

**CORE QUESTIONS and REPORT TEMPLATE
for
FY 2009 NSF COMMITTEE OF VISITOR (COV) REVIEWS**

Guidance to NSF Staff: This document includes the FY 2009 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2009. 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.

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

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 2009 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)**

The table below should be completed by program staff.

Date of COV: July 13-14, 2009
Program/Cluster/Section: All Programs
Division: CBET
Directorate: ENG
Number of actions reviewed: Awards: 72 Declinations: 66 Other: 6
Total number of actions within Program/Cluster/Division during period under review: Awards: 1412 Declinations: 7310 Other: 204
Manner in which reviewed actions were selected: <p>CBET has 4 clusters. Each cluster will have 36 jackets pre-selected for sampling. The jackets will be comprised of 2 categories (Awards and Non-Awards) across the 3 Fiscal Years (FY 06-08). Within the categories, 3 types will also be sampled: CAREER, unsolicited and other. The jackets will be downloaded by CBET staff to cover FY 06-08. CBET staff will remove from the listing: Withdrawn proposals, special initiatives/trans-directorate programs, and IPA agreements. The jackets will then be sorted in the following order: by cluster, by FY, by type, by award status, by jacket number (standardized). After sorting as described above, the inverse of the jacket ID number was taken and displayed in scientific notation with 9 significant decimal digits. The first 6 numbers were removed. The jackets were then ordered from lowest to highest remaining digits, and the 2 jackets with the lowest resulting numbers were selected from the sample. This yields standardized, random stratification of the 36 sample jackets per cluster for a total of 144 jackets across the 4 clusters.</p>

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

<p>QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS</p>	<p>YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE¹</p>
<p>1. Are the review methods (for example, panel, ad hoc, site visits) appropriate?</p> <p>Comments:</p> <p>The use of mail reviews and panel reviews seems appropriate for CAREER and unsolicited proposals. Panels force the reviewers to meet deadlines, allow the programs to make timely decisions and can bring uniformity to the deliberations of a grouping of proposals. Further, repetition of some panel members can ensure a level of corporate memory in how a particular program reaches funding recommendations. Alternatives to an assembled panel at NSF should be considered, such as teleconferences or other internet-based group meetings to save on travel and travel time, and still allow the panel participants to interact.</p> <p>For panel-based reviews, a minimum of three reviews were provided, however, some of the jackets contained examples in which the three reviews were not as thorough as desired, and as required, for a fair assessment. The Division is encouraged to acquire additional documentation from the original reviewer or possibly an additional review from an area expert, as necessary, for all panel reports to be as informative as possible. More generally the COV encourages thorough reviews, since these help inform the funding decisions and help investigators improve their proposals.</p> <p>The review method on SGER grants and workshops varies based on the level of funding and the alignment with the program strategies. Mail reviews, internal reviews or program officer judgments alone are used in reaching funding</p>	<p>YES</p>

¹ If “Not Applicable” please explain why in the “Comments” section.

<p>recommendations. In general, this appears appropriate as some flexibility for program officers is essential</p> <p>Please see Document "20-A.1.1 Data" in eJacket.</p>	
<p>2. Are both merit review criteria addressed</p> <p>a) In individual reviews?</p> <p>In general, the reviews and panel summaries focus on the intellectual merit. Most reviews addressed both intellectual merit and broader impacts, however, there are instances in the random sampling of the jackets where broader impact was not addressed in the individual reviews. The reviews are inconsistent in addressing broader impact, and this is despite the guidelines provided reviewers and the program officers covering it at the start of panel meetings. Some reviewers appeared to interpret the meaning of broader impact narrowly. Broader impact to the scientific community, and broader impact that is inclusive of underrepresented groups, should both play a role when evaluating whether broader impact was addressed by the proposal. There is considerable unevenness in the interpretation of this criterion in the jackets reviewed. The COV recommends the Division develop more structure for reviewing the broader impact of proposals to guide the reviews, and in turn the preparation of proposals as well.</p> <p>b) In panel summaries?</p> <p>The same remarks as above can be made for the panel summaries. That is, the summary reflected the majority of the opinions expressed by the written reviews. When the individual reviews are lacking in addressing both review criteria, the program officers should insist that the panel discussion and the panel summary more effectively address both. There were instances noted where the summary ratings did not match, or adequately reflect, the weighty criticisms in the reviews and the panel summary. In most cases, the panel summary mirrored the sense of the individual reviews and were a distillation of the individual reviews. They were generally not a verbatim repetition of the panel scribe's review.</p> <p>c) In Program Officer review analyses?</p> <p>Most of the program officer analyses mirrored the summary of the review panel. Occasionally the program officer would add to the comments on broader impact when they were severely lacking in the reviews. Additional comments focused mostly on changes to budget and period of performance.</p> <p>Comments:</p> <p>Please see assigned jackets and Program Strategies.</p>	<p>a) YES</p> <p>b) YES</p> <p>c) YES</p>

<p>3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals?</p> <p>Comments:</p> <p>Almost all reviews were constructive and the assessments insightful and logical; in a few cases were the reviews missing depth of analysis of both merit review criteria. The evaluations of the science and intellectual merit were generally good. If there was a recurrent problem, it was that there were no obvious standards for evaluating the educational component.</p> <p>In cases where the proposal was clearly not fundable, the individual reviews were on the mark but perhaps too brief to be helpful to the PI in developing and describing better research plans. Perhaps the panel discussion could spend some time addressing ways to improve this and it could be offered in the panel summary.</p> <p>Some reviewers commented that they were not qualified to review the proposal, but that the PI appeared to be knowledgeable on the subject. Some mechanism for seeking additional reviews would seem necessary in these instances. The COV is concerned that the review process does everything reasonably possible to bring well-calibrated, expert opinion into the review process. In general, academic reviewers are familiar with the standards for reviews and the meaning of the rating scales, i.e., Excellent, Very Good, etc. The limited sampling afforded by the proposals in the E-jacket pool indicates a variation between academic and industrial reviewers in applying the rating scale and additional training or guidance provided to first-time reviewers would be useful to address this variation.</p> <p>Please see assigned jackets and Program Strategies.</p>	<p>YES</p>
<p>4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)?</p> <p>Comments:</p> <p>In essentially all cases, the entire panel report, not just the summary statement, presented composites of individual views. It was difficult if impossible to tell from the summaries, which comments were individual or a consensus. The panel summaries appear to be consistent with the majority opinions of the panel. When opposing views were present in the individual reviews, the panel report represented a consensus view and did not present opposing comments, perhaps to avoid confusing the PI. Where one reviewer had particularly negative comments, such comments were generally not included in the panel review.</p>	<p>YES</p>

