# DIRECTORATE FOR ENGINEERING

## MEMORANDUM

**DATE:** January 31, 2007

**TO:** 2004-2006 Engineering Education and Centers Division (EEC) Committee of Visitors (COV)

**CC:** Dr. Richard K. Miller, Chair of the Engineering Advisory Committee
Dr. Michael M. Reischman, Deputy Assistant Director for Engineering
Dr. Allen Soyster, Division Director, Engineering Education and Centers Division (EEC)

**FROM**: Dr. Richard O. Buckius, Assistant Director for Engineering

**SUBJECT:** Charge to the 2004-2006 EEC COV

Thank you for agreeing to serve on the Committee of Visitors (COV) for the Engineering Education and Centers Division (EEC) of the Directorate for Engineering (ENG) of the National Science Foundation (NSF). By NSF policy, programs that award grants or cooperative agreements are reviewed at three-year intervals by a COV. This COV will address the EEC programs in fiscal years 2004, 2005 and 2006. During this period, EEC programs included Engineering Education, Engineering Research Centers (ERC), Earthquake Research Centers (EERC), Nanoscale Science and Engineering Centers (NSEC), Research Experiences for Teachers (RET), Research Experiences for Undergraduates (REU), Industry-University Cooperative Research Centers (I/UCRC) and Partnerships for Innovation (PFI). The COV is an ad hoc subcommittee of the Advisory Committee for the Directorate for Engineering. Dr. Winfred Phillips, who will serve as the COV Chair, and Dr. Margaret Murnane are members of the ENG Advisory Committee. The COV reviews the proposal and award process and the balance of the EEC portfolio, advises ENG on significant impacts and advances from the EEC investments, and identifies emerging challenges and opportunities.

The COV charge is to address:

1. The integrity, efficacy, and quality of the processes used to solicit and review proposals and the documentation of funding decisions.

2. The quality of project management, monitoring, and evaluation of funded proposals.

3. The balance of the division's portfolio and the quality and significance of the results of the Division's programmatic investments in terms of the four NSF strategic goals (People, Ideas, Tools and Organizational Excellence).

4. Opportunities to more fully realize the potential of the Division's current programs and future directions for the EEC Division.

The COV will examine a sampled set of files for both awarded and declined proposals within the four main areas of the EEC Division: (1) Centers; (2) I/UCRCs and PFI's; (3) REU and RET; (4) Education Research and Curriculum Development. The sampling strategy will be developed in consultation with the COV chair. The COV will use the attached FY 2007 Core Questions and Report Template in preparing its report.

The meeting of the COV will take place Monday through Wednesday, March 26-28, 2007, at the National Science Foundation, 4201 Wilson Boulevard, Arlington, Virginia 22230. The COV will convene at 8:00 am, on Monday, March 26, 2007, in Room 380, Stafford I, and will adjourn at noon on Wednesday, March 28, 2007, after briefing me on the essence of the COV's findings.

No later than April 30, 2007, the COV Chair will transmit the EEC COV report to the ENG Advisory Committee Chair. The report will be discussed at the fall 2007 meeting of the ENG Advisory Committee. The ENG Advisory Committee Chair will then transmit the COV report to the Directorate for response. The Directorate will prepare a written response to the report's major recommendations. The report and the Directorate's response will be forwarded to the Director of NSF and posted on the NSF web site.

A website has been created for the EEC COV: http://www.nsf.gov/events/event_summ.jsp?cntn_id=108276&org=EEC . The site includes the following links and materials:

- Draft Meeting Agenda
- The NSF FY 2003-2008 Strategic Plan
- The NSF FY 2006-2011 Strategic Plan
- Core Questions and Report Template for FY 2007 NSF Committee of Visitor Reviews
- 2004 COV Report
- Response to the 2004 COV Report
- 2005 and 2006 updates to the response to the 2004 COV Report
- The American Competitiveness Initiative

The website contains both the FY 2003-2008 NSF Strategic Plan and the new FY 2006-2011 NSF Strategic Plan. In accordance with NSF policy, the EEC COV will use the earlier plan, FY 2003-2008, in conjunction with the FY 2007 Core Questions and Report Template to prepare its report. However, the COV will use the new FY 2006-2011 NSF Strategic Plan when preparing any remarks about opportunities or future directions for the EEC Division.

More information about EEC programs will be provided through a secure portal at this website about three weeks prior to the COV meeting date.

We appreciate your service in this important NSF activity, and we hope that you will find the process both interesting and informative.

