2007-2010 Engineering Education and Centers Division (EEC) Committee of Visitors Report

Date of COV: February 18 and February 19, 2010
Program/Cluster/Section: **Engineering Education, Human Resources Development, Engineering Research Centers, NSEC**
Division: **Engineering Education and Centers**
Directorate: **Engineering**
Number of actions reviewed: **Awards:** **Engineering Education: 19 Awards** **Human Resources Development: 19 Awards** **Centers: 15 Actions** **Declinations:** **Engineering Education: 16 Declinations** **Human Resources Development: 7 Declinations** **Centers: 3 Declinations** **Other:** **Engineering Education: 2 Other** **Human Resources Development: 1 Other** **Centers: 10 Other (Full Proposal Not Invited)**
Total number of actions within Program/Cluster/Division during period under review: **Awards:** **Engineering Education: 255 Competitive Awards** **Human Resources Development: 138 Awards** **Centers: 47 Awards** **Declinations:** **Engineering Education: 669 Declinations** **Human Resources Development: 327 Declinations** **Centers: 6 Declinations** **Other:** **Engineering Education: 62 Other** **Human Resources Development: 14 Other** **Centers: 173 Other**

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.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: **Engineering Education** • For the Engineering Education program, 97% of the reviews were conducted through panels. The panel process is run professionally and provides high quality and timely reviews. • For the IEECI program, 93% of the 1,974 reviews were performed by panels. Of the 7% of reviews conducted by mail, 47 (of 180) were late. 132 of these reviews were completed and returned. • For the NUE and BRIGE programs, 100% (784 reviews) and 97% (out of 784 reviews total), respectively, were panel reviews. Of the 3% mail-in reviews for the BRIGE program 28 were requested and 24 were returned with 4 late. • The NSF procedures for mail-in versus panel reviews were not documented in the materials that the COV received. **Centers** • It is not clear how many reviewers per proposal are appropriate. For center preliminary proposals and center full proposals, the numbers ranged from 3-6. In order for *ad hoc* reviewers to be effective, it is recommended that the reviewers have experience with center proposals, or that they have multiple proposals to review to provide a basis for comparison. • The full proposal process works remarkably well. Site visits are done well.	Yes (All Sub-Teams)

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

Human Resources While review mechanisms are appropriate and have worked well for many years, additional thought should be given to instructing the review panels to be open to proposals that involve community colleges, freshmen, and sophomores. Data Sources: COV Quality and Effectiveness of the Merit Review Process, Jackets	
2. Are both merit review criteria addressed 1) In individual reviews? Yes 2) In panel summaries? Yes 3) In Program Officer review analyses? Yes. Overall excellent analyses. Comments: **Engineering Education** • Reviews were comprehensive and provided a summary of the work, as well as strengths and weaknesses in terms of the review criteria. In addition, they summarize why individual reviews may have been different than the overall panel review. **Centers** • In general, there is the need for continued emphasis to reviewers on the expectations for reviews. NSF should provide **templates for the reviews (e.g. add strengths and weaknesses sections**). Reviewers should provide evaluative reviews rather than just restating what is in the proposal. • In particular, there was a wide variation in how well broader impacts were addressed by reviewers (some reviewers just summarized the proposed activities without evaluative comments). **Human Resources** • No comments provided. Data Sources: Jackets	Yes (All Sub-Teams)

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments:	Yes (All Sub-Teams)

Engineering Education • Overall the reviewers were thorough in their reviews. Several provided detailed and substantial reviews. • The COV observed that reviews giving a low rating are often accompanied by detailed feedback. Reviewers giving high ratings should be encouraged to provide substantive comments about the strengths of the proposal and areas of improvement to guide the PI's execution of the research. **Centers** • ERC proposal reviews were more thorough than regular panels, but there are still some cases where only 1 or 2 reviews are substantive (mostly in the pre-proposal stage). • NSF should continue to emphasize the value of evaluative comments as opposed to restating proposal statements. **Human Resources** • Communications appear to be clear as to the strengths and weaknesses of the proposed ideas. • The recommendation made by the 2007 COV review to provide example reviews from the past to panelists in advance of the meeting (as an effective mechanism to obtain good reviews) should be standard for all panels. Data Sources: Jackets	
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Data Sources: Jackets **Engineering Education** • The panel summaries overall were good • In many cases, consensus was reached despite varying individual ratings. When the panel explained how they reached consensus, it was useful feedback. • The 2007COV review committee brought up the concern of panels repeating individual review statements. We acknowledge that the PDs are addressing this issue. There were numerous examples of review summaries that were more comprehensive than the individual reviews; a few were still lacking. PDs must continue to encourage panelists to include summaries of panel discussions, in particular additional information that can help the researchers improve their work. **Centers** • Summaries are very well done--well integrated and descriptive, rather than just a restatement of individual reviews. Summaries contain additional information from the discussion. • The summaries are good for even non-invited proposals • PD's are exceptional in ensuring panel summary quality	Yes (All Sub-Teams)