<p>Please see assigned jackets and Program Strategies.</p>	
<p>5. Does the documentation in the jacket provide the rationale for the award/decline decision?</p> <p>(Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.)</p> <p>Comments:</p> <p>There is generally a well documented paper trail including individual reviews, panel summary, program officer review analysis and staff diary notes. The decisions were clearly justified, and the panel summary provided the best documentation in the jacket for the award/decline decision. Reading the panel summary and individual reviews, in concert with the PI's summary of the proposal, nearly always made the reasons for the decisions quite obvious. In a few instances, the program officer would add how the program fit strategic directions and why favorably reviewed proposals were not recommended for funding.</p> <p>The justifications offered for SGER and workshop proposals relied more on how the proposals fit the program strategies.</p> <p>Proposals that were withdrawn contained diary notes summarizing the thought process. Program officers that sought help from others with greater expertise (e.g. SGER proposals) also was documented. The same can be said for proposals whose budgets were modified at the request of the program officer.</p> <p>The analysis requested of the COV would have been helped if some uniformity of the context under which the proposal was reviewed, such as panel size, number of proposals, number ranked as highly recommended, recommended, and not fund, was part of each "Review Analysis" document.</p> <p>Please see assigned jackets and Program Strategies.</p>	<p>YES</p>
<p>6. Does the documentation to PI provide the rationale for the award/decline decision?</p> <p>(Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.)</p> <p>Comments:</p> <p>In nearly all cases, the rationale for the decision was clearly stated in the information returned to the PI. Most PIs consider the panel summary to be the</p>	<p>YES</p>

<p>panel consensus and when read with the individual reviews give the PI the context for the award/decline decision. The COV found this documentation to be generally satisfactory.</p> <p>In one proposal, however, the rationale for award was less clear. In 0756567, comments made it clear that the reviewers had serious concerns about the validity of the approach as a concept as well as in practice. Furthermore, there was no educational component discussed. It was not clear to why this proposal was ranked so highly. (Presumably someone argued for funding it as a high-risk, high-payoff venture, but that was never stated in the panel summary or program officer comments.)</p> <p>Please see assigned jackets and Program Strategies.</p>	
<p>7. Is the time to decision appropriate?</p> <p>Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals.</p> <p>Comments:</p> <p>There was a 23% increase in the number of proposals submitted between 2006 and 2007. About 83% of the proposals were reviewed within 6 months of receipt from 2006-2008. In general, about the same percentages remained after 12 months.</p> <p>Rapid turn around of proposals is very important, especially for new PIs. CBET is doing well in achieving the goal of 70% turnaround in 5 months. Slippage occurred in 2008 in 4 of 16 programs. Only 1 program, 5342, had more than a few percent of proposals not addressed by 9 months (24%). There were no data to indicate why this happened.</p> <p>Please see Document "21-A.1.7 Data" in eJacket.</p>	<p>YES</p>

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

There were occasional instances when reviewing CAREER proposals that the reviewers appeared to have reasoned that although a CAREER proposal had insufficient details about the research methodology, they gave the green light to fund, with the justification that first time researchers should be given the benefit of the doubt. This is disturbing if one considers the issue of sustaining existing research and proven researchers. Such decisions might be made if the research were in close alignment with stated objectives of CBET. In such cases, it would be good to understand the rationale for such decisions explicitly.

The merit review process seems to be working well, but it is cumbersome. Some of the panels have become very large and might be more efficiently run if they were broken into subpanels around more specialized areas or combinations of interdisciplinary efforts. This might also help assure that reviewers have adequate background, expertise and interest in the topics under review. Increased use of telecon panels might also facilitate the participation of additional reviewers when needed to bring in special expertise.

It seems that in most instances the panels and the reviewers are not factoring the individual program's Program Strategy and areas of focus into the review process, at least at the level of the panel discussion. The COV recognizes that stated Program Strategies, posted on the Web, are a relatively recent innovation, one that the COV applauds. Program Strategy as a motivating tool (or to help inform the decision) seems to have been rarely invoked thus far in reaching funding decision, as reflected in a random sampling of Review Analysis documents. The extent to which Program Strategy is brought into the review process needs to be addressed at the Division level if it is to be an important component of the decision-making process.

Innovation would be encouraged if reviewers were asked to address whether or not the proposal takes on a high risk/high gain challenge. If so, guidance should be provided on how the reviewers can assess whether or not the proposer has addressed the risk. The COV encourages measures that would enable supporting high risk research if risk mitigation strategies were part of the proposed plan.

A.2 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 ²
<p>1. Did the program make use of reviewers having appropriate expertise and/or qualifications?</p> <p>Comments:</p> <p>The program strategies spell out CBETs directive to seek out reviewers that have the expertise to make quality judgments. The professional status of the reviewers is well-qualified in the area of the proposals. Many of the reviewers are known and respected in their respective fields. Those reviewers not known come from highly recognized institutions suggesting that they must also have excellent credentials. It would be helpful for the COV review, if it were feasible, to have access to a bio sketch for the reviewers. In one instance, the award appears to be based more on the expertise and credentials of the PI rather than the quality of the proposal. This does not invalidate the CBET reviewer selection process but would suggest that the reviewers should always be given clear instructions on the rules and standards governing the review process.</p> <p>Waiving reviews on SGER, conference and travel proposals seems very sensible; these can be judged quickly and easily at face value. However, it seems that some SGERs were reviewed and recommended solely by the Program Director and in other cases by more than one PD. It is understood that the principal responsibility for the review and decision in the SGER process rests with the PD who has the discretion to seek comments from other PDs. In the Proposal Summary, documenting <u>whether</u> such a second review was sought, and in the proposal jacket, recording <u>whose</u> advice was sought, might be helpful in understanding the decision. In an environment where many of the PDs are temporarily working under an IPA, it would be good for future PDs to have more details about the specific circumstances regarding a decision.</p> <p>Please see Program Strategies.</p>	<p>YES</p>

² If “Not Applicable” please explain why in the “Comments” section.

2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups?

Note: Demographic data is self reported, with only about 25% of reviewers reporting this information.

Comments:

The program strategies and demographic data would suggest that the CBET intent is to have a balanced representation in the reviewer selection process. In the reviews of the jackets, it was evident that the geographic origins of reviewers were well-balanced. While data on the distribution of qualified reviewers according to type of institution was not present, this distribution seems reasonable among the academic institutions. Some jackets were reviewed solely by faculty from RU/VH (research university/ very high research activity) institutions and one jacket was reviewed by no one from institutions with that classification. It seems important to maintain a balance in all reviews. The COV feels there should be more reviewers from government labs and industry.

From the data available, it is difficult to assess balance with respect to underrepresented groups as the status of the reviewers is unknown for a significant fraction of the population. Further, one cannot easily locate national availability estimates for the diversity of qualified reviewers. For future COV reviews, it might be useful to provide such estimates and to provide diversity information (beyond gender) for the reviewers as is done for PI's, if the COV is going to be asked to assess this point. The gender data provided shows that of the eight reviewed proposals, five received reviews by one female and the overall data shows a bias toward males in an area where there are an abundance of females, i.e. environmental area. In the CAREER awards, the preponderance of awardees are female and this is hopefully a good trend for the future.

