

FY 2012 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: July 23-24, 2012
Program/Cluster/Section: All Programs
Division: CBET
Directorate: ENG
Number of actions reviewed: Awards: 152 Declinations: 151 Other: 1
Total number of actions within Program/Cluster/Division during period under review: Awards*: 1877 Declinations*: 10384 Other: 142 *Competitive Proposal Actions
Manner in which reviewed actions were selected: CBET has 17 programs divided into 4 clusters. The CBBS, BEH, and EES clusters each have 4 programs and the TTFP cluster has 5. The jackets will be downloaded by CBET staff to cover FY 09-11. CBET staff will remove from the listing: Withdrawn proposals, special initiatives/trans-directorate programs, and IPA agreements. The jackets are categorized by award status (Awards and Non-Awards) across the 3 Fiscal Years (FY 09-11). Within the categories, 3 types will also be sampled: CAREER, unsolicited, and other. The jackets will then be sorted in the following order: by program, 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 jacket with the lowest resulting number was selected from the sample. The jackets were then grouped by cluster. This yields standardized, random stratification for all programs/clusters and a total of 304 jackets. The BEH and EES clusters will have 72 (18 per each of the 4 programs) jackets pre-selected for sampling. The CBBS cluster will have 70 (18 per each of the 4 clusters, except 1417 and 1401 which have 17 due to no jackets falling to a specific category for a specific year) pre-selected for sampling. The TTFP cluster will have 90 jackets (18 per each of the 5 programs) pre-selected for sampling.

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.

I. Questions about the quality and effectiveness of the program's use of merit review process. Please answer the following questions about the effectiveness of the merit review process and provide comments or concerns in the space below the question.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE
<p>1. Are the review methods (for example, panel, ad hoc, site visits) appropriate?</p> <p>Comments:</p> <p>The COV commends CBET for implementing a high quality review process and proactively studying ways to improve it in response to the tight constraints of federal funding, proposal pressure, and decreasing reviewer availability. The current review methods are appropriate and they consist of panels, <i>ad-hoc</i> reviewers, and internal reviews (by the program officers). Unsolicited proposals, which are currently accepted during one annual submission window, and initiative proposals such as CAREER, are reviewed by broad panels of experts. More narrowly focused proposals such as REU, RET, EAGER, etc., are reviewed internally. <i>Ad-hoc</i> reviews are used sparingly because panels are more efficient for reviewing numerous proposals.</p> <p>The COV also commends CBET for continuing to test alternative methods, such as virtual panels, which can deal with the proliferation of proposals and the decreasing ratio of highly qualified, readily available, US-based reviewers. Virtual panel reviews appear to function well at least for the smaller panels and allow the enrollment of top experts from around the world, and from time-constrained specialists from industry at a fraction of the cost of an onsite panel.</p>	YES
<p>2. Are both merit review criteria addressed</p>	YES

- a) In individual reviews?
- b) In panel summaries?
- c) In Program Officer review analyses?

Comments:

The previous COV report noted that the Broader Impact criterion was imperfectly addressed by the reviewers and program officers. Hence, this COV examined the proposal jackets to assess the current status in individual reviews, panel summaries and program officer analyses.

The sample jackets show that still only a minor fraction of individual reviews make a critical and thorough assessment of the Broader Impact criterion. Reviews tend to focus on the scientific and technical merit to a much larger and deeper extent than on the broader impact merit. Panel summaries and the program officer analyses of the broader impacts often paraphrase individual reviews or proposer's claims, and therefore lack a fuller and more comprehensive assessment of the broader impacts. This situation needs further attention.

The COV was pleased to see that CBET is actively addressing the problem of a lack of a good understanding of the Broader Impact criteria, and we encourage CBET to continue to work with NSF upper management to resolve and clarify the apparent or real ambiguity of these criteria. NSF must educate PIs and reviewers on the intended meaning, and must supply examples of sound and meritorious broader impacts. It is expected that both the summaries and analyses will improve with additional clarification of the Broader Impact criteria by the NSF.

<p>3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals?</p> <p>Comments:</p> <p>Alignment between written comments and summary grades (Excellent, Very Good, etc.) exists in the majority of jackets sampled, but this is not true in all jackets. In the examples that displayed non-alignment, the scores were uniformly more favorable than the written critiques. Reviewers should be requested to give scores that truly reflect their level of critique or praise. A majority of reviews showed a balanced and complete assessment of merit, but a few did not. CBET program officers should discourage reviews that only summarize proposal goals or methods, and that do not concentrate on the critical assessment of scientific merit and broader impacts.</p> <p>The COV recommends that CBET continue to enforce and maintain high quality, accuracy, completeness, and uniformity across program elements in the reviews collected from panels of leading experts in the subjects of the proposals. Since panels also serve as means of nurturing new researchers, and exposing them to the NSF culture, mixtures of topmost specialists combined with a few less experienced reviewers are appropriate. However, NSF program officers must ensure the quality, integrity and technical value of reviews produced by these less experienced reviewers.</p> <p>A few of the sample jackets had reviews that seemed to show implicit or explicit bias against institution size (large or small) or type (research or teaching), and/or bias against PI gender, prior research experience, etc. The COV recommends that program officers point out examples of improper biases at the beginning of a panel session, and that during the panel discussions they are discouraged.</p>	<p>YES</p>
<p>4. Do the panel summaries provide the rationale for the panel consensus (or</p>	<p>YES</p>