Human Resources • Panel review summaries should document the panel discussion and the findings/discussions of the panel, and not summarize the proposal itself. There is an indication in some cases the panel summary is used to restate individual reviews. **Recommendation**: Develop a template for the REU/RET panel summary	
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (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.) **Engineering Education** • The PD's review analysis is a complete summation of the project and expected results. • The COV recommends that there be a comparative summary of the evaluations and awards provided to the COV. **Centers** • PD review analysis and recommendations are thorough and complete. **Human Resources** • For the REU/RET programs, the program directors are thorough and provide good justification for awards and declinations. Data Sources: Jackets	Yes (All Sub-Teams)

6. Does the documentation to PI provide the rationale for the award/decline decision? (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.) **Engineering Education** • See comments under Questions 3 and 4. • We also recognize that the PDs provide additional useful input and comments after the decision. **Centers** • The PD's are exceptional in assessing review quality. • There was one example provided to the COV, where there was a change in emphasis on certain critical issues as the process moved from pre to full to site visit. This led to not enough early warning on problems with the proposal as determined at its final stage. The issue appears to be the different viewpoints brought into the process from each group of reviewers. The COV realizes that variation in viewpoints during the process naturally occurs; however, some consistency is needed in the weighting of criteria throughout the process. **Human Resources** • The summaries and PD analyses are thorough and provide justification for their recommendations. Data Sources: Jackets	Yes (All Sub-Teams)
7. Is the time to decision appropriate? 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. **Engineering Education** • The time to decision is exceptionally rapid for the engineering education programs. Although the number of proposals has increased from 180 (2007), 235 (2008) and 316 (2009), the percentage of decisions meeting the goal has progressed from 53% to 85% to 90%, respectively. • In 2009, only 10% were not reviewed in 6-9 months.	Yes (All Sub-Teams)

Centers

- Yes.
- The two-year cycle is appropriate.

Human Resources

- FY07 and FY08: > 90% of proposals had a time-to-decision that met the 6-month period. However, in FY09 some proposals were delayed due to the anticipation of additional ARRA funds (announced in Feb. 2009) that were made available (July 2009).

Data Sources: COV Quality and Effectiveness of the Merit Review Process, Jackets

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

Engineering Education

- Our reading of the jackets produced similar opinions as those outlined in the panel summaries.
- The merit review process is even stronger than the last COV. The level of detail of the reviews has been expanded. Additionally, the data provided to the COV is significantly more comprehensive. Providing statistical data made the COV review considerably easier and also allowed for better transparency of the progress being made.

Centers

- The ERC review process for funded centers is outstanding.
- ERCs have a substantial review in Year 3 to determine whether or not the ERC will be funded for an additional 5 years, and then again in Year 6 to assure that the ERC is still meeting its big picture goals.
- NSF should consider adopting the ERC (3 yr/ 6 yr review versus 5 yr renewal review) review process as a best practice for all large centers such as NSECs and STCs.

Human Resources

- The REU and RET programs have discussed the need to involve more non-research I universities, community colleges and lower division students (freshman and sophomores) in the programs.
- The COV would like to encourage the PDs to include strong language in the RFP or program announcements stressing the need to have a diverse group of participants in terms of educational background in addition to ethnicity.

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]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? **Engineering Education** • Since only geographic, gender, race, and ethnic distributions are indicated, it was difficult to judge. It would be helpful to the COV to provide information that can help answer this question, e.g., experienced versus new reviewers, field of PhD, research expertise. • Our review of the jackets revealed that most panels had expertise in engineering education. It is imperative that panels have sufficient engineering education research expertise to evaluate the proposals. **Centers** • Yes. **Human Resources** • Yes. Data Source: Jackets	Yes (All Sub-Teams)
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. **Engineering Education** • The data illustrate that the Engineering Education programs did select reviewers from diverse geographies. It appears there was some weighting on the southeast with 41% of the reviewers coming from that region. This compares to the mid-east with 19%, far west with 12%. The lowest representation is from regions with the lowest population. • It would be helpful to have data normalized by population of the state and number of engineering faculty. • Females are well represented as reviewers with 32% of those reporting their gender being female. The directorate has done an excellent job in involving women in the process.	Yes (All Sub-Teams)

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

• 4% of females and 8% of males reported that they are from multi-cultural groups. Over 70% of the PIs did not report their ethnicity so it is difficult to determine the actual representation. It was noted that no reviewers were from Puerto Rico, and they are currently involved in engineering education research. Nevertheless, NSF is clearly making a conscious effort to engage a diverse community. • The types of institutions that are represented are also very broad. For engineering education only about a third of the reviewers are from doctoral research universities. The other reviewers represented all other types of institutions including Baccalaureate, Master's, industry, and federal government/labs. • Overall, Engineering Education programs have done an exceptional job of engaging a diverse set of reviewers. NSF may consider using video conferencing to involve more reviewers from geographic areas that require two travel days. **Centers** • Reviewers tend to be concentrated from the east coast (not sure if this is because of reluctance of invited reviewers who have to travel farther) - especially from the southeast. Perhaps some panels could be held in other geographic regions of the country. • It is not possible to make a judgment on demographics due to 77% of the reviewers not reporting their demographics. • "All reviewer" demographic charts do not seem to correlate with individual breakdowns. • More industry reviewers are needed - especially for ERC proposals. **Human Resources** • Yes Data Source: COV Selection of Reviewers	
3. Did the program recognize and resolve conflicts of interest when appropriate? **Engineering Education** • Yes. There were reviewers that had been selected but opted out based on COI. Context statements indicated they were resolved. **Centers** • Yes. **Human Resources** • Yes. Data Source: Jackets	Yes (All Sub-Teams)

3. Additional comments on reviewer selection:

Engineering Education

- With an increased emphasis on international collaborations, the program should consider including international reviewers when appropriate.