It appears that the reviewer selection process is weights more heavily easy-to-quantify characteristics such as geography or type of institution. rather than underrepresented groups. CBET is moving in the right direction. but should review its strategies concerning underrepresented groups to see if the selection process can be improved further.

The reviewer selection process was not clearly defined, particularly as it applies to providing expertise in assessing the broader impacts review criterion. Do program directors have access to a reviewer data base that has the information needed to make a diverse choice? The program directors should be more proactive in their outreach mechanisms particularly to identify qualified reviewers among underrepresented groups. Permanent directors have a much greater knowledge of potential reviewers, particularly among underrepresented groups, than temporaries. CBET would be well served to have more programs with permanent heads.

Please see Program Strategies and Document "22-A.2.2 Data" in eJacket.

Insufficient Data to Assess

<p>3. Did the program recognize and resolve conflicts of interest when appropriate?</p> <p>Comments:</p> <p>In all the jackets reviewed, the reviewers indicated no conflict of interest. The PO should be commended for this careful attention to COI. No information was given as to how any stated conflicts may have been resolved. However, based on input to the COV, it is felt that, there is great care taken to ensure that all conflicts are resolved and that panel members have clear lines drawn regarding their participation in discussions where there may be a conflict. An assessment cannot be made in the cases in which reviews were waived. This is not to say there is any reason to expect that COI was not recognized and resolved if appropriate, but that no information on which to base an opinion was available.</p> <p>Please see assigned jackets.</p>	<p>YES</p>
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<p>4. Additional comments on reviewer selection:</p> <ol style="list-style-type: none"> 1. The award decisions are generally quite consistent with the review results, with funded projects receiving uniformly higher scores than non-awards. 2. In the only case where there is data, a CAREER proposal from an individual was declined on an earlier submission, then funded on a subsequent revised submission. The reviews in this case were constructive and the PO and CBET should be commended for providing this useful feedback mechanism for the PI. 3. In one case of a CAREER award being made, the PI had previously received SGER funding that allowed for some preliminary results to be obtained in support of the successful CAREER proposal. This is an excellent example of how a SGER should work.

A.3 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.

<p style="text-align: center;">RESULTING PORTFOLIO OF AWARDS</p>	<p style="text-align: center;">APPROPRIATE, NOT APPROPRIATE³, OR DATA NOT AVAILABLE</p>
<p>1. Overall quality of the research and/or education projects supported by the program.</p> <p>Comments:</p> <p>The overall quality of the funded proposals is very high. For the most part, proposals were funded that had an average reviewer’s evaluation of above very good and were highly recommended by the review panels. Several funded proposals (BEEH and Environmental Engineering Clusters) were rated only ‘recommended’ by the review panels. The rationale for funding proposals at the recommended level was not always articulated in the jackets, though lunches between COV and program directors clarified some of the thinking in these matters. Nor was it clear if any review panel highly recommended proposals that were not awarded or were partially funded at the expense of funding proposals in the review panel’s recommended category. An overall yearly summary of the ranking and justification of proposal funding should be prepared for each program. In addition a calibration of this information at the CBET level should be done to provide insight about the differences in processes across programs.</p> <p style="color: red;">Please see assigned jackets and Program Strategies.</p>	<p>APPROPRIATE</p>
<p>2. Does the program portfolio promote the integration of research and education?</p> <p>Comments:</p> <p>The COV believes unequivocally that the CBET Division ‘promotes’ this kind of integration; the question should be: does it ‘achieve’ the desired integration.? All the proposals contained education and research components. The strength of the integration as viewed by the panels ranged from poor to high. Educational plans typically contained similar components, e.g. new classes, participation of student and post docs in research and K-12 activities. In one case the educational plan was judged to be mediocre by the review panel. However, the panel highly recommended the proposal for funding. This suggests the integration of research and education may not be</p>	<p>APPRORIATE for CAREER Awards and variable for others</p>

³ If “Not Appropriate” please explain why in the “Comments” section.

<p>as heavily weighed as the research component. It also suggests a place for clarification and consistency across CBET. CAREER Awards integrate particularly well.</p> <p>Please see assigned jackets and Program Strategies.</p>	
<p>3. Are awards appropriate in size and duration for the scope of the projects?</p> <p>Comments:</p> <p>For the most part, the awards are not adequate in size and duration; they too small and, occasionally, of too short duration. PIs are rarely, if ever, funded at the levels requested. As a result, the funding levels are not matched to the cost to execute the projects via the scope defined in proposals. Indeed, they are often unable to meet the stated goal of supporting one graduate student, an undergraduate and some modest associated expenses, such as supplies and/or some summer salary for the PI.</p> <p>Awards to universities were longer than non-university awards. In the BEEH cluster of awards reviewed, the award size for the Disabilities and BME programs were generally lower than average. It is not clear if there is strategic decision or an anomaly.</p> <p>Please see Program Strategies and Please see Document “23-A.3.3 Data” in eJacket.</p>	<p>NOT ALWAYS</p>
<p>4. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Innovative/potentially transformative projects? <p>Comments:</p> <p>It is difficult to answer this question based on the review of a small subset of proposals. Also, the COV struggled with the question since the COV was given no direction on what is considered to be the “appropriate balance”?; Without knowing what the appropriate balance is for NSF, the group felt that there are some awards within the Division that are considered truly transformative. With these caveats, the COV believes that the Division portfolio is well balanced with innovative/potentially transformative projects. The committee also recommends that panel members address the “transformative” potential of a proposal as part of the review process.</p> <p>Please see Program Strategies and Document “24-A.3.4 Data” in eJacket.</p>	<p>APPROPRIATE</p>

<p>5. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Inter- and Multi- disciplinary projects? <p>Comments:</p> <p>All of the CBET programs participate in some type of co-funding with other CBET programs, ENG Directorate programs or NSF Programs and initiatives. Co-funding suggests, though does not confirm, some degree inter- or multidisciplinary research activities. During the past 3 years, CBET programs funds directed to co-funding activities ranged from a low of less than 5% to as high as 30%.</p> <p>At the project level, there was evidence in many (of order 50%) of the proposals of collaboration with investigators outside the PI's discipline. These appear to be appropriate balances.</p> <p>The COV recommends that metrics or some guidelines for gauging inter or multidisciplinary research activities be established.</p> <p>Please see Program Strategies and Document "25-A.3.5 Data" in eJacket.</p>	<p>APPROPRIATE</p>
<p>6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program?</p> <p>Comments:</p> <p>The predominance of proposal submissions by single investigators is reflected in the proportion of awards to single investigators. The size and in some cases the duration of the awards are too small.</p> <p>Appropriately funded multiple investigator awards, with PI's from different areas of expertise should lead to an increase in the inter and multi disciplinary nature of the research and should be encouraged.</p> <p>Two observations are noted for further study.</p> <ol style="list-style-type: none"> 1. The size of single PI awards in some programs is larger the multiple PI award, 2. Some programs in the BEEH Cluster (Disabilities and Systems and MultiScale Engineering) have lower than average award sizes. 	<p>AWARD SIZE TOO SMALL IN MOST CASES</p>