<p>reasons consensus was not reached)?</p> <p>Comments:</p> <p>In a majority of jackets sampled, the summaries were well constructed and provided a complete argument supporting the decision. The final classification and ranking of proposals into highly recommended, recommended, and not recommended, are an appropriate and efficient means of identifying the most meritorious proposals. This classification scheme gives program officers the ability to balance their program portfolios.</p> <p>In some of the jackets, the summaries seemed incomplete. The COV recommends that a more detailed template be developed to gather complete information, such as a list of strengths and weaknesses for each criterion. The strengths would not automatically be construed as qualifying, or the weakness as disqualifying, the proposal for funding. The program officer would determine their proper weight in the final decision. The summary should also describe the nature of the discussions instead of copying verbatim from individual reviews. The program officer should encourage good agreement between final classification (HR, R, DNR) and the panel summary comments.</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>The context statement, reviews, summaries, review analysis, and diary notes in the majority of sample jackets were well documented and they rationalized the decision process managed by the program officer. However, a majority of review analyses do not include programmatic priority or strategic or CBET budgetary issues. For the sake of transparency and clarity, the internal documentation in each jacket should contain the additional reasons besides panel ranking that lead to the program manager decision to recommend or not the proposal for funding. When the program manager asks the PI to respond to reviewer concerns, the PI responses should be placed in the electronic jacket so they will be available in the official file.</p> <p>The COV recommends that the program officer analysis include rationale that more transparently explain the final decision for the proposal.</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>The investigator receives all verbatim anonymous reviews and a panel summary. In the jackets sampled by the COV, the documents sent back to PIs were appropriate and complete in a majority of cases. The language employed in the panel summary was usually sufficient to explain the rationale for placing a proposal in the HR, R and DNR categories. When PIs find the rationale unclear or imperfect, they may obtain further information from the program officer directly. However, some of the jackets contained analyses that were inconsistent (e.g., at least one excellent review and a classification of the proposal as DNR without further explanation).</p> <p>The COV recommends that the documentation sent back to the PI be complete and self-explanatory, eliminating most of the need of the PI to call the program officer for explanations.</p> <p>In order to ensure that complete information be sent back, the COV recommends that a template or form be developed which could include a list of strengths and weaknesses, the panel review summary listing the conclusions from the panel discussions, the numerical fractions of HR, R and DNR proposals, and higher level information (check-boxes with standardized language) informing the PI on the program officer recommendation and the reason(s) for the recommendation.</p> <p>The COV briefly discussed whether the documentation sent back to the PIs should also include checkmark boxes that straightforwardly transmit information or decisions that are not covered in other parts of the documentation. Examples are checkboxes to declare: "The proposal did not merit panel discussion" (although the individual panel member reviews are provided), "The proposal does not merit future resubmission" (as a clear signal that even major changes to the proposal would not be sufficient to move it into the HR category)", and others as might be helpful to reduce the number of submissions and reduce the time needed by the panel to handle the proposals. The COV recommended further discussion by CBET for including these types of comments for the sake of improving the transparency of decisions and indirectly improving the success rate of future proposals.</p>	<p>YES</p>
<p>7. Additional comments on the quality and effectiveness of the program's use</p>	

of merit review process:

Since the proposal content directly pertains to merit review process, the COV discussed ways to improve the proposals themselves.

The COV suggests that the content or format of final reports is due for revamping, and that final reports should be evaluated together with or as part of the renewing proposals. This is a recommendation to the NSF, not just CBET, as this would have to be a uniform NSF policy change. The reports should describe the extent to which the proposed goals and objectives were achieved (both scientific/technical and broader impact goals). If intermediate findings caused the project to drop some of the original goals and adopt new and more fruitful goals, that should be highlighted as well.

The COV discussed whether resubmitted proposals should include rebuttals of prior reviews for the new reviewers to assess whether significant differences exist between the old and new proposals. The COV recommends further discussion of this suggestion within NSF.

The COV found the review process well run in general, and commends CBET for continuing to ensure its integrity and improve its quality despite the large number of proposals handled by this division.

II. Questions concerning the selection of reviewers. Please answer the following questions about the selection of reviewers and provide comments or concerns in the space below the question.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE
<p>1. Did the program make use of reviewers having appropriate expertise and/or qualifications?</p> <p>Comments:</p> <p>Overall the quality of the review panels was very high (i.e., well qualified) and included a diverse representation from different institutions and geographic regions. In general, each review panel consisted of one or two key thought leaders of the field as well as one or two young researchers and provided an appropriate breadth of experience. The panelists asked to review a specific proposal (generally 3-4 with the overall panel to application ratio being between 1:2 and 1:3) were the most qualified to perform the review. However, the panel sizes varied quite significantly (6-38). Further conversation with program staff suggested that the smaller panel size reflected a more focused topic and thus fewer proposals to review, which reduced panelist time at the panel review. COV members recognized that increasing the panel size adds to the burden on the community; however, it is essential to have good representation across disciplines to ensure equity. Moreover, some disciplines may be inherently broader than others, and panel sizes should reflect that. For example, fluid mechanics spans micro/nanofluidics to high-speed aerodynamics, touching communities with little interaction or overlap (including Chemical Engineering, Mechanical Engineering, Civil Engineering, Aerospace Engineering and Bioengineering). On the other hand, Interfacial Processes and Thermodynamics are somewhat narrower topics, primarily lying within Chemical Engineering. The caution raised by COV members was the critical need for program staff to identify the right panelist for these smaller panels (<i>i.e.</i>, no room for error). There were a few cases with the smaller size panels where the panel did not have the appropriate expertise to review a particular proposal. As one COV member noted, "On at least one occasion that appeared to have a detrimental impact on the proposal."</p>	<p>YES</p>