# 2007 EEC Committee of Visitors Members

| first name | last name | Title | Affiliation | Sub-Team | E-Mail | Phone Number |
|---|---|---|---|---|---|---|
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| | | | | | | |
|---|---|---|---|---|---|---|
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**National Science Foundation**
Directorate for Engineering
Division of Engineering Education and Centers (EEC)

**Committee of Visitors**
**Review of the**
**Engineering Education and Centers Programs**

March 26-28, 2007
National Science Foundation
Room 380 4201 Wilson Blvd.
Arlington, VA 22230

**MEETING AGENDA**

**March 26, 2007**

| | |
|---|---|
| 8:00 a.m. | Sign-in, Light refreshments |
| 8:10 a.m. | Welcome<br>*Richard Buckius, Assistant Director for Engineering* |
| 8:20 a.m. | Charge to COV<br>*Jo Culbertson, Staff Associate for Planning and Evaluation, Directorate for Engineering* |
| 8:30 a.m. | Conflicts of Interest<br>*Bruce Kramer, Senior Advisor, EEC* |
| 8:40 a.m. | Overview of EEC Programs and Strategic Plan<br>*Allen Soyster, Division Director, EEC* |
| 9:10 a.m. | Template and EEC data briefing<br>*Barbara Kenny, Program Director, EEC* |
| 9:30 a.m. | Review of COV Charge and Template Process<br>*Winfred Phillips, COV Chair* |
| 9:45 a.m. | Break<br>Move to breakout rooms by sub-team<br>• Centers Sub-team (Room 380)<br>• Education Sub-team (Room 580)<br>• Industry/University Cooperative Research Center (I/UCRC) and Partnerships For Innovation (PFI) Sub-team (Room 630)<br>• Research Experiences for Teachers (RET) & Research Experiences for Undergraduates (REU) Sub-team (Room 530) |
| 10:00 a.m. | Program Director briefings to sub-teams |

**National Science Foundation**
Directorate for Engineering
Division of Engineering Education and Centers (EEC)

**Committee of Visitors**
**Review of the**
**Engineering Education and Centers Programs**

March 26-28, 2007
National Science Foundation
Room 380 4201 Wilson Blvd.
Arlington, VA 22230

**MEETING AGENDA**

**March 26, 2007 (continued)**

| | |
|---|---|
| 10:45 a.m. | COV Sub-team Review and Discussion<br>Template Part A: Program Processes and Management |
| 12:00 noon | Lunch |
| 1:00 p.m. | COV Sub-team Review and Discussion<br>Template Part A: Program Processes and Management |
| 3:30 p.m. | Break |
| 3:45 p.m. | COV Sub-team Review and Discussion<br>Template Part B: Results of NSF Investments |
| 5:30 p.m. | Adjourn |
| 6:30 p.m. | Dinner (COV members only) |

**National Science Foundation**
Directorate for Engineering
Division of Engineering Education and Centers (EEC)

**Committee of Visitors**
**Review of the**
**Engineering Education and Centers Programs**

March 26-28, 2007
National Science Foundation
Room 380 4201 Wilson Blvd.
Arlington, VA 22230

**MEETING AGENDA**

**March 27, 2007**

| | |
|---|---|
| 8:00 a.m. | COV Sub-team Review and Discussion<br>Template Part C: Other Topics, to include advice on strategic direction for EEC and identification of emerging opportunities and challenges |
| 10:15 a.m. | Break |
| 10:30 a.m. | COV Sub-team Review and Discussion<br>Template Part C: Other Topics, to include advice on strategic direction for EEC and identification of emerging opportunities and challenges |
| 12:30 noon | Lunch |
| 1:30 p.m. | COV members regroup by Template portion to consolidate reports (COV members only)<br>• Team A convenes in Room (380)<br>• Team B convenes in Room (580)<br>• Team C convenes in Room (530) |
| 3:45 p.m. | Break |
| 4:00 p.m. | Presentation and review of integrated A, B, and C Template portions to full team in Room 380 |
| 5:30 p.m. | Adjourn |
| 6:30 p.m. | Dinner (COV members only) |

**National Science Foundation**
Directorate for Engineering
Division of Engineering Education and Centers (EEC)

**Committee of Visitors**
**Review of the**
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March 26-28, 2007
National Science Foundation
Room 380 4201 Wilson Blvd.
Arlington, VA 22230

**MEETING AGENDA**

**March 28, 2007**

| | |
|---|---|
| 8:00 a.m. | COV Full Team review and audit of report (COV members only) |
| 9:00 a.m. | Preparation for presentation to NSF (COV members only) |
| 10:15 a.m. | Break |
| 10:30 a.m. | COV presents briefing to NSF |
| 12:00 noon | Adjourn |

NATIONAL SCIENCE FOUNDATION
Directorate for Engineering
4201 Wilson Boulevard, Room 505
Arlington, Virginia 22230

**TO:** Richard Buckius
AD/ENG

**FROM:** Allen Soyster
DD/EEC

**DATE:** March 10, 2008

**SUBJECT:** Report on Diversity, Independence, Balance and Resolution of Conflicts for the EEC COV

This is my report to you on the diversity, independence, balance and resolution of conflicts of the Committee of Visitors (COV) for the Division of Engineering Education and Centers (EEC) held during March 26-28, 2007.