<p>Please see Program Strategies.</p>	
<p>7. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Awards to new investigators? <p>NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant.</p> <p>Comments:</p> <p>Overall, about 30% of awards go to new investigators. The COV views this as an appropriate balance. However, for programs with an award ratio for new investigators that are below the average, a review of program processes, procedures, etc. should be conducted to ascertain barriers to encouraging and awarding new investigators.</p> <p>Please see Program Strategies and Document “26-A.3.7 Data” in eJacket.</p>	<p>APPROPRIATE</p>
<p>8. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Geographical distribution of Principal Investigators? <p>Comments:</p> <p>Overall the geographical distribution of PIs seems balanced for CBET.</p> <p>Please see Program Strategies and Document “27-A.3.8 Data” in eJacket.</p>	<p>APPROPRIATE</p>
<p>9. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Institutional types? <p>Comments:</p> <p>About 95% of the awards go to academic institutions. The largest numbers</p>	<p>APPROPRIATE</p>

<p>of these awards go to the top 100 Research Institutions. This distribution appears reasonable. The remaining 5% of the awards are to businesses, state and local governments, etc.</p> <p>A breakdown of institutional types receiving awards (characterized by the Carnegie system) would be helpful for the COV to understand better the balance of institutional types.</p> <p>Please see Program Strategies and Document “28-A.3.9 Data” in eJacket.</p>	
<p>10. Does the program portfolio have an appropriate balance:</p> <ul style="list-style-type: none"> • Across disciplines and sub disciplines of the activity? <p>Comments:</p> <p>The Division shows an appropriate balance of support for disciplines that are reflective of its vision. The definition of the goals and objective by program area encourages the participation of disciplines as appropriate.</p> <p>The distribution of funds among clusters and topical areas within clusters should be reflective of emerging frontiers and national needs.</p> <p>The COV strongly encourages the continued support of specific (core) research as a foundation to its inter and multidisciplinary supported activities.</p> <p>Please see Program Strategies.</p>	<p>APPROPRIATE</p>
<p>11. Does the program portfolio have appropriate participation of underrepresented groups?</p> <p>Comments:</p> <p>The funding ratio for women and minorities appear to be approximately equal to the average funding across NSF (17%). The number of proposals received, however, is low. The number of awards to women and under represented minorities represented only 15% each of the total.</p> <p>The number of awards for persons with disability and Native American/Alaskan Natives was extremely low, consistent with the low numbers of the submissions.</p> <p>These are areas that should continue to be focal points for improvement for</p>	<p>NOT APPROPRIATE</p>

<p>CBET and NSF.</p> <p>Please see Program Strategies and Document “29-A.3.11 Data” in eJacket.</p>	
<p>12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports.</p> <p>Comments:</p> <p>CBET makes thorough and thoughtful efforts to align its awards with White House priorities, NAE Grand Challenges, NSF-wide investments, ENR Directorate themes and CBET priorities. The COV is satisfied that there is an appropriate, indeed, high, level of relevance in CBET-supported programs.</p> <p>Please see Program Strategies.</p>	<p>APPROPRIATE</p>
<p>13. Additional comments on the quality of the projects or the balance of the portfolio:</p> <p>In some programs, proposals evaluated by review panels as highly recommended are not being funded. Increased funding levels and execution of a flexible funding model that facilitates more funding across programs will provide funding for more highly regarded proposals.</p>	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

The merger of BES and CTS to form CBET has been smoothly accomplished and the COV sees no problems here. There is a good balance between funding for core disciplines and emerging areas, noting that three new Programs have been added since the merger.

The Program Directors appear to strive for balance: among topic areas and proposal type, following priorities in a program plan. Program managers have mapped CBET program activities to ENG, NSF-wide, NAE and federal priorities in engineering and science. Program managers have co-funded projects with other programs within CBET, ENG, GEO, BIO, CISE, etc. Program Directors are engaged in cross-cutting initiatives (e.g., EFRI, CDI).

There are a number of openings for PDs. This offers the opportunity to put balance in the number of permanent staff and “rotators” in each cluster. The searches for these positions should be even more broadly advertised than they are. The COV believes that it is in an excellent position to assist with these searches and encourages as much external involvement in these searches as possible. Once hired, it is important to have good programs in place to mentor and develop leadership skills for the new PDs who are hired.

In all cases, those proposals that were funded received very strong reviews. Proposals not funded did not receive strong support from the reviewers.

The PDs are overextended by the excessive number of proposals submitted for review. Also, there are too few program staff given the number of proposals, especially in some of the programs.

Outreach activities by the PDs to the constituencies of the program are good and should be expanded. PDs should be encouraged to travel to conferences and workshops with the objective of educating potential proposal writers. Sufficient resources should be made available to allow this.

Women have represented about 40% of Panelists but only about 12% of awarded grants. The analogous statistics for minorities and handicapped persons are even bleaker.

Please see Program Strategies and Document “30-A.4.1 Data” in eJacket.

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

Comments:

The program has exhibited flexibility in dealing with emerging research/educational opportunities. This is evidenced by the creation of programs in environmental and energy sustainability and increased emphasis in education. Though the PDs have a good grasp of their respective sub-field, the program is somewhat inhibited in its ability to engage the research and education communities external to NSF due to insufficient funds to support travel by PDs on the permanent staff.

Please see Program Strategies.

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

Comments:

By relying on unsolicited and CAREER grants, as well as meetings/workshops the program is bottom-up driven, which generally makes sense. The program does not appear to have a systematic approach to determine investment in future opportunities. More integration and cooperative funding across programs within CBET would be desirable.

Please see Program Strategies.

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

Comments:

The program has made an effort to address previous problems though some of these still persist. In particular the refining of the meaning of the phrase, "broader impact" must be made in order for researchers to understand what is required in their proposals. Some more concerted educational efforts on this criterion would be valuable.

The merger was expected to lead to an increase in acceptance rates in some programs when in fact, the reverse have occurred. This needs to be remedied.

There is a strong case for having panel members continue for, perhaps, three years in some staggered rotation in order to maintain some continuity.

Please see BES and CTS COV Reports, Responses, and Updates. Documents "40-BES 2005 COV" and "41-CTS 2006 COV" in eJacket.

5. Additional comments on program management:

None.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

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

B.1 OUTCOME GOAL for Discovery: *"Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:

The CBET Division Plan is to meet the Discovery Objective by "... lead[ing] engineering discovery and innovation in chemical, bioengineering, environmental and transport systems through the following objectives."