<p>2. Did the program recognize and resolve conflicts of interest when appropriate?</p> <p>Comments:</p> <p>There was no evidence of unresolved conflicts of interest (COI) with the sampling assignments. It seemed that all the program staff were careful with respect to eliminating all COIs (as reinforced by the COI procedure experienced first-hand by COV members). Given the overall expectation that incidences of COI should be negligible when program ‘recognizes’ and ‘resolves’ a perceived COI in the building a review panel, it is not surprising that COIs were not observed in the sampling assignment. However, the requirement (and enforcement) of program officials to report COIs – even as late as during actual review – is not clear. It might be a better learning metric during this evaluation to pull (isolate) the presumably few incidences that needed resolving and examine those cases to see how program recognized and resolved COIs and hence address the question being asked.</p>	<p>YES</p>
<p>Additional comments on reviewer selection:</p> <p>NSF should strive for more consistency with regards to diversity amongst panelists. One COV member noted that, among the sampling assigned, only one panel did not include women, and one panel had a significant ratio of women to men. However, other COV members noted that the representation of women on these panels was universally low and in some cases zero. There were discussions that the demographic ratio comprising the panelists did not reflect the same demographic ratio of applications being reviewed. The diversity (gender, under-represented minorities (URMs), industrialists, etc.) of panels vary by panel topic so hard to assess whether an issue potentially exists or long term problem. The COV members recognize that this reflects to some degree the representation in academia; nevertheless, it would seem that some diversity guidelines on forming panel reviews should be considered. A few COV members noted a tendency for program staff to rely on the same diversity panelist repeatedly rather than reaching to a larger available pool.</p> <p>Another important area that is an opportunity for improvement with the reviewers is increase representation from industry. In the one panel the two industrial reviewers were consistent in their comments that the subject of the proposal (on inorganic and carbon membranes) would be difficult to scale-up, despite the enthusiasm of the academics for work in this area. The COV members felt that a stronger push by CBET to pursue industrial researchers/technologists (current or retiree) for application oriented panels/topics is needed, so as better to address the whether the research is really addressing key issues, and whether findings could have a long-term and transformative impact.</p> <p>With regards to more junior reviewers, one COV member noticed a panel where there were more postdocs than assistant professors – “Given that there are a lot of early investigators’ who have yet to serve on review panels, it might be</p>	

beneficial to include them (assistant professors) over postdoctoral fellows' as experience of being in a panel would be useful to develop successful proposal for a young PI." While it may be burdensome initially to bring in an increasing number of junior investigators, one can phase them into the review process. Ideally, more face-to-face review panel opportunities for junior investigators provides the best means of developing a larger (qualified) pool of reviewers.

A couple of COV members did notice an occasional case of reviews having a large percentage (in once case, 1/3) of the reviewers coming from the same state. The COV members did reflect upon that the ease and availability of reviewers to travel to the review panel site, as well as the number of institutions in a state, may account for the large percentage; however, this may also be viewed as an imbalance in the review.

Implementing more virtual panelist reviews was discussed on numerous occasions by COV members as a way to might help alleviate some of the issues described above (i.e., diversity with respect to geographic location, gender, URM, industrial experience, international activities, etc.). While technical challenges exist to expand the number of virtual panelists on any given panel, COV members were very supportive for CBET to explore better way to implement and leverage virtual panelists when appropriate.

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

MANAGEMENT OF THE PROGRAM UNDER REVIEW

1. Management of the program.

The quality of any scientific enterprise is no better than the people managing it. The COV recognized and applauded the dedication and hard work of the Program Directors (PDs) in stewardship of a large and growing portfolio of grant applications and awards that emanate from an energized and engaged community of scholars. It was immediately apparent at the time of the site visit that experienced PDs had accumulated a variety of skills that ranged from provision of pre-proposal advice to junior investigators, sorting and referral of applicants to more relevant programmatic areas and the skillful management of review panels. With respect to the latter, more experienced and engaged PDs employ a variety of techniques and approaches to elicit valuable information from the review panel. Examples of these include use of scheduled discussions to identify *hot topics* and areas ripe for innovation, constant surveillance of the review panel to make certain that minority opinions are solicited and heard and working to ensure that summary statements are well aligned with the narratives and scores provided by the reviewers. The COV recommends that these best practices be adapted more broadly. The provision of focused training and *boot camps* for new s at orientation is a notable strength of the current onboarding process. However, CBET may wish to consider periodic continuing education in management techniques for all s to ensure that best practices are shared across the division and codified where prudent or necessary.

With respect to more *strategic* management of programmatic areas, CBET does not appear to have an adequate roadmap that places in context a series of well-justified topical priorities and a division-wide set of values that govern the number, scope, magnitude, etc., of proposals to be funded. This roadmap need not be prescriptive, but would be helpful in the generation of assessment tools that would enable CBET leadership to shape the overall direction of existing and emerging priorities. Some of the values expressed by the PDs were supporting the core engineering disciplines, mentoring junior investigators, and funding a broad array of investigators. Formally stating some of these values along with emphasis areas in a division plan would encourage alignment and strategic thinking across the organization. Furthermore, the information provided to the COV did not shed light on the strategies employed by CBET leadership in recruitment/retention of PDs. It was not entirely clear whether or not s were encouraged to bring their vision to the development of a portfolio or whether there was sufficient time in rank to allow adequate shaping of the overall direction of programs. This issue is judged to be all the more serious by perceived understaffing at the level of PDs. The COV encourages consideration of the addition of an associate deputy director with a primary focus on PD development and cross division process development and adoption.