The COV, which was assembled to review the EEC Division, and whose report was presented to the Engineering Advisory Committee on October 25, 2007, consisted of eighteen persons, of whom eleven are male, six female, and one "unreported." Two of the members of the committee are African-American, two are Hispanic and one is Native American. They represent twelve states including two EPSCoR states.

Fourteen of the COV members are from academia, three from industry, and one from a state Government. Of the academia members, one is from an Historically Black College or University (HBCU). The Chair of the COV is the Vice President for Research at the University of Florida and was a member of the Engineering Advisory Committee at the time of the COV. One of the members is an Engineering Research Center (ERC) Deputy Director and serves on the Engineering Advisory Committee; another is associated with a Nanotechnology Science and Engineering Center (NSEC). Three of the members had formerly served as NSF Program Officers with experience in EEC programs. Two of the members are department chairpersons at their institutions, three are associate deans, one is a dean, one is an associate vice-chancellor and another is an emeritus professor. The other members from academia are at the rank of professor. The two of the three industry members are at the Director level, one is at the Vice President level. The state government member is the Director of federal and university programs for his state. Their

backgrounds represent 15 disciplines covering engineering, science and business. All invited COV members attended the meeting.

Five (Fiez, Klein, Murnane, Phillips, Reid and Washington) of the eighteen members had been applicants to EEC in the past five years or served as ENG Advisory Committee members. None had proposals pending with EEC during the COV meeting. A conflict of interest briefing was held on the first day of the COV meeting. The absence of any conflict of interest was confirmed by asking all to complete the NSF Conflict of Interest form, none of whom disclosed any conflicts. Assignments were made to ensure that there would be no conflicts of interest. No real or apparent conflicts arose during the course of the meeting.

NSF Engineering Education and Centers Division (EEC)
Committee of Visitors (COV)
Report 2007

## Executive Summary

The COV met March 26-28, 2007, in Washington, DC to review the NSF EEC Programs of the Directorate for Engineering for FY 2004-2006.

The COV reviewed a broad range of materials on the programs of the Division electronically prior to the meeting and received a briefing by Division staff.

The COV Charge was to address:

1. The integrity, efficacy, and quality of the processes used to solicit and review proposals and the documentation of funding decisions.
2. The quality of project management, monitoring and evaluation of funded proposals.
3. The balance of the division's portfolio and the quality and significance of the results of the Division's programmatic investments in terms of the four NSF strategic goals (People, Ideas, Tools and Organizational Excellence).
4. Opportunities to more fully realize the potential of the Division's current programs and future directions for the EEC Division.

The COV divided into sub-teams on Centers, Education, Industry University Cooperative Research Centers (IUCRC) and Partnerships for Innovation (PFI), and Human Resources (encompassing the Research Experiences for Teachers (RET), the Research Experiences for Undergraduates (REU) and the Bioengineering and Bioinfomatics Summer Institutes (BBSI) programs.)

Each sub-team worked with the "Core Questions and Report Template" provided, and a summary template, including comments, constitutes this report.

In summary, the COV findings include:

### Operations

- Strengths

  Review processes – very good.
  Selection of reviewers – very good.
  Feedback – generally very good.
  The Division is moving in the right direction and often leading in the right direction.
  Program managers operate very efficiently and work hard for the programs.
  There is continuity of leadership in many programs.

- Opportunities for Improvement

Data provided is variable; needs to be more comprehensive, more uniform, while good in some areas, poor in others.
The Committee depended on the program directors for the data rather than the EIS data.

- Comments

What is continuity plan for program leadership succession and transitioning to the future?

**Engineering 2020**

- ERC and IUCRC Programs were ahead of the curve. They addressed Engineering 2020 issues long before the reports were written. They help to push change.

- EEC programs should work with universities to deal with the declining number of women undergraduates in engineering.

- The EEC Division plays a leadership role, especially in the pipeline issues.

- NSF's goal of integration of teaching and research is done as well here (EEC) as anywhere in the organization.

**Education Issues**

- EEC should take a leadership role in transforming engineering education.

- Over a 5-10 year period, engineering education funding has not seen any significant growth.

- There is a need to take a look at the opportunity for an engineering pipeline solution for women and minorities.

- Innovation, pipeline, and retention issues will demand an increased investment in engineering education.

- Sustained programs in education are needed to establish and implement best practices (e.g. Department Level Reform (DLR) cut abruptly).

- 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.

- Avoid creating a dichotomy where there are engineering educators and engineering researchers.

**Human Resources (RET, REU, BBSI)**

- Program officers doing a good job with good direction and working well with strong leadership.

- RET and REU have a huge impact on pipeline issues.

- EEC should strongly support these programs and explore opportunities for scalability (pipeline issue).