Centers

- No comments were provided.

Human Resources

- Use of young faculty on review panels is commendable, but their lack of understanding of the overall program goals can negatively impact funding recommendations. Additional guidance/orientation should be provided for new reviewers.
- Reviewer demographics: Efforts should be made to collect demographic data from review panels. The information provided reflects a significant percentage of unreported data – thus, it is of little value.

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.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. **Engineering Education** • Good quality projects have been recommended using a thorough review processes. **Centers** • ERC quality is outstanding and cutting edge. The rigor of the proposal process leads to strong centers. **Human Resources** • The program offers high quality research projects with substantive involvement of the undergraduate scholars and teachers. Data Source: Jackets and Program Summaries	Appropriate
2. Does the program portfolio promote the integration of research and education? **Engineering Education** • Review of the e-Jackets suggested that the overall integration of research and education was good. The program goals and objectives emphasize research in education, in particular the NUE program integrated research findings into the curriculum. **Centers** • The RET effort is good and productive, and should continue to increase. • ERCs have done very well in this area (e.g., REU, RET) because there is more infrastructure possible than in individual investigator awards. There is also an excellent track record of improving graduate education. • There needs to be some insurance of a positive impact on undergrad instructional programs (not just a specialized course); it is best to develop materials for core courses that can be replicated at all institutions. • The ERC program needs to continue to encourage the participation of undergrads in Center research	Appropriate

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

Human Resources • REU and RET are excellent examples of NSF programs that integrate research and education. Data Source: Jackets and Program Summaries	

3. Are awards appropriate in size and duration for the scope of the projects?
 	
Engineering Education
 	
• The number of awards has increased from 30 in 2007 to 55 in 2008 and 81 in 2009. This is a positive increase given the recommendation of the last COV to build an emphasis on engineering education. The size of the awards has increased from $125K in 2007 to $249K and $214K in 2008 and 2009, respectively. The effective award size was less in 2009 since the award time increased from 2 years to 2.2 years.
• Comments:
  o The Engineering Education program is severely underfunded, as suggested in the previous COV report. To increase the impact of the program, NSF must increase the funding.
  o The impact of the research may have been reduced as result of the short 2- year duration. Additional tracks are recommended that have, for example, single PI (e.g., $300K for a minimum of 3 years), small group PIs ($750K for a minimum for 3 years) and multi-PI/institutions (>$2M/yr) up to 5-10 years.
  o One approach in this regard would be to create ERCs in engineering education.
  o Note: There was ambiguity in the reporting of the $/year/PI data.
 	
Centers
• Yes, generally true. Caution should be exercised to avoid diluting funding of core engineering and science efforts as Gen-3 initiatives are introduced.
• Caution should be exercised to avoid underfunding new initiatives (unfunded mandates)
 	
Human Resources
 	
• Given the successful track record of the REU and RET programs, additional funding must be provided to these programs for greater impact. There is a sense of urgency in this matter as expressed by the NSB report. With concerns over the STEM pipeline, REU and RET are established models to address these concerns.
 	
Data Source: COV Resulting Portfolio of Awards
	Appropriate (could be improved to increase impact)

4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? **Engineering Education** • There appears to be funded projects that have the potential to be transformative; however, there is not sufficient information to clearly evaluate this balance. • Broad transformation requires longer and better funded projects similar to ERCs. • Change the wording on the highlight template to "is the project transformative" rather than "Does this highlight represent potentially transformative research?" Give examples of what transformative means. • A good example of a transformative highlight is WGBH's Design Squad. • The CAREER awards are all potentially transformative. **Centers** • The ERC program portfolio is outstanding –an interdisciplinary, systems approach is necessary to address complex scientific problems. • The new partnership with the SBIR program is very promising – it leverages other funds, improves connection between research advancements of ERC's and technical needs and potential success of the small businesses • Care needs to be taken that Discovery is preserved as ERC's move towards entrepreneurship **Human Resources** • Highlights from REU and RET contain a representative sample of transformative projects. Data Source: Jackets and Program Summaries	Appropriate (additional data needed)
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? **Engineering Education** • EEC has partnered with numerous directorates and offices including: Directorates of Social and Behavioral Sciences, CISE, Office of Cyber-Infrastructure, Geological Sciences, Education and Human Resources, as well as programs that include IGERT, ATE, CAREER, and HBCU-UP among others. In addition, the program directors have managed panel reviews for a number of programs. **Centers** • Yes, required for ERC **Human Resources** • Yes Data Source: COV Resulting Portfolio of Awards	Appropriate