The articulation of at least 19 different and distinct mission statements without a more cohesive framework or unifying vision makes difficult the assessment of the correlation between the decision to fund and the core mission of individual programs within the division. Nevertheless, review of the E-Jackets suggests that there is reasonably good correlation between the review and the funding outcome. Reviews generally provide the appropriately detailed scientific justification to the to support the decision to fund or otherwise. Occasionally, reviews appeared to border on the taciturn

and provided a poor linkage to funding decisions. Some reviews appear to be hastily composed and others reveal that the reviewer may not have sufficient depth of expertise to fully evaluate the scientific merit of the proposal. Too frequently for the comfort of the COV, reviews were merely summaries of the proposals without critical evaluation of the scientific merit or technical feasibility of the approach. It is the judgment of the COV that this suboptimal review is likely a reflection of the large number of proposals received at each cycle and the consequent stretching of the scientific capabilities of the typical review panel. These concerns are further compounded by the inevitable time pressure under which reviewers operate and the related, pervasive concern regarding low funding rates and small budgets. CBET is encouraged to consider proposal management protocols such as triage (as employed at NIH, for example) to reduce reviewer and application processing loads, improve the quality of review, and preserve the culture of openness at NSF.

According to information provided by the division, CBET receives the most proposals and has the lowest success rate in ENG directorate. The low success rate for proposals submitted to CBET is of concern and is estimated to be between 10-15 % for most programs in 2011. The COV recognizes, as does CBET, that the success rate is too low and needs to be improved. The success rates for the various CBET programs were much more variable in 2009 and 2010, but seem to have stabilized at more uniform levels in 2011. Nevertheless, the fraction of highly recommended (HR) proposals that were funded appears to vary widely by program. For example, in program 1401 (Catalysis & Biocatalysis), less than half of HR proposals were funded in 2011, while about 90% of HR proposals in program 1406 (Thermal Transport Processes) were funded in the same year.

The average CBET award size is unacceptably small – just 2/3 of the NSF average – although the Division has no plans to increase award sizes since this would suppress success rates still further. Low success rates coupled with the low funding levels are likely to exacerbate the problem by obliging PIs to submit even more proposals just to maintain a minimum level of research activity. This problem has grown increasingly acute during the review period as the costs attendant to the performance of research at universities have risen steeply (tuition, recharges, overhead). The previous COV noted that award sizes were not large enough to cover even the cost of one graduate student, an undergraduate assistant, research supplies and a small portion of PI salary; this is even more true today than at the time of the 2009 COV report.

The Division's response to this convergence of pressures is to move to a single submission window per year for unsolicited proposals, in an attempt to decrease the number of submitted proposals. After one cycle, this change appears to have been successful, as there were 20% less proposals received last year, and this should translate into a slightly increased success rates. However, this drop in proposal numbers could be short-lived, as the PI community adapts to the new process. It may also be useful for the PDs to narrow program descriptions. The use of descriptors of areas that are not of interest to the program, in addition to those that are, may reduce the pre-review burden engendered by proposals that do not address the core mission of each program.

The Division faces the very real possibility that strong PIs conducting the most 'transformative' research will stop applying to CBET because the awards are too small and too infrequent to be worth the investment of time and effort. The CAREER program will likely remain heavily subscribed, despite the low funding rates and levels, because of the prestige of these awards and their importance in tenure decisions. In the long run, the high proposal pressure needs to translate into strong arguments for additional funding of CBET programs.

The Division is to be congratulated on the very significant increase in the number of proposal decisions made within 6 months of submission, from below 70 % in 2009 to over 90 % in 2011.

There was some concern in the previous COV about whether existing mechanisms for identifying suitable new program officers are effective. The Division has made important changes to facilitate the integration of new program officers, including assigning mentors, encouraging them to enroll in NSF training courses, and obtaining new staff positions to reduce the workload.

It was noted by the COV that the travel budget for program officers to conduct outreach to prospective proposal writers is limited. While this type of travel may seem less necessary with increasing and effective use of alternative meeting formats like interactive webinars, there is no replacement for in-person contact.

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

This question was very difficult to address based on the information provided to the COV. The self-evaluation provided to the COV indicates that CBET has sponsored a number of workshops (although not uniformly across programs) aimed at soliciting input on future directions worthy of research support, and this is judged to be meritorious. However, it is not clear how priorities generated by stakeholders are internalized and processed into the ultimate call for proposals, or how this affects success rates. There persists in the external stakeholder community the perception that the culture of NSF does not support innovation and prioritizes *safe science*. CBET is encouraged to adopt the best practices of other granting agencies that use the published proceedings of workshops to engage and motivate the applications in priority areas.

The Division cites the use of NAE grand challenges, workshops, retreats, and proposal pressure as the ways in which it prioritizes funding for existing and new areas. Three AAAS fellows were hired to identify areas and best practices. Broad and timely dissemination of their findings is encouraged.

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

The site visit revealed structural impediments to the development of what is classically referred to as a *strategic vision*. The COV strongly encourages CBET to continue to think more *strategically* about the vision, goals, milestones and metrics that pertain to identification and support of existing and new areas of emphasis, the prioritization of considerations such as more funded investigators *versus* expanded budget for high-impact projects, etc. Such a *roadmap* is all the more important in times of constrained resources when difficult decisions (with winners and losers) need to be made. The absence of such a document/culture is likely to result in dilution of impact and disenfranchisement of precisely those investigators the Foundation wishes to encourage. The COV is left with the distinct impression that program planning takes a back seat to simply meeting the day-to-day needs of handling a very large number of proposals with a very small funding budget. This suggests that additional personnel, or outside technical experts, are required to ensure a clear vision for use of grant resources.