    - Best practices, e.g. team up with DOD and others to co-fund projects.

- International educational and research opportunities should be explored to develop programs that will sustain the long-term health of U.S. competitiveness.

**Centers**

- Centers are a high visibility American Competitiveness Initiative (ACI) opportunity.

- Centers are the only place that have the critical mass to address some of the broader issues related to integrating research and education and pipeline issues.

    - Not something an individual investigator can do.

- Centers are critical for industry involvement.

- Managerial challenges – avoid artificial university partnerships, have true partnerships so partnerships are a leveraging opportunity.

- Centers provide students the "best" educational opportunity. Industry believes that Centers are a strong educational background for students. Students are prepared to be productive right away. The best way for technology transfer is via human capital.

- Support ERC-Lite Experimental Program to Stimulate Competitive Research (EPSCoR) concept.

- Centers need to be increased, not decreased. Twenty-five ERCs (full ones) plus the "Lites."

**IUCRCs**

- Another high visibility ACI opportunity.

- Small NSF funding leverages significant industry dollars.

- Industry supports these experiences.

- NSF contribution should be increased to around $100K per partner.

- An international component should be considered.

**PFI**

- Funding is in one place, management in another; therefore, might be in danger. Good program, should be retained.
- The program is young (not a lot of metrics). Funding is needed to develop metrics, but PFI is a good idea. (Embryonic stage, not very visible.) There has been no continuity of Division since inception (7 years), three different divisions since inception. Needs funding to do proper marketing. "Stepchild" syndrome. Intended to try and involve state and local governments.

**Marketing and Export**

- Make results available.

- Knowledge transfer and dissemination is important. Need a pro-active effort for knowledge transfer and dissemination.

- Publications on highlights are excellent.

**FY 2007 REPORT TEMPLATE FOR**
**NSF COMMITTEES OF VISITORS (COVs)**

| **Date of COV:** March 26-28, 2007 |
|---|
| **Program/Cluster/Section:** Engineering Education, Human Resources (Research Experiences for Teachers (RET) & Research Experiences for Undergraduates (REU), Bioengineering and Bioinformatic Summer Institutes (BBSI)), Centers (Nano-Centers, Engineering Research Centers and Earthquake Engineering Research Centers), and Industry/University Cooperative Research Centers (IUCRC) & Partnership For Innovation (PFI) |
| **Division:** Engineering Education and Centers (EEC) |
| **Directorate:** Engineering Directorate |
| **Total number of actions reviewed:** 124 (distributed as follows):<br>*Pre-proposals:*<br>Invited for Full Proposal: 3<br>Not Invited or Discouraged for Full Proposal: 9<br>*Full Proposals:*<br>Awards: 57<br>Non-awards (e.g. Declinations, returned without review or withdrawn.): 55 |
| **Total number of actions within the Division during period under review:** 2089 (distributed as follows):<br>*Pre-proposals:*<br>Invited for Full Proposal: 27<br>Not Invited or Discouraged for Full Proposal: 82<br>*Full Proposals:*<br>Awards: 449<br>Non-awards (e.g. Declinations, returned without review or withdrawn.): 1531 |
| **Manner in which reviewed actions were selected:**<br>Random Stratified Sampling |

Note: The template report includes sections where the comments are consolidated for the entire Division and sections where the comments are separated by sub-term. This is noted as appropriate.

## PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

**A.1 Questions about the quality and effectiveness of the program's use of merit review procedures.** Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

| **QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES** | **YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]** |
|---|---|
| **1. Is the review mechanism appropriate? (Panels, Ad Hoc Reviews, Site Visits)**<br><br>**Overall Division Comments:**<br><br>The review of jackets selected at random revealed that most panel and individual reviews are of high quality and effectiveness.<br><br>For some programs, it is challenging to get sufficient technical expertise for review panels. | Yes |
| **2. Is the review process efficient and effective?**<br><br>**Overall Division Comments:**<br><br>For Centers, the use of pre-proposals is a good way to address the large number of ERC proposals. For IUCRC's, the use of planning grant proposals ensures that the review process ultimately leads to funding of deserving centers. | Yes |

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

| | |
|---|---|
| **3. Do the individual reviews (either mail or panel) provide sufficient information for the principal investigator(s) to understand the basis for the reviewer's recommendation?**<br><br>**Overall Division Comments:**<br><br>It is estimated that 15 to 25% of the individual reviews fail to provide adequate justification for the recommendation.<br><br>NSF Program Directors should reinforce expectations for reviewers, and underscore the importance of the reviews for feedback to principal investigators. PD's should furnish reviewers in advance of initiation of the reviews with examples of good and bad reviews.<br><br>Some panel summaries are excellent, but should go beyond just regurgitating the lines from the individual reviews. | Yes |
| ***Centers specific comments***<br><br>In general, because of the number of reviewers for the Center proposals, the net result is sufficient information. For some of the proposals with fewer reviews (e.g., NIRT), the amount of information was not sufficient for the magnitude of the award. | Yes |
| ***Education specific comments***<br><br>As noted in 2004 COV, it still appears that 25% do not. Suggestions: provide reviewers with examples of good and bad reviews. Provide a more detailed template for reviewers. | Could be Improved |
| ***IUCRC / PFI specific comments*** | Yes |
| ***RET / REU / BBSI specific comments*** | Yes |