(1) Fund more investigator-identified and defined awards: By 2010 CBET will dedicate at least 50 percent of its budget to unconstrained investigator-identified and defined awards

(2) Support research in four thematic areas (a) Energy, Water and Sustainability; (b) Systems, Multiscale Modeling and Applications of New Techniques in Engineering Research; (c) Nanoscience and Engineering; (d) Integrating Life Sciences with Engineering

Further detail on these objectives is provided in the CBET Division Plan and in the Program Strategy documents. Overall, the COV review indicates that CBET is meeting the Outcome Goal for Discovery via these Objectives.

Objective 1: There was an initial concern that insufficient information was available to address this question. This has been resolved by information compiled by NSF staff at the request of COV ("Discretionary Budget History," 7/10/2009 from John J. McGrath). In fact, the data show that CBET

has met this goal two years early. The COV appreciates the excellent response of the NSF staff.

Objective 2: CBET has identified and supported both senior distinguished researchers as well as young investigators who have subsequently been recognized for their excellence in each of the four areas. CBET has an established track record for selecting and supporting work that leads to innovative and transformative results. In some cases, awards have led to patents and other activities that advance the innovation agenda, at least based on the anecdotal information that is available to the COV (this aspect could be reported in more detail). The vast majority of Discovery Outcomes in the Highlights were rated E or V/E. In a few cases, they were rated G/V indicating a relatively low level of risk taken in the Awards. In one case, the Discovery Outcomes were rated as Unclear and in another the award seemed more appropriate for NIH support than for NSF.

Examples of Excellence are

- Award 0744413, Nathanael Gray at the Dana Farber Cancer Institute, is using a systems biology approach to design kinase inhibitors. Using molecular modeling to design inhibitors for specific kinase families, he is trying to (1) identify substrates and (2) develop potential anti-tumor agents that block overexpressed or “addictive” kinase function. It is an elegant combination of “in silico” systems engineering, biochemistry, and chemistry that is already starting to yield potential drug candidates and new research tools.
- The SGER Award 0457370 provided a basis for Award 0708347 to John Harb, Brigham Young University is a great example of the purpose for an SGER award. The use of DNA Shadow Nanolithography to fabricate nonelectric circuits and other methods of nanopatterning and nanofabrication is both strong interdisciplinary work and potentially transformative. The COV applauds this increased risk-taking leading to increased rewards in Discovery.
- Award 032899 to D. Tyler McQuade, Cornell University, not only provides an excellent discovery leading to new catalytic microcapsules, but also connects to applications in several different areas and to a student-based business concept, thereby furthering the innovation agenda.
- Award 0354279 to Jay Benziger, Princeton University, provides high impact discoveries in both the science and engineering of PEM fuel cells. The work is strong on fundamentals and at the same time has immediate potential impact.
- In Award 0102983 to John Crittenden, of Michigan Technological University; Nanotube photocatalysts were shown to have a higher quantum yield than other TiO₂ based photocatalysts and to be a promising technology for the purification and treatment of both contaminated air and water. This work was reported in in a 2005 paper published in the journal *Environmental Science and Technology*, 39 (5) 1201-1208 and received Editors Choice award for best paper submitted in 2005.
- Pu-Chun Ke of Clemson University received an SGER Award 0736037 to study the fate of synthetic nanomaterials in biological and ecological systems. The scientific merit of this research is threefold. First, it has shown, for the first time, the uptake of discharged nanomaterials into food crops. Second, it has demonstrated, for the first time, the remarkable multigenerational transfer of nanomaterials in the food chain. Last but not least, it has unraveled, again for the first time, the opposite effects of nanomaterials on plant growth, indicating the complexity and challenge of evaluating the impact of nanomaterials on the environment. This research received a highlight at Live Science (“Ground breaking developments in science, space, technology, health, and the environment”).
- Kazuhiro Saitou of University of Michigan received Award 0124415 to study design for product-embedded disassembly using reversible integral attachments. In contrast to conventional research on design for disassembly that simply attempts to manage

disassembly cost vs. recycling/reuse benefits based on existing technology, the uniqueness of this research is the simultaneous pursuit of the development of a new technological enabler for eco-friendly product design and the optimal management of product life-cycle integrating the enabler. This work presents a methodology to provide designers with a specific design solution to improve environmental friendliness of mass produced products. Saitou has an active partnership with Toyota Motor Co. initiated by this research grant.

Of particular note for Objective 2 (d) are three ongoing projects address the integration of life sciences and engineering in exciting new ways:

- *In Award 073113 Ibrahim Karaman and Mariah Han at Texas A&M are developing nickel-free shape memory alloys for use in prosthetic devices—especially stents. They are addressing a serious problem with nickel degradation and toxicity and have already made progress in both fabricating the shape memory alloys and characterizing the processed materials. They have also leveraged the capacity to characterize these materials by characterizing similar alloys made by groups outside the US. This type of collaboration should keep the pace of progress high.
- *In Career Award 0643190, Gan Yao of U MO is developing optical methods for interrogating muscle—a really innovative idea that has obvious implications for both medical and meat applications. He has already done significant modeling and developed both a polarization imaging system and a multispectral imaging system to develop the experimental technology. He has published 5 rapid papers/conference proceedings in the first year.
- *In Award 0756338 Mahta Moghaddam and Carl Carson at U Mich are combining ultrasound and microwave imaging for breast cancer screening. They are using ultrasound to provide a coarse filter and microwave imaging to home in on density differences as low as 10% to provide a much less uncomfortable and more sensitive screen. They have built a phantom system of appropriate densities to use as a test bed and focused on developing the imaging algorithms to make the needed measurements.

CBET has contributed to the development of a diverse workforce through CAREER Awards to diverse faculty and support for outreach programs to diverse students, e.g.,:

- Yadong Li, Jackson State University a CAREER Award 0238765 to study E-waste Environmental Hazards and Treatment. Approximately ten African American undergraduate students from Jackson State University are working with Li to characterize the environmental hazards of E-waste and trying to develop cost-effective methods to treat E-waste for safe disposal. The results suggest that some components in PCs have great potential to contaminate the environment once they are released to the environment or dumped in the landfill. The data will help EPA in establishing regulations for effective management of E-waste.
- CAREER # 0748133 to Alberto Aliseda, University of Washington, Department of Mechanical Engineering, is proffered as an example of Excellence. This Award supports the investigation of the dynamics of microbubbles injected in the human circulation. The investigation consists of a systemic study of the fundamental physics that control the dynamics (trajectory and volume oscillations) of bubbles in an environment dominated by a non-uniform, unsteady velocity fields as exist in arteries and veins while subjected to a high-amplitude, fast-changing pressure field produced by applied ultrasound. Medical applications in therapy and diagnostics are significant. The broadening participation plan is rated Very Good.