The Division recently conducted a grantee conference in 2012, which should be a very rich source of information about what types of research and educational initiatives the community wants. The comments on the effectiveness of this conference were mixed: Some attendees felt that it cost a lot of money, and asked whether webinars would be just as effective and a lot less expensive. Some felt that the conference covered too broad a range of research, and that too much time was spent

reporting specific science (of narrow interest) while not enough time was allocated to broader impacts (of general interest). Other respondents truly enjoyed the very broad topics. There appears to be widespread support for holding another conference (80% of respondents agreed), but not every year. However, a consideration not mentioned in the post-conference survey is the time committed to this exercise (over 300 busy PIs spent 3 days, including travel, attending the conference). The COV believes this conference can be quite useful to the research community, but that non-NSF funded PIs (particularly younger researchers) might be allowed to attend the conference if they support their own travel and expenses. Many junior faculty could benefit greatly from possible mentoring aspects of the meeting, such as getting tips on writing effective proposals or making new research collaborations with more senior researchers.

It was clear at the COV meeting that CBET is underfunded relative to a large number of metrics. However, when asked what the Division would do with increased funding, the main response seemed to be just to increase the success rate. It would have been good to have seen more evidence of a more strategic investment of additional funds if those were available. The COV encourages the development of a more comprehensive approach to the prioritization of needs that is driven by the science, and that takes into account stakeholder input.

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

CBET has been highly responsive within the limitations of management's constraints. The COV appreciated having available the previous COV reports and information on the program changes in response to the previous COV.

With regard to management of the review process, clearly it can be very challenging to get excellent reviewers, and to get participants to write thorough reviews. This is particularly true in a panel setting where it is may not be possible to have 3 or 4 true subject matter experts present. Likewise, NSF upper management controls budgets and most policies, and CBET has a limited ability to maneuver independently within that framework.

One previous comment was on proposal review time. Based on the COV reviews, it appears that the Division has improved proposal-processing times substantially.

Program officers are continuing to work with panels to ensure that individual reviews and panel summaries are more thorough. The Division Director has also been vigilant about requiring program officers to provide clear justification for awards, returning proposals for additional information where this is missing. This is very desirable, but suggests that panel summary writers still need more instruction and monitoring by program officers to ensure that justifications are made during the panel meeting.

The Division has been piloting the use of virtual panels. While the COV did not review detailed information on this subject, during the COV meeting discussions with program managers seemed to indicate that their early analysis indicated that this approach was promising, but that there remained many issues to be addressed and optimized. This subject of virtual panels is therefore one that a future COV should consider. Based on our general assessment of this approach, the COV does encourage the use of IT and other technologies in the reduction of administrative costs and the efficient management of grant review.

The Division's response to the need to better inform its reviewers about broader impacts and program strategies is to direct them to website links. This may not be the most effective approach,

given the already strong time-pressure on reviewers. The COV recommends that more proactive steps be taken, for example, by allocating time for Q&A with the program managers during the pre-panel discussions.

IV. Portfolio Review.

1. CBET's Division Strategic Areas (e.g., BioEconomy and relation between NSF/CBET and NIH; Sustainable Environment and Energy; Advanced Manufacturing, etc....)

Overall, there is general agreement among the COV that CBET is wisely making strategic investments and finding a balance in identifying specific areas that are at the cutting edge of scientific (e.g. sustainable energy), and national needs (e.g. advanced manufacturing). These strategic emphasis areas need to be incorporated into a Division plan. CBET appears to be in the process of updating their last plan from 2008, and so progress should be made in this area soon. Two retreats were held in 2012 for division planning in support of this effort. If the plan moves along the lines established by these strategic areas, then there is a good likelihood that the plan will be helpful in addressing these strategic areas in a more concerted and clear manner. There should be an ongoing effort to identify new strategic areas, and a willingness to realign program names and their emphasis areas to accommodate these topics within the core areas, so as to keep the research vision focused on the cutting edge. Even within a general topic, it helps to focus on especially critical issues and the really "big breakthrough challenges". Educational aspects are particularly important and should be included within both core topics and strategic emphasis areas.

Good evidence of the interest by the science and engineering community in the CBET strategic areas was the large number of proposals received in these strategic topics. The downside of that heightened interest, however, was a low percentage of the proposals funded, as available funds within these areas were not sufficient to fund all of the proposals in the highly recommended category. The impact of this high scientific community interest in the CBET areas, and the low funding rate, are pervasive topics in this report as they affect many aspects of CBET activities and operation.

Examination of the topics within CBET with respect to nanotechnology resulted in mixed comments on the appropriate level of emphasis. On the one hand, it was argued that this topic is so important that it should be its own strategic area within CBET. However, others thought that nanotechnology has been an overarching emphasis across the Foundation for many years, and this was a thrust that was justifiably getting less specific attention in strategic activities in future years in favor of newer specific thrusts. Except for one program, nanotechnology is not a program topic within CBET. Rather, it is now a topic that is intertwined within many programs across the Division. The one program that specifically addresses nanotechnology (within Environmental Engineering and Sustainability) does not focus on development of nanotechnology, but rather on the health and safety aspects of nanotechnology. The COV felt that this approach of integration of nanotechnology into many different programs was appropriate.