| | |
|---|---|
| **4. Do the panel summaries provide sufficient information for the principal investigator(s) to understand the basis for the panel recommendation?**<br><br>**Overall Division Comments:**<br><br>The panel summaries are generally well written, but could do a better job of documenting the panel discussion and highlighting the key strengths and weaknesses, rather than just cutting and pasting from individual reviews.<br><br>Panel reviews are less useful for feedback to improve proposals, especially for proposals in the fund if possible category. If the purpose of the panel is to provide formative feedback to the PI, then panel summaries should summarize the discussion and reconcile variances in individual reviews, not merely summarize the individual reviews. Suggest providing panelists with examples of good and bad panel summaries. | Yes, but some improvements could be made. |
| **5. Is the documentation for recommendations complete, and does the program officer provide sufficient information and justification for her/his recommendation?**<br><br>**Overall Division Comments:**<br><br>The review analyses for the Center reviews are thorough and provide strong justification for the recommendations. | Yes |
| **6. Is the time to decision appropriate?**<br><br>**Overall Division Comments:**<br><br>Data indicate that 75 to 95% of the proposals (depending on program) are reviewed in 0-6 months, the remainder >6 MONTHS. We assume that there are legitimate reasons for the remainder. | Yes |
| **7. Additional comments on the quality and effectiveness of the program's use of merit review procedures:**<br><br>**Overall Division Comments:**<br><br>Throughout the review process, the panel summaries and individual reviews should address program specific criteria as well as NSF criteria. It is critically important to provide constructive feedback to the PI in the spirit of capacity building.<br><br>Continuous process improvement is encouraged for proposal instructions to avoid proposal submissions by the PI to the wrong division and for internal proposal tracking when a proposal is submitted to the wrong division. | |

**A.2 Questions concerning the implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by reviewers and program officers.** Provide comments in the space below the question. Discuss issues or concerns in the space provided.

| IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA | YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2] |
|---|---|
| **1. Have the individual reviews (either mail or panel) addressed both merit review criteria?**<br><br>**Overall Division Comments:**<br><br>The use of the template has improved the consistency of the reviewers addressing both merit criteria. GPRA statistics support this. | Yes |
| **2. Have the panel summaries addressed both merit review criteria?**<br><br>**Overall Division Comments:**<br><br>The use of the template has improved the consistency of the reviewers addressing both merit criteria. | Yes |
| **3. Have the *review analyses* (Form 7s) addressed both merit review criteria?**<br><br>**Overall Division Comments:**<br><br>None | Yes |

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

**A.3 Questions concerning the selection of reviewers.** Provide comments in the space below the question. Discuss areas of concern in the space provided.

| SELECTION OF REVIEWERS | YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[3] |
|---|---|
| **1. Did the program make use of an adequate number of reviewers?**<br><br>**Overall Division Comments:**<br><br>None | Yes |
| **2. Did the program make use of reviewers having appropriate expertise and/or qualifications?**<br><br>**Overall Division Comments:**<br><br>It is encouraging to note that practicing K-12 teachers are being asked to serve on RET panels. | Yes |
| **3. Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups?[4]**<br><br>**Overall Division Comments:**<br><br>EIS data are inadequate to answer this question. Further, a small percentage of the reviewers report the essential data.<br><br>For those who did provide the information to NSF, the balance is appropriate.<br><br>NSF should provide reviewers with a rationale for providing the demographic information, which might encourage more reviewers to do so. | Yes |
| **4. Did the program recognize and resolve conflicts of interest when appropriate?**<br><br>**Overall Division Comments:**<br><br>None | Yes |

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

**5. Additional comments on reviewer selection:**

**Overall Division Comments:**

Improved data collection (EIS, GPRA) needs to be addressed.

We encourage additional industry reviewers on panels. For example, Industry Advisory Councils of both ABET and ASEE would be sources of potential reviewers.

The PFI program is extremely broad, spanning partnerships in education, industry and infrastructure in many fields. The program is developing ideas to select an appropriate set of panelists to cover both area expertise and big picture ideas. Approaches such as requiring Letters of Intent that explain the proposed partnerships in advance would facilitate selection of appropriate reviewers.