CBET has supported the efforts of investigators in the promulgation of science and engineering through outreach activities in grade schools, high schools and the community at large, e.g.:

- Eakalak Khan of North Dakota State University received a CAREER Award 0449125 to study

Cell Entrapment for Water Pollution Control. For the first time, it was found that free and entrapped mixed bacteria from wastewater treatment systems have different specific growth rates and substrate utilization rates when substrate is not a limiting factor. Austin Lafromboise, a Native American Indian high school student in North Dakota, was one of the 2006 Grand Award winners at the National American Indian Science and Engineering Fair for his research on the use of entrapped cells for energy generation from sugar beet processing waste under the guidance of Khan.

Most of the involvement of PIs in K-12 programs and undergraduate research made use of opportunities established and funded through other mechanisms.

Additional Notes:

1. This review was based primarily the NSF Strategic Plan 2006-2011, the CBET Division Plan dated Dec 2007, and either the on Document "31-B.1 Data," or the proposal jackets assigned to the team members in one of the following areas: CBBS, BEH, EES or TTF. (In a small number of cases, Highlights for projects at the home institution of the COV team member, were not included in the review.)
2. The proposals jackets were rated mixed in terms of over-all quality as measured by degree of risk, completeness of research plan, involvement of graduate, undergraduate students, post-doctoral professionals, education impact, qualifications of the research team, infrastructure, and broadening participation. Integrating over all proposal jackets, CBET is rated as contributing to CBET accomplishing its Discovery Goals.
3. *A greatest area of general weakness is an absence or an insufficient plan of assessment of broadening participation. In the education plans of several of the proposals there is need to (1) state learning objectives,(2) educational outcomes, and (3) anticipated impact. A rigorous assessment strategy is required for each education plan.*
4. There is some concern among the team members that the Highlights, jackets, and planning documents should be supplemented with additional materials to track the impact of the Discovery Outcomes over a longer period to provide a more comprehensive assessment of the impact. If this is not anticipated as a task for the COV, we suggest that this question should be rewritten to clarify the intent with respect to the global leadership component for the Goal.

B.2 OUTCOME GOAL for Learning: “Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.”

Comments:

The CBET 2007 Division Plan goals relevant to B2 are:

*“3. **Support new faculty:** CBET will annually fund workshops focusing on new faculty and on the successful recruitment, retention and advancement of minority engineering faculty, graduate students and undergraduates, including African-American, Hispanic, Native American and women engineers. Funding rates for CAREER proposals will increase to 15% with CAREER funding more uniformly distributed across programs.”*

In general, the Highlights and project reports provided insufficient information to determine if this goal is being addressed. No data were provided on involvement of faculty or students with disabilities. Sponsorship of a workshop at Univ. TX at El Paso (0801410) was an excellent example of a student-oriented workshop with special appeal to minority students, but another workshop proposal/report lacked such documentation (0830144). Few, if any, statistics on recruitment or retention of minority faculty and students were provided, though PIs training such students did document their status. Several PIs did participate in summer programs targeted toward minorities. Another has mentored undergraduate minority students who have won high profile national awards. The minority/female PIs (as nearly all of the PIs) were publishing their research in top quality journals.

and

*“4. **Promote lifelong learning and professional development for science, technology, engineering and mathematics (STEM) workforce and science at large:** CBET will increase the number of graduate and undergraduate students trained through the funded research by encouraging all proposals to include at least one graduate student and several undergraduate students.”*

All of the projects provided some support to graduate students and/or postdoctoral fellows. There were also references to active mentoring of graduate students by postdoctoral fellows. The PIs also demonstrated a strong dedication to undergraduate education. The use of undergraduate internships through larger, pre-organized programs was frequent, suggesting that NSF should continue to support the development of such programs as well as support of undergraduates through investigator-oriented projects. Examples of specific activities with undergraduates also included the development of instructional modules for undergraduate courses in use at multiple universities and the inclusion of undergraduates in the course development process (073113). Multiple reports described undergraduates who won awards either locally or in national competitions. It was not unusual for undergraduates, as well as graduate students, to publish papers based on their work.

While not specifically mentioned in the two goals above, CBET has a commitment to K-12 education and public literacy. Many PIs of regular awards have some connection with K-12 education. This is to be highly commended. The range of activity includes: making presentations at local schools, developing educational modules for K-12 teachers, running a workshop for K-12 and community college teachers and publishing on the web a series of modules for both students and teachers. One PI has been active giving lectures to both community groups as well as working with the news media

to describe discoveries made under a previous NSF award. This individual has also worked with a museum to provide materials for an exhibit. He has also been very active in providing samples made in his laboratory to students at various points in the educational system. In most cases, however, PIs involved K-12 used project support to participate in already-organized programs such as a high school Engineering Summer Camp (0643190) or helping a local K-12 school identify topics for science fair projects (073113).

Outreach can also include contributions to the professional community for activities such as the development of standards or public policy. There is no description or request for description of this type of activity.

The learning strategic goal includes activities in K-12, understanding how people learn, educational pathways, diverse-globally-engaged STEM workforce, research and education and informal science education of citizens. While the 2006 highlights show an abundance of projects that impact the training of undergraduates, graduate student and post docs, there were very few projects that advanced the fundamental knowledge base on learning and STEM workforce development. Although no targets (i.e. percentage distributions) are given for each of the objectives in the Learning Goal, guidance to the expected outcomes by learning goal type should be provided to facilitate assessment on a yearly basis.

Every proposal should have documentation of the broader impact, which would include objectives and methods for assessment. For NSF/CBET purposes, the education components could be measured across a collective group of projects based on measurable learning result, rather than for each project to be required to identify a significant learning component. In order to perform such a collective assessment, each project must report learning activities and the methods by which they were assessed.

Please see Document "32-B.2 Data" in eJacket for program "highlight" information.
Please also see the NSF Strategic Plan 2006-2011 and CBET Division Plan dated Dec 2007.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

Comments:

The NSF Strategic Plan for Research Infrastructure states that NSF will: 1) raise limits on instrumentation funding to allow for funding of mid-sized instrumentation; 2) identify and support next generation large research facilities; 3) develop a cyber infrastructure such as petascale computing and next generation internet; and, 4) develop unique networks and innovative partnerships. The CBET Division Plan contains three strategic objectives toward the NSF Infrastructure Goal which are: 1) encourage interdisciplinary group projects; 2) apply cyberinfrastructure to CBET engineering fields; and, 3) fund small and intermediate instrumentation and equipment requests. To date, plans to achieve these three strategic objectives have been made. To address objective one, CBET reports that currently less than 4% of awards are investigator-initiated interdisciplinary awards and thus they have set a goal to reach an investment of 15% of the budget on interdisciplinary awards through unsolicited proposals and set-asides for co-funding of projects. For objective 2, they report that currently they invest about \$25M in activities related to cyberinfrastructure and most of that is in the development of models and simulations. However, these are associated with individual research projects, and have not produced strong cyber or instrumentation networks. The goal now is to have

PIs build relationships and a framework for validation of data and simulation models on a larger scale. This will enable CBET investigators to succeed in NSF- and ENG-wide cyber initiatives. The Division plans to facilitate this by funding planning grants to produce successful proposals for large initiatives. To address objective 3, the CBET Division Plan states that CBET awards currently support mainly personnel. Their goal is to increase funding of small instrumentation (less than \$200,000) from none in 2006-2008 to up to 5% of CBET's annual grants. They will do outreach to encourage researchers to seek equipment support through unsolicited proposal submissions.