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? **Engineering Education** • Including a table that summarizes award size, number of investigators and other appropriate characteristics would have been helpful to the COV. **Centers** • Not Applicable **Human Resources** • The 2007 COV report presented a recommendation to increase the participation of community colleges in the REU and RET programs. However, not much increase is noted in the new awards. A new approach to increasing community college participation should be considered. Data Source: COV Resulting Portfolio of Awards	Appropriate (Center Sub-Team) Appropriate (summary data needed: Eng. Ed. Sub-Team) No (Human Resources Sub-Team)
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. **Engineering Education** • EEC supported 79 out of 194 new PIs. The Engineering Education portfolio included 10 CAREER awards, 19/43 NUE awards, and 50/141 Engineering Education awards to new PIs--a relatively high number of new PIs for an NSF program. This encourages new faculty to become engaged in education research. **Centers** • Statistics on new investigators within ERCs would be required to evaluate this in some depth. New tenure-track faculty should be brought into ERC's to help them get started, get connected, and receive mentoring. • ERCs are uniquely positioned to provide leadership mentoring for junior faculty and graduate students. **Human Resources** • The percentage of new investigators as PIs of REU and RET awards combined is approximately 20% which is appropriate for these programs. Data Source: COV Resulting Portfolio of Awards	Appropriate (All Sub-Teams)

8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? **Engineering Education** • The distribution appears reasonable. To help the next COV, it is recommended that the geographic distribution data be normalized by the number of engineering faculty in each state and the population of each state. **Centers** • Yes. Consistent with research activity levels across the country. **Human Resources** • The geographic distribution of awards for REU and RET is good. However, given the impact of these programs, additional efforts should be made to engage participation by states currently without such awards. Data Source: COV Resulting Portfolio of Awards	Appropriate (All Sub-Teams)
9. Does the program portfolio have an appropriate balance of: • Institutional types? **Engineering Education** • The highest number is from PhD granting institutions (168), and the portfolio includes 20 MS, 13 MSI, 5 non-academic, 2 small business, 2 two-year and 1 Bachelors. It should be noted that all the CAREER awards are to PhD granting institutions as appropriate. **Centers** • Yes, each ERC must have affiliated institutions and core partners that include MSI's, etc. **Human Resources** • The award portfolio favors research intensive institutions. Data Source: COV Resulting Portfolio of Awards	Appropriate (Eng. Ed. and Centers Sub-Team) No (Human Resources Sub-Team)
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? **Engineering Education** • The data provided was insufficient to judge this issue. • NUE has run 8 years and should be evaluated for continuation. **Centers** • Yes. The portfolio shows that a broad range of disciplines are funded.	Appropriate (Centers and Human Resources Sub-Team) Appropriate (need more data – Eng. Ed. Sub-Team)

Human Resources • Yes Source: Jackets and Program Summaries	
11. Does the program portfolio have appropriate participation of underrepresented groups? **Engineering Education** • Data is inconclusive since over 70% of PIs do not report this. • Approaches to better identify members of underrepresented groups are needed. • Engineering Education should continue their efforts to invite panel reviewers from under-represented minorities to ultimately increase the number of successful proposals from under-represented minorities. **Centers** • While ERC's are strong in diversity by including MSI's as a core partner and having diversity programs, there is concern about the lack of underrepresented groups in leadership teams (outside of education and outreach leaders). **Human Resources** • With respect to awardees, while there appears to be representation from underrepresented groups in REU and RET programs. Efforts should be made by NSF staff to increase this participation including awards to MSIs. Possible suggestions include PD presentations at national professional society meetings of underrepresented groups. Data Source: COV Resulting Portfolio of Awards	Appropriate (Need more data-Eng. Ed. Sub-Teams) Appropriate (Centers and Human Resources Sub-Teams)
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. **Engineering Education** • Given the increased demand for education with the economic down-turn, increased emphasis is needed on engineering education research. This would include novel ways of making graduates work ready, new ways of thinking about educational access, innovative approaches to education and retention with emphasis on approaches for encouraging women and URMs . • EEC is the only program that funds engineering education research. This positions EEC in a critical national role. This program can address major needs for workforce preparation. **Centers** • Most proposals reference national priorities • NSF is the only agency that focuses on research that directly affects the civilian (commercial) economy; as such, it should be funded at a much	Appropriate (Sense of urgency needed to line up with national priorities-Eng. Ed. Sub-Team) Appropriate (Centers and Human Resources Sub-Teams)

higher level (especially now that industry no longer takes on the R&D function).

Human Resources

- Absolutely, which is why the funding for REU and RET must be increased. They are also closely aligned with the 2007 NSB report, the NAE Engineering 2020 report, and the American COMPETES Act.