**A.4 Questions concerning the resulting portfolio of awards under review**. Provide comments in the space below the question. Discuss areas of concern in the space provided.

| RESULTING PORTFOLIO OF AWARDS | APPROPRIATE, NOT APPROPRIATE[5], OR DATA NOT AVAILABLE |
|---|---|
| **1. Overall quality of the research and/or education projects supported by the program.**<br><br>**Overall Division Comments:**<br><br>Technical advances, publications, systemic improvements, etc., of the Centers are all exemplary. The visibility of the Centers is outstanding.<br><br>The IUCRC concept has served as a flagship NSF program that was replicated by other centers. It covers a broad range of industries, and leverages a small amount of NSF investment into a large investment by industry. The new publication on technology breakthroughs by the IUCRC programs underscores the breadth of impact of the program. | Appropriate |
| **2. Are awards appropriate in size and duration for the scope of the projects?**<br><br>**Overall Division Comments:**<br><br>Our judgment is that too little funding is available for each of the programs evaluated. Low success rates continue to be a major concern in some programs. In these cases, there is a tension between funding an appropriate number of awards and the amount that can be allocated to each award.<br><br>We support the Engineering Directorate goal of increasing the success rates to at least the NSF averages.<br><br>In most cases, the duration of awards seems to be sufficient. | Not appropriate |

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

| | |
|---|---|
| ***Centers specific comments***<br><br>The trend in award sizes appears to be downward, while the trend in expectations of the Centers is increasing. All the new Gen-3 requirements are excellent, but are moving into the realm of unfunded mandates. Award sizes need to increase or at least maintain the prior levels. | Not Appropriate |
| ***Education specific comments***<br><br>Too little funding is available for engineering education. Duration is sufficient. There is a tension between funding an appropriate number of awards and the amount that can be allocated to each award. Target success rate of 20% is desirable. | Not Appropriate |
| ***IUCRC / PFI specific comments***<br><br>The funding model for the IUCRC has been extremely effective. However, the overall impact of these centers of excellence is limited by a low base level of support. | Yes (PFI)<br>No (IUCRC) |
| ***RET / REU / BBSI specific comments***<br><br>The institutions construct meaningful program experiences that fit the financial guidelines. If additional funding were available, the institutions could construct stronger programs. The reduction to 3 years for most REU programs was a positive change. The ENG directorate mandates that future funding cannot be mortgaged more than 50%. We concur with this limitation. The tradeoffs among size, duration, and scope seem appropriate. | Appropriate |
| **3. Does the program portfolio have an appropriate balance of:**<br>• Innovative/high-risk projects?[6]<br><br>**Overall Division Comments:**<br><br>Generally, there is an appropriate balance. However, program officers should explicitly address the appropriate balance for their program in their review analysis. | Appropriate |

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

| | |
|---|---|
| **4. Does the program portfolio have an appropriate balance of:**<br>• Multidisciplinary projects?<br><br>**Overall Division Comments:**<br><br>The 50% balance now occurring in the Engineering Directorate seems appropriate and a good target to maintain. | Appropriate |
| **5. Does the program portfolio have an appropriate balance of:**<br>• Funding for centers, groups and awards to individuals?<br><br>**Overall Division Comments:**<br><br>This division is likely atypical within the NSF and Engineering Directorate, because of the ERC and IUCRC programs. | Appropriate |
| **6. Does the program portfolio have an appropriate balance of:**<br>• Awards to new investigators?<br><br>**Overall Division Comments:**<br><br>None | Appropriate |
| **7. Does the program portfolio have an appropriate balance of:**<br>• Geographical distribution of Principal Investigators?<br><br>**Overall Division Comments:**<br><br>Data were provided on the geographic distribution of proposals and not awards. If awards have the same distribution as proposals, then the distribution is appropriate.<br><br>More that 15% of the IUCRCs and 35% of the PFI awards are to centers/sites and PIs located in EPSCoR states. | Appropriate |
| **8. Does the program portfolio have an appropriate balance of:**<br>• Institutional types?<br><br>**Overall Division Comments:**<br><br>For Centers, smaller institutions may be disadvantaged or discouraged from submitting proposals.<br><br>For Education, IUCRC, PFI, RET, REU, and BBSI, the distributions are appropriate. | May not be appropriate in Centers.<br><br>Appropriate in Education, IUCRC, PFI, RET, REU, and BBSI |

| | |
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| **9. Does the program portfolio have an appropriate balance of:**<br>● Projects that integrate research and education?<br><br>**Overall Division Comments:**<br><br>For the review period, an appropriate balance has been achieved. Concerns have been raised about in-process changes in Education. | Appropriate |
| ***Centers specific comments***<br><br>The Centers program addresses this by design. | Appropriate |
| ***Education specific comments***<br><br>For 2004-2006 (while DLR was in operation), there was an appropriate balance of discovery, application, integration and teaching. We are concerned about the in-process change in emphasis toward "research". Scholarship (Boyer) is a more inclusive and useful goal than research. | Appropriate |
| ***IUCRC / PFI specific comments*** | Yes |
| ***RET / REU / BBSI specific comments*** | Appropriate |
| **10. Does the program portfolio have an appropriate balance:**<br><br>▲ Across disciplines and subdisciplines of the activity and of emerging opportunities?<br><br>**Overall Division Comments:**<br><br>None | Appropriate |
| **11. Does the program portfolio have appropriate participation of underrepresented groups?**<br><br>**Overall Division Comments:**<br><br>Detailed EIS data were not available for Centers. Program data for ERC, Education, PFI, and REU/RET showed appropriate participation.<br><br>For IUCRCs, participation was not appropriate for women. | Appropriate for some programs. |