The program Highlights provided to the COB were projects which had the development of advanced instrumentation, facilities, cyberinfrastructure and experimental tools as primary or secondary Goal Indicators. Of particular note was highlight number 11604, "Antibiotic Synthesis on a Biochip", that resulted in two patent applications for the device, a teaching module on metabolic engineering in a graduate Enzyme Technology course, and several publications in JACS. Another noteworthy highlight is number 11736, "Cell Protrusions Driven by Actin Polymerization Depend on Their Loading History". Not only has the investigator discovered an interesting property of actin dynamics, "physical memory," but he has also developed a new technique for force microscopy. This work was published in Nature Cell Biology. On the cyberinfrastructure side of things, highlight number 16056 is about a JHU Turbulence Database web portal. This is a tool for high performance computing in computational fluid dynamics providing experimental data for analysis by the research community in a user-friendly way. It is essentially a portal that enables researchers' access to multi-Terabyte turbulence databases. Cyber infrastructure was a primary outcome of Highlight project 13690 in which investigators at Georgia Tech used terascale computing to develop a 3-D model of chemical reactions in a turbulent system. Simulations were run using DataStar, the Terascale Supercomputer at UC San Diego. A Highlight project with strong interdisciplinary focus was # 15086, where a team at the University of Virginia representing mathematics, physics, chemistry, neurology, and chemical engineering developed a multipurpose model of dynamic (rhythmic) systems with applications in neurosciences.

Summarizing information from the 29 project descriptions in the Highlights material revealed that 7 of those (24%) indicated that research infrastructure was a primary goal of the project, and was secondary for the remainder. The infrastructure outcome reported by the largest number of Highlight projects was interdisciplinary research, for 48%. Instrumentation was a primary or secondary infrastructure goal for 45%; models and experimental tools for 31%; and cyberinfrastructure for 21%. It was of interest that 21% of the CBET Highlights projects noted an affiliation with an MRI (Major Research Instrumentation) project.

No expenditure information was given in the Highlights section, so it is difficult to quantify the role of infrastructure in these projects. Equipment items in proposal budgets may serve as a quantitative indicator of major expenditures for instrumentation and cyberinfrastructure. For 11 proposal jackets in the Environmental Engineering Sustainability cluster, only 4% of the requested funds were for equipment (small computers and instrumentation). Six proposals did not request any funds for equipment, and only two projects budgeted funds for equipment over \$50,000 (both were declined). This is not surprising considering the relatively small size of awards. The average proposal budget for the sample group was \$323,000 and most of the grants were multi-year, e.g., four were CAREER proposals, with a budget cap that would constrain funds for significant equipment purchases. Interestingly, the average budget size for this small subset is consistent with the CBET Portfolio data for 2006 (Division Plan, Appendix VII) which reported 1280 active grants and a total of \$430,455,380, for an average of \$336,293.

PI's in the CBET division did participate in two cross-cutting initiatives, the Major Research Instrumentation (MRI) and Cyber-enabled Discovery and Innovation (CDI). A search of the NSF websites for MRI and CDI grants attributed to CBET between 2006 and 2008, resulted in

identification of 43 MRI awards totaling \$14,350,110, and 21 CDI awards totaling \$6,985,179. Another CBET initiative, WATERS, has strong cyberinfrastructure and instrumentation (sensor) network components. In addition to direct support of infrastructure in the CBET program areas, that 6 of the 29 Highlighted projects were affiliated with MRIs indicates that a number of CBET projects have leveraged this equipment for their own work. Another of the Highlighted projects used the NSF-supported San Diego Supercomputing Center.

The COV supports the idea proposed in the CBET Division Plan to allocate up to 5% of awards for instrumentation and cyberinfrastructure in the range of \$50,000 - \$200,000. The 2007 Plan suggested implementation by “encouraging” investigators to request equipment support through unsolicited proposals. However, this has not resulted in actual funding for equipment near the desired 5% range. It is recommended that the Division develop effective methods to implement making awards for acquisition of small and intermediate instrumentation and infrastructure.

Please see Document “33-B.3 Data” in eJacket for program “highlight” information.
Please also see the NSF Strategic Plan 2006-2011 and CBET Division Plan dated Dec 2007.

PART C. OTHER TOPICS

Please reference the provided eJacket data documents and Program Strategies.
Please also see the NSF Strategic Plan 2006-2011 and CBET Division Plan dated Dec 2007.

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

The merger of CTS and BES into CBET has gone well, and the Division Plan (dated Dec. 2007) lays out a well-considered path forward. The following are some points that this COV would like to highlight for the Division’s guidance, as it moves forward.

- It is essential that the Division sustain its strong support for core disciplines. CBET has done exceptionally well in supporting interdisciplinary and topical research. This is laudable and should be sustained, but at the same time it should be recognized that research needs to be encouraged and supported in the core engineering sciences, which are not immediately identified with specific topical goals, and that underlie many multidisciplinary, interdisciplinary, application-oriented programs.
- COV is seriously concerned with the inadequate level of funding for the Engineering Directorate in general and for CBET in particular. Given the importance of the Division’s areas to the nation’s grand challenges (for energy, environment, water, sustainability, healthcare technology, etc.), it is alarming to have funding constraints that cause CBET’s success rates to be in the low teens (lowest in ENG) for submitted proposals, and for proposals to be consistently underfunded in terms of dollars and duration. A case in point is the Biophotonics Program where the success rate has decreased from 26% in 2006 to 6% in 2007 and 8% in 2008. In Environmental Engineering, funding dropped 25% between 2006 and 2007, and the acceptance rate decreased from 19% to 10%. The 15% increase in the 2008 budget still left funding below the 2006 level with a below-average acceptance rate of 12%.
- The balance of different award mechanisms such as CAREER, SGER, etc. varied among programs within CBET. For example, BME appears to have no CAREER or SGER awards. The rationale should be made clear, and any such variations should then be as a result of strategic planning and not from chance.

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.

In general, the program objectives and goals are being met. In areas where they are not, the Division Plan outlines steps that will be implemented to reach the objectives and goals, such as planning grants for cyber infrastructure, funding for small equipment grants, and increase of investigator-initiated interdisciplinary awards. Suggestions for further attention follow below.