Several COV members also thought that CBET participation in novel approaches to address general areas of interest, were a good strategic effort. For example, to spur innovation across NSF the ICorps was seen as a useful approach for addressing seed funding for startup companies in a completely new way. The COV encourages participation in these programs as well as others (such as GOALI) which help to support university-industry collaborations as methods to translate NSF research into potential commercial applications.

The importance of these strategic areas could additionally help with fulfilling the Foundation's mandate to provide a "Broader Impact" in research work. The COV is aware that NSF is addressing the need to better define and implement Broader Impacts. As this NSF effort further develops, program managers within CBET are encouraged to work with PIs and the community to address this important area. In some part, the specific strategic area itself could constitute a topic of importance. However, this emphasis on topical area should not dilute the efforts of many PIs in maintaining

diversity in different core and strategic investment areas, and in the community. It was noted, for example, that there is sometimes a lack in diversity in PIs, panels, and reviewers, and this subject of diversity will continue to need to be addressed.

2. Emerging opportunities where CBET could play a leadership role (e.g., SEES; National Issues/ Crises: Gulf Oil Spill, Natural Gas /Hydraulic Fracking; etc.)

The SEES initiative is one that is over-arching across many NSF programs, and an excellent opportunity for CBET involvement as many of the SEES strategic areas are related to those of CBET. While there is a danger of excessive budget commitments and expenditures in strategic topics, CBET has shown that it is committed to maintaining a good amount of funding in unsolicited proposal areas, and that it is avoiding overspending in these topics. The COV commends the efforts of the CBET leadership and staff for moving in the direction of a high percentage of funds for unsolicited topics. In previous years, it was noted that as much as 50% of the funds were put into directed efforts. Currently, ~75-80% of funds are available for unsolicited proposals, which the COV concluded was an excellent and appropriate level.

CBET has used rapid funding approaches for tracking suddenly developing environmental activities, such as Gulf oil spill (through the Grants for Rapid Response Research, or the RAPID program), and it appears that this approach has had substantial positive impacts. For example, a workshop was held on the Gulf oil spill, which the COV recognized as an excellent cross-disciplinary effort, and one very appropriate for CBET. The oil spill was a problem of sudden and national importance that required a crosscutting approach, and CBET/NSF was uniquely suited to address this broad and sudden issue. This workshop led to additional funding through Gulf Oil consortium for continued research for a group of ~50 universities, and thus this relatively small effort by CBET had a large, positive impact on the research community. With regard to natural gas and hydraulic fracking, this issue is one that is having an enormous impact on society and possibly the environment. There are great opportunities for NSF to have an important role in researching overarching issues such as impacts on air, water, soil and groundwater. The COV encourages CBET to continue to identify those topics of national interest where it is uniquely qualified to have a substantial impact through rapid funding, and leadership through the establishment of strategic thrust areas and specific actions such as workshops.

3. CBET Collaborations (Other NSF units/Other Agencies / Industry; e.g., NIH, Dept Energy; DARPA, other NSF divisions and activities (e.g., CMMI and EFRI, and ERCs)

CBET is doing a good job of fostering collaborations among agencies, but more could be done. Urgent areas of interest for the Nation that cut across but do not fall squarely in one or the other mission agency area would be suitable. CBET/NSF can take a unique leadership role in cross-disciplinary topics, such as sustainability, as there are no mission agencies that focus specifically on this important topic. Sustainability research enables research in multiple-focus topics such as green catalysts, combined wastewater treatment and energy production, and energy saving technologies (as opposed to only energy production), among others. In addition, CBET activities in these areas can achieve additional goals which are not necessarily main objectives of the mission agencies, such as: providing training for a new work force in emerging areas such as the renewable energy market; integrating research and education in both core and strategic areas; facilitating international collaborations; and the integration of social scientists with engineers and scientists on different technical topics. Each agency should bring something unique to a collaboration such that the resulting effort is greater than the sum of its parts. These interagency collaborations provide a venue for the different agencies to bring unique perspectives and approaches to address and solve issues of national importance. These existing interagency collaborations are important, and should be better identified and highlighted by CBET and the other agencies. It is important to communicate these efforts to both the scientific communities and the public.

CBET should focus on topics that cut across all of the agency missions. This does not mean the CBET funds the basic work while the mission agency funds the applied work. Mission agencies do fund both basic and applied research. Mission agencies must focus their efforts in specific areas so they can make an impact, and there is a lot of space that is left uncovered. The temptation is to fill those gaps, but NSF should instead try to focus its efforts in areas that cut across mission agencies.

There was a consensus among the COV that collaborative efforts between CBET/NSF and other agencies in complimentary areas are beneficial and desirable, and that continued collaborations are encouraged. It would be helpful in the future to make better efforts to clarify delineations between research that CBET/NSF funds, and for example that NIH or DOE fund. It was suggested that during reviews of NSF proposals in the medical fields, for example, that appropriate NIH representatives could participate in these panel reviews to provide additional clarity on separation of topics.

CBET is making good progress in terms of collaborations with industry, but these collaborations should be strengthened. The COV recommends that in addition to activities with industries, that greater efforts be made to work with professional societies. Examples of such activities could include jointly funded workshops, to promote and explore programs such as GOALL; increased participation of industry representatives in panel or external reviewers; and a continued presence on advisory committees in the Engineering Directorate by individuals with industrial expertise relative to those in the CBET program areas.

