. "In a phenomenon that at first seems counterintuitive, larger gas molecules like CO_2, and polar molecules, pass through the new film, while the much smaller hydrogen molecules stay behind."

3. Liquid core capsules via interfacial free-radical, alternating co polymerization. A new polymerization approach has been developed that allows liquid-core capsules to be synthesized without the need for sacrificial cores. These capsules have wide-ranging applications in health care, including delivery of drugs, enzymes and DNA for gene therapy.

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."
Comments:

Computational tools to describe, model, and predict complex processes are a common outcome of investigations supported by CTS. Two exemplary tools are:

1. Turbulence simulation. Long a grand challenge problem in physics, our understanding of turbulent fluid motion has taken great strides by virtue of being able to compute realistic turbulent fields using direct numerical simulations. These simulations are constantly being refined to accommodate flows with higher Reynolds number and more complex physical geometry. Likewise, increasing physical complexity, such as non-Newtonian behavior in dilute, drag-reducing polymer solutions and complex bounding surfaces, are being incorporated into the numerical simulations. For applications in the sciences and engineering, approximate computational methods/models of turbulence are being developed to permit simulation at Reynolds numbers and scales beyond those accessible by direct numerical simulation. These "large eddy solutions" compute the large energy containing eddies and statistically model the small eddies. They are at the frontier of solving the intellectual issues in turbulence.

2. Molecular dynamics integrated with finite element methods. . At the nano scale, physical systems of interest may involve thousands or even tens of thousands of molecules.

Atomic/molecular effects may be essential aspects of such systems, but the number of molecules far exceeds the number that can be computed by molecular dynamics simulation. This problem is of the key issues in multi-scale physics and it is squarely centered in CTS. A very interesting recent development allows atomistic force models to be incorporated in such a way that they fit naturally in finite element models. The latter are widely used in computational simulation of continuum systems.

Instrumental tools for physical experimentation are developed as natural adjuncts to many investigations supported by CTS. An example of an exploratory investigation being conducted expressly to evaluate a new idea for an instrument is:

Magnetic Resonance Velocimetry. MRI is capable of mapping three-dimensional vector flow fields in flows that are opaque and otherwise inaccessible to measurement probes. This research seeks to develop MRI for experimental fluid mechanics and determine limits of applicability.

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."[7]

Comments:

New organization in the Engineering Directorate separates intellectual groupings and crosscutting areas. The goals of the reorganization are to provide a new mechanism to pursue frontier research by introducing a new division specifically for this purpose. It shall enable research at the intersection of diverse disciplines and shall promote more flexibility. The reorganization is too new to judge the extent to which these goals will be achieved, but it has been done in a rational and promising manner. We applaud the Directorate for undertaking this reorganization.

[7] For examples and further detail on the Organizational Excellence Goal, please refer to pp. 19-21 of NSF's Strategic Plan, FY 2003-2008, at <http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf04201>.

PART C. Other Topics

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

Windows for submission are a reasonable approach to the problem of markedly increasing proposal pressure within CTS. However, with the windows, multiple proposals can be submitted at each window by replying to the multiple solicitations. Thus a PI may still send in multiple proposals in both categories (solicited and unsolicited). To understand the impact of submission windows we hope that the Directorate as a whole and the new programs will collect data that will allow for a full analysis during the next three year period.

Dwell times to a decision are now within six months for over 70% of submissions. One would like to see more uniformity in proposal review dwell times across the programs in CTS. For example, in both 1415 and 1406 dwell times varied markedly in 2004 and 2005.

The CTS COV panel would suggest that some consideration be given to a plan that would balance the need for investigators to receive fair and timely reviews of their proposals against the tendency of many investigators to make multiple and repeated submissions of their proposals. Clearly this is a problem that needs to be addressed with all due sensitivity to the needs of all groups from pretenured faculty to women and minorities, but we feel that this can be accomplished.

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.

The Engineering Directorate as a whole and CTS in particular has done a superb job of addressing the needs of our nation and of the scientific community that it serves. One of the hallmarks of CTS has been the extent to which the community has been involved in setting goals and managing its intellectual portfolio. Reorganizing the Directorate to streamline the programs and to align them more functionally with the dynamics of engineering today is a very good idea; we hope that the level of involvement of the academic community will be maintained in the new structure.

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

As solicitations begin to rely increasingly on limited submissions (e.g. in the IGERT and NIRT programs to take two) the simple approach of treating every institution identically with the same number of submissions should be reconsidered. If a faculty team is at an institution with fewer total faculty members or with fewer research active faculty, then a submission maximum of say four preproposals may not pose a serious limitation to having good ideas be considered. On the other hand, very good faculty members with very good ideas who happen to be appointed at large institutions with high levels of research activity across the spectrum from engineering to social and behavioral sciences are limited by the same submission ceiling. This significantly disadvantages faculty members at large research universities. If the goal is to limit the total numbers of submissions, then perhaps some consideration of this can be done in such a fashion that does not disadvantage these faculty at large and successful institutions or those at smaller institutions.

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

Overall, Engineering and CTS perhaps especially are quite open to accepting and even funding excellent proposals from our colleagues in the physical sciences. This is commendable and should

be continued because it serves the overall mission of the Foundation and our nation well. At the same time, however, the COV is concerned that with mounting pressure on an already stressed budget decisions to fund outside of the core disciplines, although commendable, will reduce funding available for those doing engineering science and educating engineers. We urge program directors to consider all aspects of this practice and suggest that in theses times this be done with the utmost of care. However, rather than curtailing funding for non-engineers who are doing good engineering science, we would hope that the Foundation would seek to reward CTS and other programs in Engineering for their ecumenical attitudes by providing more resources for this to continue.

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

The COV considered the use of the e-Jacket system to have been successful and very helpful since most of the jackets for each CTS program were read and reviewed *prior* to the meeting at the NSF.

TO make the COV review process even more organizationally effective, we respectfully suggest the following:

1. The morning session for the COV committee put on by the AD, the DD and the PDs should begin with a reprise of suggestions made by the previous COV and the progress made toward these suggestions. (Suggestions that were not implemented should be discussed also.)
2. The COV committee members should be given a clear explanation of how their work ties to that of the Eng. Ad. Com. and how management utilizes input and mandates change.
3. The programmatic content of the morning sessions was very good but could be even more tightly focused on the data that is needed by the COV to complete its report. Some time should be set aside for private one-on-one discussions with the PDs and the COV so that any issues that they wish to raise may be done in strict confidence.
4. The ratio of funded to unfunded proposal jackets should move from 2:1 to1:1. We also recommend increasing the total number of jackets per program from 9 to 12.
5. Some of the questions in section A of the report template are worded in such a fashion that it is not clear that they can be answered accurately (in a statistically valid manner) by the COV. Although much data is supplied ahead of time and at the time of the meeting, one wonders why for example data from the EIS was provided for example on success rates when it is considered to be invalid even by the NSF staff and cannot be quoted. We acknowledge that the staff members are ready and able to gather data and to supply information at any time in the process of completing the report. However, it would be helpful to the process for the proper "first level of analysis" data necessary to answer each question be prepared in advance and keyed to each question. If the COV committee finds this to be inadequate and if they want to go deeper, to a second level of analysis, then they would have the time to do so.

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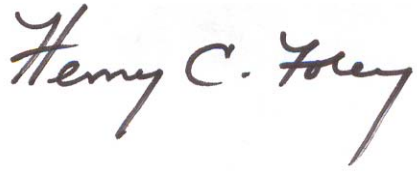

For the Chemical and Transport Systems Division 2006 Committee of Visitors
Henry C. Foley
CTS COV 06 Chair