- COV feels that the support level for funded programs should satisfy at least some lower threshold, sufficient to provide support for a graduate student, participation by at least one undergraduate student, partial summer salary for PI, and necessary operational costs, consistent with the Division Plan. This is of such importance that it should be sought even at cost of reduction in total number of funded projects.
- Regarding budget levels for programs within the Division, COV recognizes that some variability is normal and expected -- to reflect strategic focus, quality of proposals received, and to maximize NSF's contributions for intellectual impact and broad impact on the nation's key challenges. In current times, it behooves CBET to focus its considerable strengths in disciplines that are central to the nation's scientific and engineering challenges such as energy, healthcare and climate change.
- Program foci developed in strategic plans often are not factored into the review process by panels. Review panels should be made aware of such foci, and be encouraged to balance their recommendations for foci and for core engineering science. Also, the publication on the web of divisional foci, once selected, would be informative and helpful to the research community.
- COV is of the opinion that the program officers should have some flexibility to apply discretionary judgment, while weighing inputs from reviewers and the program foci. It is important that new POs, including rotators, be instructed and mentored at start of service on this responsibility.
- The heavy work loads of Program Officers (POs) argue for consideration of some mechanism to reduce the volume of proposals that is processed by CBET. COV recognizes this need and encourage the Division to propose specific actions to redress the situation, including the possible addition of several new PO positions.
- CBET staffing sometimes require recruitment of new members and rotators. COV suggests that the search for highest quality candidates can be aided by more transparency within the professional community, including seeking suggestions and nominations from the large collection of past panelists and various advisory committees (including present and past COVs).
- CBET's programs are in 17 areas (e.g. catalysis/biocatalysis, biomed engineering, environmental sustainability, fluid dynamics, etc.), organized into the four clusters of (1) chemical, biochemical, and biotech. systems, (2) bioengineering and engineering healthcare, (3) environmental engineering and sustainability and (4) transport and thermal fluids. This organization appears to work and COV does not see a pressing need for re-organization. However, more clarity can be achieved if differences between disciplinary areas (e.g., reaction engineering, separations, fluid dynamics, etc.) and application areas (e.g. energy for sustainability, biosensing, aid to persons with disabilities, etc.) are noted appropriately. A

two-dimensional matrix view, with disciplinary areas in one dimension and application areas in the 2nd dimension could clarify the overall coverage of subjects and help discern interactions and interfaces. A continuing effort at the Division level to maintain a high-level perspective of subject coverage and emphasis is encouraged. Advisory committees and COVs can be beneficially utilized in this effort.

- Review panels are valuable to the Division's objective of high quality and timely reviews of submitted proposals. COV does not favor a change to cyber panels which convene only electronically, although we recognize that some portion of the panels may need to participate via video or telephone. COV does favor the concept of multi-year panels, to improve continuity in the performance of reviews.

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

In its considerations and discussions, several issues came up which should be considered above the division level. These are noted for attention of the Engineering Directorate and/or by the Foundation.

- A stated principal and guidelines for risk management would be helpful to the "investment priorities," described in the NSF Strategic Plan. There is a clear desire to support some level of high-risk research, which has the potential for high gains. This is especially true if NSF seeks to enable some "transformative" research, defined as "research which promise extraordinary outcomes, such as: revolutionizing entire disciplines; creating entirely new fields; or disrupting accepted theories and perspectives." A deliberate risk management policy can be effective in balancing risk vs. reward, and promote the communities' response toward this end.
- The relative weighting that is given to scholarship impact and broad impact should be identified as an NSF goal, and review panels need to be educated and better prepared to respond suitably in their deliberations and in feedback to the PIs.
- In view of topical objectives that are common to different directorates in NSF, and to many other federal/state funding agencies, cooperative support can be beneficial and should be actively pursued. Currently, this occurs mostly through initiative of individual program officers. If cooperative support of deserving research is desired, it should be stated as a Foundation goal and efforts for its development should be facilitated and enabled by NSF management including participation above the level of program officer.

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

Three issues are noted below.

- In the opinion of this COV, some form of "advisory committee" at the divisional level can be extremely beneficial in setting, assessing, and updating CBET's strategic and tactical directions. The parallel in academic institutions is the utilization of both departmental advisory committees and college advisory committees. Currently, an advisory committee exists for the Directorate, but not for Divisions. The COV, meeting once every three years, lacks continuity.

- The criterion of “broad impact” is unclear, and appears to be interpreted variably by review panels. Generally, consideration of the research/scholarship impact appears to outweigh consideration of educational/broad impact. Whatever the desired balance, it needs to be well-articulated in instructions to reviewers. Better quantitative measures to assess “broad impact” of individual programs would be helpful and be in line with “transformative”.
- “Impact”, whether of scholarship or of learning, may require examination of programs over longer periods (many years). This is especially true with regard to transformational research, the impact of which may not be discernable for some time. Whenever this issue is to be examined, it is suggested that data and information on targeted programs be collected over a minimum history of 5 years.

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

The following suggestions come from specific observations that arose in this COV review process.

- In addition to the information in the eJackets, it would be very helpful to have a “self-study” document as a starting point for the COV review, e.g., similar to the document that academic engineering programs prepare for accreditation visits. This would help distill the detailed information in eJackets and sharpen the attention of COV members on highlights and lowlights of divisional status.
- The “Highlights” examples provided on the Learning and Research Infrastructure Goals (items B.2 and B.3) were not very useful for evaluation of these goals. Some other resources, including a summary with statistics that relates to the NSF Strategic Plan and specifically to the CBET 2007 Plan would be helpful. For instance, how many Ph.D. students and how many undergraduates were supported on the grants? What is the diversity of each group? What is the diversity of the faculty group that is supported on each grant, relative to the national availability in the field and relative to the proposals submitted? What specific infrastructure was created or used as a result of the award? What fraction of the NSF funds were spent on infrastructure? If highlight examples are provided, it would be better to group them according to program areas, instead of just large collections in items B.1 and B.2 of the eJackets.
- Finally, the following three specific suggestions concern details of the COV process:
 - a) In view of the rather low funding rates, it would be helpful to report not just the overall success rate, but to present the success rate according to the median scores of the proposals.
 - b) In a similar manner, it would be helpful to present statistics on funding success, as correlated to review rankings (i.e. E, VG, G, etc.). A year-end summary by program officers for their areas would be informative.
 - c) For COV to assess quality and credentials of reviewers, it would be helpful to provide biosketches of panel members in sampled jackets.
- Communication among COV members should be improved. It would be helpful to have two conference calls prior to the face-to-face meeting. The second call should occur after the

COV members have had a chance to study the e-jackets that they are assigned and after they have reviewed the questions.

SIGNATURE BLOCK:

A handwritten signature in blue ink that reads "Matthew Tirrell". The signature is written in a cursive style with a horizontal line under the first name.

For the 2009 CBET COV
Matthew Tirrell
Chair