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|---|---|
| ***Centers specific comments***<br><br>There is a commitment to increasing diversity, which should continue to be strengthened and enhanced. Based on the ERC data (the EIS/GPRA cover page data is not very complete), the ERC numbers are well above the national average. | Data Not Available |
| ***Education specific comments***<br><br>Data was only provided on awardees. It would be informative to compare the data for awardees and for all submissions. | Appropriate |
| ***IUCRC / PFI specific comments***<br><br>The IUCRC program has an impressive number of under-represented groups in site leadership positions 21 of the 76 Directors and Site Directors are from under-represented groups (5 women, 3 African American, and 13 Hispanic). The representation of women is still a concern. In the PFI program, a total of 12 awards have been made to the following institutions: HBCUs (6 awards), other minority/minority-serving institutions (4), and Native American institutions (2). | Yes/No |
| ***RET / REU / BBSI specific comments***<br><br>The REU, RET, and BBSI programs have been particularly effective in involving underrepresented groups. | Appropriate |
| **12. Is the program relevant to national priorities, agency mission, relevant fields and other customer needs? Include citations of relevant external reports.**<br><br>**Overall Division Comments:**<br><br>The goals of each of the programs reviewed directly address the recent American Competitiveness Initiative and Rising Above the Gathering Storm reports. | Appropriate |
| **13. Additional comments on the quality of the projects or the balance of the portfolio:**<br><br>**Overall Division Comments:**<br><br>A combination of pre-screening and leveraging in the case of the IUCRC program, and a high number of applications and low acceptance rate for the PFI, guarantees a very high quality of the awards. Many highly qualified awards could not be funded.<br><br>The REU and RET supplements provide a flexible approach to broadening the reach of these programs. | |

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

**1. Management of the program.**

**Comments**:

***Centers specific comments***

The management team is excellent and very dedicated. It is severely under staffed, especially given the number of proposals being received, site visits, and post-award management. More staff would further improve efficiency and reduce the dwell time. The public dissemination of the "Best Practices" is a significant contribution, although more frequent updating (with more staff) would further enhance the impact.

***Education specific comments***

Operations are well run and efficient, especially considering the volume of proposals received, number and selection of reviewers, etc.

***IUCRC / PFI specific comments***

The IUCRC program management is excellent. The program manager not only runs a program that impacts economic competitiveness and technical workforce in the US, but also helps university PIs design successful management approaches that interface smoothly with industry. The high success ratio and quality of the program is due to extensive pre-screening through Planning Grants. The PFI program management is also excellent, particularly given the enormous breadth of the program. Responsibility for program management has changed from EHR to EEC to IIP in a relatively short time. The new program manager is considering strategies for fine-tuning this relatively new PFI program such as Letters of Intent, Letters of Commitment, Grantee workshops, and a Best Practices Document and Metrics. The COV strongly supports her vision for a more focused program in the future.

Both the IUCRC and PFI programs have moved to the IIP Division within the Engineering Directorate at NSF. This division should serve as a good home for these excellent programs. The COV is concerned that the PFI funding line responsibility is through the OIA, while the program management is through the IIP. This split responsibility might lead to inadequate resources for managing the program, limits on cross-collaborations with other programs in the IIP, and a disconnect for planning for the future.

***RET / REU / BBSI specific comments***

Program portfolio success speaks loudly to the quality and professionalism of the dedicated full-time staff and rotators. The REU, RET, and BBSI program directors are effective and knowledgeable and facilitate the success of the programs.

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

**Comments:**

***Centers specific comments***

The Centers are responsive by design, with emerging ideas proposed by the technical community and the option to provide supplements to address emerging opportunities.

***Education specific comments***

Responsiveness of the program to emerging research and education opportunities.
Comments: They are very responsive, but possibly too responsive to "in-vogue" (nano, entrep) areas at the expense of core, systemic efforts. The Course, Curriculum, and Laboratory Improvement (CCLI) program is to be admired for its continuity. More funding is needed to properly address both underlying core issues and applications to emerging areas. Portfolio should allow support for innovations that do not fall neatly into categories.