Source: Program Summaries

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

Engineering Education

- Given EEC's unique role in engineering education research, the division should ensure research rigor, similar to discipline research, including potential for transformative results, sound assessment and evaluation methods, concise review of the literature, and well designed experiments.
- The COV agrees with the recommendations from the October 2008 Workshop Report, The Evaluation of Engineering Education Research: Emerging Issues and Promising Developments, in particular:
    - NSF program announcements include explicit statements in the program announcement and funding criteria regarding its expectations for an evaluation component in reports files by engineering education research grantees.
    - NSF program announcements should include the expected outcomes of the projects it funds.
    - NSF should broaden its portfolio in engineering education research to allow a greater mix of high-risk/high impact research together with more traditional education research, given the availability of longer-term evaluation research methods.
    - NSF should communicate research success stories through fact sheets or other mechanisms—not only to engineering education community, but throughout the education research community.

Centers

- Partnering with other funding agencies is a positive approach and is leveraging limited NSF funding.
- There exists a need to maintain a number of open themes as the centerpiece of ERC competitions. This also applies to NSECs. There does not appear to be a need for a separate competition unless there is specific designation by congress.
- Gen-3 modifications (international, small business, long-term K-12 relationship with school systems) are excellent. These new initiatives will need to be assessed to determine their impact over time.

Human Resources

- The quality of the programs would be enhanced significantly with additional funding that will insure the offering of more REU and RET sites.

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

1. Management of the program.

Engineering Education

- The program is well managed even with the significant increase in proposals to review and process.
- We compliment the NUE program director for establishing a web portal for dissemination.

Centers

- There are some processes in place to train other PDs, but if Lynn Preston were to retire now, the succession of a new director and maintaining program momentum would be difficult.

Human Resources

- Great, committed program staff. They are creative and professional, and they are very resourceful in identifying funding sources/streams to leverage their small budgets, including securing funding from DOD, AFOSR, etc.

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

Engineering Education

- The program could further benefit by connecting to recent advances in cognitive psychology, learning theory, and assessment and evaluation research.
- The division should return to the practice of accepting unsolicited proposals to better encourage innovative research and collaboration.

Centers

- The ability to understand new opportunities – including complementary activities such as international, technology transfer – and develop best practices is outstanding.
- Partnerships with other funding agencies (e.g., DOE, NIH) are a plus and should be pursued.
- Continuing to solicit proposals, which are not limited to targeted themes, will allow unanticipated emerging areas to be addressed (want creative and innovative efforts.)
- EFRI also can seed group efforts in targeted emerging fields

Human Resources

- The program staff is very responsive within the limitations of their current budget.

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

Engineering Education

- Program announcements were well written.
- Planning and prioritization process is not available to the COV for evaluation.

Centers

- There is not enough information on the process that guided the development, but the portfolio outcomes are excellent (e.g., in terms of research topic, geographical distribution, research quality).

Human Resources

- Presentations made at the COV meeting suggest that sufficient effort has been devoted to developing the programs and setting priorities for the portfolio.

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

Engineering Education

- The program directors have done an excellent job of responding to concerns raised by the 2007 COV.
- The additional data provided this year gave the COV the information necessary to more effectively evaluate the program.
- Three major recommendations from the 2007 COV remain a critical need and must be addressed:
  1. Sustained programs in engineering education are needed to establish and implement best practices.
  2. There is a need for a major program (collaborative, multi-PI, multi-university) effort to allow faculty to try high-risk ideas and have national impact.
  3. Knowledge transfer and dissemination is important. Need a pro-active effort for knowledge transfer and dissemination.

Centers

- The EEC has been very responsive to all comments and recommendations. The one suggestion on "ERC-lite" should be addressed by other programs such as EFRI.

Human Resources

- Overall, the program staff has been responsive to the 2007 COV report. More discussion is needed with respect to better defining what constitutes the appropriate participation of community colleges in these programs. That is, should community college faculty serve as PIs or should Community College faculty and students participate in programs awarded to four-year institutions?

5. Additional comments on program management:

Engineering Education

- The call for proposals needs to be on a perennial predictable schedule and there needs to be an opportunity for unsolicited proposals.

Centers

- Annual reviews (not including the Year 3 and 6 critical reviews) should be kept more concise. Level of detail on research progress and plans, and on other program elements, should be appropriate to identify areas that should be highlighted or that need improvement.
- As new emphasis areas of discipline research (e.g., Nano, Energy) are defined (e.g., by Congress or partner funding agencies), new Centers should be competed through the ERC process, rather than as a stand-alone process that does not take advantage of the best practices developed over the history of the ERC program. For example, nanotechnology-focused centers (e.g., NSEC) should be integrated into the ERC program.
- ERC funding should be increased, but care must be taken to not decrease single investigator awards as these are the seeds for the future

Human Resources

- The REU/RET program staff is doing a superb job in managing their programs, especially with such limited funding. They are committed to the goals and outcomes of their programs.

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.*"

Engineering Education

- EEC should be commended for two CAREER grantees being awarded PECASE recognition in 2007 and 2008. Each PI has developed a rigorous research program focused on engineering education.
    1. Dr. Borrego, Virginia Tech, #0643107 (2007 PECASE))
    2. Dr. Cox, Purdue University, #0747803 (2008 PECASE))
- EEC is commended for its role in advancing engineering education scholarship. Among all divisions, it uniquely supports the scholarship of discovery in engineering education.