4. Support for potentially transformative research

It was difficult for the COV to identify, at this stage in the review of proposals and highlights, transformative research in the CBET program areas. Truly transformative work can take decades to evolve and become apparent. The COV certainly supports the emphasis by CBET/NSF to work towards this goal of transformative research. Aside from just transformative work, it is important that other successes and important discoveries and advances be well identified and described in publicly accessible material, and that this be presented in a manner useful to scientists and the public alike. The research highlights did contain information about how the work could be transformative, but ultimately only a small percentage of work will achieve this goal. Therefore, while it is good for the program managers to think about this aspect when they are putting together their highlights, we encourage CBET to highlight any and all exciting advances and accomplishments in addition to those transformative ones. NSF often highlights some of the most exciting findings and accomplishments within the Foundation in their “spotlights” page. We encourage CBET to highlight some of these projects on their own webpages.

There are special programs that enable high risk/high reward types of projects that are excellent vehicles to enable the formative stages of truly transformative research, such as Early-concept Grants for Exploratory Research (EAGER). It would be useful in the future to provide some examples on how these EAGER funds have been used, and historically how they fared in terms of impact compared to standard (panel-reviewed) grants. It is not expected that EAGER projects have high success rates in terms of translating high risks into projects that continue. Indeed, by definition, the opposite is expected due to the inherently risky nature of this work. However, it would be hoped that a few of these EAGER projects would lead to some truly remarkable discoveries and facilitate new research directions. Highlighting specific examples of these successful projects would lend support to the use of EAGER funding mechanisms.

OTHER TOPICS

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 was completed prior to the review by this COV, and by all measures it appears to have been successfully accomplished as all indications were that the CBET Division was operating well as an integrated entity. CBET currently has 17 program areas organized into four subject clusters. This organization appears to be working well and Program Directors function effectively within the clusters. Nevertheless, COV suggests that the collection of 17 program areas should be revisited periodically to ensure their appropriateness as contemporary emphases and interests of the research community evolve. It behooves CBET to remain alert for “old” programs that should be reviewed for their continued relevancy. This is particularly true for technology/application based areas which bubble up because of current national interests, and political or administrative visions.

The main issue as CBET moves forward is the funding levels for this Division. There is a persistent need to increase the resource base for ENG in general, and an obvious need for additional funding for CBET in particular. One obvious consequence of this inadequate funding base is the small fraction of proposals that CBET is able to fund. In 2011, CBET’s funding rate was only 11%, compared to NSF’s average of 22%. Even for “highly rated proposals”, CBET was able to fund only 61% in 2011 (an improvement over 2010, but a decline from the 83% rate of 2009). Such statistics, if not corrected, marginalizes the effectiveness of CBET and Engineering Directorate in supporting high quality research. This need for increased resource was noted in the 2009 COV report, but it still remains a serious and urgent issue.

An inadequate resource base imposes undesirable trade-offs between award size, duration and number of funded projects. The COV further suggests that the current averages of ~\$100,000 and 36 months for CBET projects are insufficient. For example, average project duration of 36 months does not take into account the fact that PhD studies usually take 48 months or more. To increase duration of support by 1/3 without additional resource would require a proportional reduction in funding rate if the funding levels were not changed. This is obviously an undesirable trade-off, and thus one that cannot be changed unless the funding based for CBET is increased. If funding resources could be improved, then the COV recommends increasing both average funding level and duration for CBET projects.

Based on our assessment of the high performance of CBET, and this low success rate, the COV therefore recommends to NSF (by way of the Engineering Directorate), that funding levels be increased for CBET. This will likely not happen, however, unless CBET is more pro-active in publicizing the importance of the research it supports and the notable successes of its grantees. Such activities will help make a stronger case for an increased share of NSF funding.

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.

CBET has been generally successful in meeting program goals and objectives, as discussed in parts I through IV above. Some additional comments and suggestions are provided here to aid further Division directions.

In some cases the foci developed in strategic plans are not reflected in actual awards, perhaps due to disconnect between foci selection and community submissions. The Division should seek ways to reduce such disconnects. Alternately, the Division can consider if foci should be allowed to evolve as driven by community participation. Research foci initiatives often arise in response to perceived societal needs or engineering challenges. Such foci are sometimes more mission oriented than traditional research in classic engineering sciences. The COV recognizes the necessity for supporting both types of research (strategic and core) but urge that an appropriate balance be judiciously maintained. The COV further notes that there can be a consequence of identifying specific strategic areas to the academic community, as some universities will hire faculty based on these identified research directions in order to obtain improved research funding in their departments. This could potentially lead to an imbalance in faculty expertise by subject areas through the nation in strategic rather than core areas.

The COV urges that support for strength in classic core areas be sustained. This is important for itself, but also to sustain the fundamental capabilities needed to quickly respond to new foci as they are identified.

The COV further commends CBET for its strong support for unsolicited proposals, which comprise 75 to 80% of the funds awarded. The NSF is really the major funding source for curiosity/discovery driven fundamental research in the applied fields covered by CBET, so maintaining a high level of funding in the unsolicited areas is in the national interest.

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

The COV appreciated the opportunity to consider agency-wide issues, and a substantial part of our discussions were open-ended in order to provide good consideration of this topic. Several points were identified that may aid CBET as well as other divisions in NSF.

First, in reviewing the past proposals and examining the way that previous research is reported, it was noted that there was great variation in the way that this was reported as well as the relative emphasis given to Intellectual Merit compared to Broader Impacts. In general, much less attention is given to Broader Impacts. Part of this results from a lack of understanding by many PIs on what needs to be done in this category. However, as noted in this report, the Broader Impacts category is being analyzed further by NSF and we assume that additional guidance will be provided in the future. Thus, at this stage, no further comments are provided by the COV.