Centers

- The ERCs have made important cutting-edge advances in a broad range of fields. Such knowledge enables the nation to be competitive. The ERC structure encourages researchers to tackle challenges requiring multi- and interdisciplinary collaboration. Because the center proposals are not restricted to any specific topic, it allows for creativity and innovation in the research fields and process. The

extraordinary competitiveness of the program and the rigorous annual reviews ensures that these centers continue to produce world-class research results. The systems-level approach leads to the cultivation of basic research that translates to commercial opportunities.

- Some interesting highlights from the ERCs include:
  - Reliable conductor-semiconductor interface for high temperature packaging (ERC for Power Electronics, VPI)
  - World's smallest radio fits in the palm of the hand…of an ant (NSEC of integrated nanomechanical systems, UC Berkeley)
  - Snake-like robotic system for minimally-invasive surgery (ERC for Computer-integrated surgical systems and technology, Johns Hopkins U)
  - Bending light, negative refraction, and semiconductor metamaterials (ERC for mid-infrared technologies in health and the environment, Princeton U)

Human Resources

- Many REU and RET participants make substantive contributions to funded research programs as attested to by their role as co-authors on refereed publications and/or as co-inventors. Engaging young and unencumbered minds as participants in peer reviewed research projects can often stimulate even the most experienced researcher to explore answers to questions not previously considered.
- Engaging students in the research process early in their educational careers can provide both an important foundation and motivation for them to pursue careers that involve research and discovery. And engaging K-12 teachers in the process of research provides for them an experience and foundation that they can take to their classrooms to influence the career paths of their students. Both programs contribute to scientific literacy.
- REU Highlight: REU student Justin Wilkerson, a senior in the Aerospace Engineering Dept. and an REU student, is co-inventor of U.S. provisional patent application no. 61/058,098, "Fiber reinforced polymer nanocomposite laminates," with D.C. Davis and J. Zhu, Texas A&M University.
- RET Highlight: Ms. Mila Bersabel, a 2007 and 2008 RET participant at the University of Houston, was recognized as the State of Texas winner for a Presidential Award for Excellence in Mathematics and Science Teaching (PAEMST). EEC-0742296, PI: Frank Claydon.

Data Source: COV Results of NSF Investments

B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

Engineering Education

Excellent outcomes impacting K-12 education, higher education and the general public have resulted from this program. Specific highlights include:

- K-12 curriculum and messaging -- Design Squad, WGBH, #0810996
- Undergraduate Service Learning and sustainability -- Dr. Swan, Tufts, #0935082
- Nanotechnology -- Dr. Hegab, Louisiana Tech, #0407097
  Dr. Shahbazyan et. al, Jackson State U., NUE-0532468
  Dr. Jaszczak, Michigan Tech, #0741490
- Understanding Capstone Design -- Dr. Paretti, VA Tech, #0846605

Centers

Students trained in the ERCs are highly sought after by industry and are consistently rated much higher than their non-ERC peers. Industry supervisors cite the ability of these students to quickly contribute in an industry environment, breadth of technical knowledge, and ability to work in interdisciplinary teams as strengths of these ERC graduates.

The centers program has made significant contributions to the integration of education and research. ERCs involve students from PK-12 to the PhD level, from a wide variety of institutions. These centers have developed robust outreach programs to precollege schools and teachers. For example, in FY09, 158 teachers and 28,644 K-12 students participated in ERC education activities.
In addition, centers have improved undergraduate instruction through REU's and through the development of new course materials drawn from center research.
The records of the centers contain many examples of successes in these areas, including, for example:

- ERC sponsors FIRST Robotics team from Indian nation team (ERC for Compact and Efficient Fluid Power, U. Minnesota)
- 2006 Light and Optics Workshop for High School Teachers (ERC for Extreme UV Science and Technology, Colorado State U)
- Undergraduates helping to design clinical research for cancer treatment (ERC for Biomimetic Microelectronic Systems, USC)

Human Resources

Both the RET and REU programs have objectives designed to attract and retain U.S. students in disciplines critical for maintaining a pre-eminent workforce in science and engineering. The programs are highly successful in targeting the broad participation of underrepresented groups, including women. Additionally, both programs have broad geographic participation as individual sites and geographically dispersed participants at the given site. They also promote awareness with sites that have an international component.

Highlight: Dr. Rajaram Janardhanam, REU PI at the University of North Carolina – Charlotte, recruits a diverse group of undergraduate students from around the country and from a variety of underrepresented groups into his program, "Transcending Boundaries Through Geotechnical Research." Here, the students investigate the physical and chemical behavior of the subsurface to gain a vital geotechnical understanding for advanced robust construction and of environmental systems.

Highlight: Dr. Michael Lovell, RET PI at the University of Pittsburgh, works with urban high school teachers in improving their understanding of science and technology concepts through innovative design. Twenty five teachers have participated to date, thus potentially impacting more than 1000 high school students from under-performing urban schools. These students are primarily from underrepresented groups. EEC 0502035

Data Source: COV Results of NSF Investments

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

Engineering Education

The division has developed new infrastructure that supports learning, new methods for assessing learning, and communities of researchers. These infrastructure tools are exemplars of the integration of education and research.

- Facilities: Virtual construction simulator, Dr. Messner, Penn State, #0343861
- Instrumentation: Large databases, analysis and modeling tools, metrics to measure learning, Dr. Ohland, Purdue, #0343961
- Cyber-infrastructure: Virtual organizations, networking of researchers and students, Dr. Madhavan, Clemson/Purdue, #0956819

Centers

Testbeds required of the ERCs provides a great research infrastructure platform. Many centers have made significant contributions in building extensive computing and simulation capabilities (e.g., CASA) that are applicable across a broad range of fields. Some examples include:

- Four-radar testbed installed to forewarn of hazardous weather events (UMass Amherst ERC)
- ERC/RMS reconfigurable inspection machine installed on GMC manufacturing line (U. Michigan)
- Extreme UV light microscope generates high resolution images of nanoscale objects (ERC for Extreme UV Science and Technology, Colorado State U

Human Resources

Research tools (i.e., instrumentation, facilities, cyberinfrastructure, etc.) are without question critically important to advance basic knowledge and innovation. Human resources are also critical components of research infrastructure and, thus, should be given serious attention in terms of funding levels and integration into the research infrastructure fabric.

Data Source: COV Results of NSF Investments

PART C. OTHER TOPICS

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

Engineering Education

The following section provides the observation and recommendations for the engineering education program.

NSF is encouraged to address all the recommendations; however, the COV believe that the following three <u>must</u> be addressed:

- Given EEC's unique role in engineering education research, the division must continue to drive the community to increase research rigor, similar to discipline research, including potential for transformative results, sound assessment and evaluation methods, concise review of the literature, and knowledge transfer and dissemination.
- Sustained programs in engineering education are needed to establish and implement best practices, including programs that specifically address recruitment, retention, and advancement of women and URMs.
- There is a need for a major program (collaborative, multi-PI, multi-university) effort to allow faculty to try high-risk ideas with the potential for high national impact.

- To ensure our nation's prominence in engineering, it is essential that the U.S. invest in attracting and preparing our future graduates for the opportunities and challenges of the 21st century, including an ability to operate in a global, highly technical work environment. *Engineering education research* is critical to meet these challenges through efforts that lead to new and improved educational programs, curricula, and instructional methods. It is imperative that the NSF increase funding of engineering education programs.
- It would be helpful to extend the Engineering Education programs to include large multi-PI program and multi-institutional awards.
    - As an example, add multiple tracks with single PI, small group PI and multi PI/institutions with varied funding levels ($300K/year; $750,000/year with a minimum time duration of 3 years and >$2M per year up to 5-10 years
    - Create Engineering Education Research centers.
- Encourage submission of more unsolicited, high-risk, innovative proposals.
- Create separate programs or tracks that focus on the recruitment, retention, and advancement of women and URMs.
- Create a general standing program announcement that is open, along with a perennial, predictable schedule that allows investigators to develop proposals in a timely manner.
- Faculty development can play a significant role in transformation of the classroom and transfer of research findings. Grant supplements may be one means to achieve this, e.g., workshop presentations.

Centers

- The ERC program staff needs to be increased, given the workload. It is important to have permanent staff (rather than IPAs) to ensure a continuing high level of quality and efficiency in the management of these long-term investments.
- There are several areas that remain a challenge for not only EEC but for the entire technical community. We recognize that there are no clear solutions at this point, but wish to simply note these as areas that need further thought:
    - Education of the general public about science and engineering

- Greater participation of underrepresented groups in the research leadership of centers
- Transfer of technology to commercial application

Human Resources

REU gaps:

- There is not enough data on participant demographics
- Inadequate funding

RET gaps:

- Should be NSF-wide program
- There is an opportunity to leverage efforts with the well-funded Robert C. Noyce and MSP programs.
- There is an opportunity to work with pre-service teachers.
- Inadequate funding

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.

Engineering Education

- Encourage more proposals with community college involvement by explicitly requesting such participation n the RFP (see comments under Human Resources).

Centers

- No comments provided.

Human Resources

- To enhance the participation of community colleges and non-research intensive universities, consideration should be given to include specific language in the respective program solicitations that detail expectations for including the participation of representatives from these groups in site proposals. This would expand their participation beyond individual awards made to these groups.

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

Engineering Education

- Three major recommendations from the 2007 COV remain a critical need and must be addressed:
  - Sustained programs in education are needed to establish and implement best practices It is unfortunate that the Department Level Reform (DLR) program was cut abruptly.
  - There is a need for a major program (collaborative, multi-PI, multi-university) effort to allow faculty to try high-risk ideas that have the potential for national impact.
  - Knowledge transfer and dissemination is important. Need a pro-active effort for knowledge transfer and dissemination.
- Continue efforts to encourage underrepresented minorities to become involved in panel reviews; this will ultimately lead to an increase in the number of future successful proposals from URM; correspondence with deans and chairs may be one approach to increase junior faculty from underrepresented groups who serve on review panels

Centers

- HRD and EEC are running programs independently of each other in the STEM fields. More collaboration should be encouraged to leverage funds. For example, ADVANCE (HRD) and BRIGE (EEC) both address underrepresented groups in the faculty. IEECI (EEC) and CCLI (HRD) both address curriculum issues.
- To obtain more evaluative reviews (rather than just a summary of the proposal content), the review forms should have specific headings for strengths and weaknesses in the Intellectual Merit and Broader Merit sections.