The COV recommends that the template for the final technical report provided to NSF be updated, revised, and made more fully accessible to panel members and reviewers when considering new proposals. The existing reporting system is antiquated, not well organized, and thus it is due for an overhaul. It is suggested that an improved and separate Report file, which succinctly identifies accomplishments versus "promises" in original proposal can better document impact of the completed project, and also be useful for assessment of renewal proposals. We are not recommending that the report be extensive in scope or unduly demanding in time to prepare. However, the information in the report should readily identify actual accomplishments and be made more accessible.

The COV recommends that following a panel meeting that panelists be asked to comment on the panel process by an anonymous process, for example an electronic survey. This would give immediate feedback to the Program Directors as well as provide a source of additional information on the panel process for the COV.

As noted by the 2009 COV, cooperation between programs within CBET, and with complementary programs in other ENG Divisions, Directorates, other funding agencies is beneficial for all parties. Program directors in CBET have been motivated to seek such cooperation – a laudable effort that should be encouraged and actively supported.

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

Two general issues were noted by the COV. First, the workload for Program Directors in CBET is very heavy. In the period of 2007 to 2011, the number of submitted proposals increased by 69%, while the Division budget grew 27%. CBET Program Directors handle a great number of proposals each year per PD, well above the averages for other divisions and directorates in the NSF. To their credit, the PDs have not allowed this overload to negatively impact the quality of their program or the processing of these proposals in CBET. Nevertheless, the COV feels that this situation is not desirable or sustainable for the division in the long run. The COV recommends that additional staffing and needed resources be granted to CBET to ameliorate this overload on the PDs.

Second, CBET instituted a new policy of one window per year for submission of proposals. The experience in first year is promising, seeing reduced number of proposals without apparent negative reaction from the research community. This experiment should be continued for at least another year, to enable an assessment of the longer-term effects. For example, will the number of proposals rise as academics shift to this single window and try to produce more proposals for once a year chance to get funding? Also, how will this impact funding of creative and innovative ideas? Will ideas become “stale” if they are around for potentially a year or more before being funded? There should be an assessment of the number and quality of proposals that result from this move to a single window.

Finally, as noted in Section II, several panels had little or no underrepresented minorities or women. We recognize this reflects the lack of diversity in the larger CBET community. The COV encourages CBET to look for innovative ways to support diversity. For example, in past years CBET funded a series of highly successful workshops that were aimed at encouraging late-stage URM graduate students and postdocs to consider careers in academia as well as providing coaching on career advancement to those already in the professoriate. These and other high-value activities strengthen local diversity efforts, and send an important message throughout the CBET community on the importance of continuing to work to achieve faculty and student populations that reflect the population at large.

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

The overall COV process was generally very good. There was excellent preparation and support by CBET management and staff, and they provided a wealth of information for COV members. Based on this experience, we do have a few comments on specific aspects and suggestions to improve the future COV review process.

The Self-Analysis report that was prepared by Division was a new set of material provided to a COV. We found this report to be extremely helpful to COV members in evaluating past and future directions. Continuation of this practice is urged for all future COV reviews.

The original Agenda prepared for the COV was fairly constrained in terms of time for open discussions. The previous COV noted that it was essential to provide more time for discussion rather than summaries. With the help of CBET staff, we “opened” the structure of the Agenda to leave

more time for both group and full panel discussions. This worked out very well, and we encourage future COV panels to use a more open agenda. The main feature of future agendas should be to conclude the Parts I to III on the first day, in order to allow time for discussions on the more open-ended points that need to be addressed in Parts IV and V.

CBET Division Director John McGrath also gave two presentations, one related to Parts I-III, and the other on sections IV and V. Rather than just summarizing the CBET organization or structure, Dr. McGrath gave a very effective evaluation of CBET and he provided responses to the initial points raised by the COV in their draft comments (provided to CBET only days before the meeting). This presentation was extremely helpful and it provided pertinent data that addressed many of the questions raised by COV members in their preliminary discussions.

The main area that the COV feels there is a need to improve was the schedule for COV to do its work. The schedule we worked under was very hectic and it was begun only 3 weeks before the COV panel meeting at NSF. It was unreasonable to ask the COV to undertake the collection of input on the section, the drafting of template sections by leaders, and the transmission of drafts to NSF management for initial answers/presentations within a 3 week period, when many panel members were traveling or otherwise unavailable during this short period of time in the summer. More lead time is needed and much more of the actual work should be done earlier, once the COV is formed. It is suggested that Engineering develop a standard schedule, working backwards from whatever panel meeting date is selected, with ample time given for the review of the 300 jackets and deadlines established for input into section reports. This would greatly facilitate a more thorough and less hectic review by the COV members.

The next COV should be provided a summary sheet of the program numbers and cluster abbreviations since so many of the charts and data are defined by these numbers. Other acronyms that are frequently used would also be helpful to have defined, especially for those COV members who are not as familiar with the different engineering programs. The next COV should also be provided a list of all currently funded grants for each program so that they can obtain a better perspective on the current portfolio. Furthermore, it is suggested that the materials provided to the COV be more condensed and on one site, thereby minimizing the time needed to learn how to access information and then to download that information.

SIGNATURE BLOCK:

A handwritten signature in blue ink, appearing to read "Bruce Logan", is written over a horizontal line.

For the 2012 CBET COV
Bruce Logan
Chair