Human Resources

- NSF leadership should adopt the RET program as a Foundation-wide program by charging other directorates to develop and fund similar, but collaborative, programs. Candidate directorates should include MPS and CISE. This expectation is supported by the National Science Board (NSB) report that recommended expansion of the RET program within the NSF. Concomitant with this recommendation is the need to increase funding for the existing RET program in the Engineering Directorate.
- Strategic planning should include plans to increase the funding to REU and RET programs as well as ideas to build upon the current successes and program impacts made over previous years.

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

Engineering Education

- Emphasize to PIs the importance of submitting motivating highlights that makes the research accessible to the general public. One approach is to make highlights part of the annual report.
- We recommend a change in the wording on the Highlight template from: 'Does this highlight represent potentially transformative research?' to 'Is this a transformative project?' Provide a definition of transformative to help PIs accurately report their highlights.
- Geographic distribution maps were not useful when looking at selection of reviewers.
- Table A3.3 row "Average Annual funding" is misleading.
- It would be helpful to disaggregate the data to show the number of PI's (versus the number of investigators) from underrepresented groups.
- Comments on the BRIGE program:
- A note in the Panel Summary for a BRIGE-funded project stated that the department chair had not been compliant. There was no documentation in the e-Jacket regarding why the action of "return without review" was not followed.
- There were examples in which the reviews from the BRIGE program appear to be inconsistent with how reviews are conducted in ECE.

Centers

- The ERC program continues to be a showcase for NSF.

Human Resources

- In order to broaden the portfolio of REU awardees across institutional type and size, a tiered award plan could be developed that offered tracks based on engineering enrollment or Carnegie classification, for example, such as is utilized in other NSF programs. This would allow smaller schools to compete against their peers. Additionally, the smaller institutions may propose smaller cohorts.
- Evaluation metrics should be aligned with the program activities, be measurable, and appropriate to the size of the investment. Care should be taken to avoid defining the success of a program by measures that are not directly targeted by specific program activities.
- The Division and Directorate is encouraged to give priority to the NSB suggestion to develop programs to capitalize on the NAE effort to improve the public's image of engineering using the themes that have been identified to be effective, and to unify the programs' messages to increase the national impact.

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

Engineering Education

- It would be helpful for the COV to have a summary table and a comparative summary that could help the COV members understand how decisions were made, in particular cases when there are mixed reviews.
- Keep statistics about the reviewers to better understand the level of expertise and/or qualifications, e.g., number of new and experienced reviewers (want a mix), field of interest, and check box about degree of knowledge in particular area of proposal being reviewed.
- In distribution of reviewers, consider normalizing the number of reviewers by populations and engineering faculty/schools and disaggregating by number of requests and number accepted
- Include a table that summarizes award size, single and multi investigator awards, and other characteristics, i.e., need summary data. It would be helpful to have statistics that support the analysis.
- Consider ways to encourage higher identification of the investigator's ethnicity, perhaps by explaining how demographics are used.
- The process for planning and prioritization for funding projects should be included in the COV eJacket

Centers

- The number of reviewers for the Centers subgroup could be increased by 2-3 more people.
- Two teleconferences would have been helpful. One earlier (two months before) to orient the group to the COV process, eJacket, etc. and a second one a couple of weeks before the COV to discuss observations after reading some of the jackets. Getting the matrix assignments earlier would have been helpful.
- The templates were very helpful.
- Highlights could have been organized by subgroup.

C.6. Centers-team specific issues

- Strategic initiatives to increase economic development – ERCs are uniquely situated to bridge the gap between university research and industry. Stronger interactions between centers and industry are important, but not all of the efforts listed below would be viewed as priorities over funding of core center needs or funding more centers.
    - Professors of Practice – In general, bringing high-level (e.g., PhD in R&D lab, technical leader) industry people to the university and the centers is of value. The funding should come from sources other than the ERC funds.
    - Postdoc Fellows in Industry (Corporate Postdoctoral Fellowships for Engineers) – The goal of providing potential faculty with experience in industry is good, but the panel does not have enough information to evaluate the effectiveness of this effort.
    - Design-Build Facilities and Testbeds to speed translation of ERC technology – these should be supported through partnerships with industry. For example, SBIR funds or company funds are appropriate.

- ERC-Lite – please see Section A

- Subsidizing graduated centers – Graduated ERC components (e.g., education, outreach, and research projects) should be subjected to the same review process as non-ERC groups. Strong components should be encouraged to continue to seek competitive NSF funding in appropriate areas (e.g., REU and RET sites, informal science education, unsolicited program). Centers can acknowledge their graduated ERC status in applying for other competitive programs.

- Gen-3 constructs – please see Section A

SIGNATURE BLOCK:

March 15th, 2010
For the 2007-2010 Engineering Education and Centers Division (EEC) Committee of Visitors
Steven Castillo
Chair