***IUCRC / PFI specific comments***

The IUCRCs are very responsive to emerging and important research as a partnership between universities and industry. Industry support is the primary driver for the research. Examples include Embedded Systems, Precision Forming and Reconfigurable Computing and Health Information and Decision Systems. The PFI program is impacting education opportunities for minority groups. The University of Alaska Anchorage Technology Applications and Learning Toward Professional Achievement (TALPA) program is significantly increasing the number of native American students pursuing engineering degrees.

***RET / REU / BBSI specific comments***

The BBSI program was established to meet the need of emerging areas of the field. The RET program has evolved to be even more responsive to current professional development literature to ensure that the teacher experiences result in positive changes in the classroom. The REU program ensures that career and professional development issues are directly addressed along with current topical research.

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

**Comments:**

***Centers specific comments***

The internal focus is on program design that addresses desired program elements (e.g., integration of research and education). The portfolio composition is guided by the merit review process.

***Education specific comments***

a. Concern about new emphasis on "research" at expense of implementation and dissemination

b. How are programs initiated and terminated? Should there be an external advisory mechanism to assist in these decisions between COV visits?, or does the ENG Directorate's advisory board serve this function. Specifically, it is unclear why DLR program was terminated abruptly, especially when planning grant proposals were solicited during the last year.

c. We recognize the inherent tension between continuity of programs vs. flexibility to stimulate new initiatives/areas. It is important to have a balance of programs that stimulate continuous and broad participation, while being responsive to contemporary needs.

***IUCRC / PFI specific comments***

Both the IUCRC and PFI programs are well planned and prioritized. Industry partners influence the priorities of individual centers. The COV advises that issues of globalization may be more important for the future for certain industries. Therefore, "formal" mechanisms to include foreign universities could be considered.

***RET / REU / BBSI specific comments***

The programs have been enhanced to address the 2004 COV report and the 2005 strategic plan. The portfolio has been enriched with an increase in the number of proposals received and the number of awards made. The *American Competitiveness Initiative*, *Engineer of 2020*, and Rising Above the Gathering Storm also guided the development of the new strategic plan.

**4. Additional comments on program management:**

***Centers specific comments***

The Centers are one of the most demanding programs within NSF in terms of multidisciplinary coordination, systems-level efforts, interaction with industry and other internal/external constituents. Despite this rigor, the numbers of proposals is increasing and this speaks to the commitment of the Center leadership teams. In addition, the success and impact of the Centers program is clearly a result of the continuity in the program management staff.

***Education specific comments***

Plans to increase the number of IPA's in EEC are encouraged. The ratio of IPA to permanent employees in this division is significantly different from ENG in general.

***IUCRC / PFI specific comments***

None.

***RET / REU / BBSI specific comments***

The programs show evidence of professional execution toward desired goals.

## PART B. RESULTS OF NSF INVESTMENTS

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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. Since relevant aspects of the Stewardship goal are included in Part A, the COV is not asked to respond to that goal in Part B.

**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 <u>OUTCOME GOAL for Discovery: "</u>** ***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."***

**Overall Division Comments:**

The overall research quality of the various EEC programs is excellent. The Centers portfolio, for example, addresses a huge breadth of research. As a result of the multidisciplinary nature of the Centers, the discovery outcomes are transformational, relevant, and address major societal needs and market opportunities.

By fostering the development of future researchers, the EEC programs ensure that there are highly qualified US investigators, well-prepared to undertake studies leading to new knowledge at the frontiers of engineering research. Moreover, these programs have contributed to the emergence of engineering education as a research-based field.

**Items for improvement:** Access to results, technologies, and innovations could be improved. A repository (website) administered by NSF for grantee results might be a solution/suggestion.

***Centers specific comments***

The ERC examples below represent:

- A creative industry-ERC partnership to address a critical homeland security need for portal entry monitoring.
- The ability to address two unique research challenges in terms of packaging a biomedical device (cardiac defibrillators) for both implantability and portability.
- The opportunity for undergraduate researchers involved in an ERC to identify an emerging market need in computer security and to develop a novel technology (fingerprint reader) that has led to a startup company and the transfer of this technology to a range of commercial products.

***Highlight (nugget) examples:***

**GORDON CENTER FOR SUBSURFACE SENSING AND IMAGING (CenSSIS)—Northeastern University** *(class of 2000)*
**Award Number and PI: 9986821, Michael Silevitch**
**Product/Process Successes**

**Arrayed Spectrometric High Efficiency Radiation Detector (ASHERD):** Reliable, high-speed radiation detection has become an urgently needed element of homeland security. The ASHERD team was headed by signal processing and sensor fusion experts at the Gordon Center and instrument developers at Bubble Technology Industries. Together they developed the ASHERD unit, a flexible and cost-effective option for a next-generation portal monitor. ASHERD is an adaptive array of state-of-the-art spectrometric neutron and gamma ray detectors, chosen to maximize sensitivity and minimize false positives in accordance with the ANSI N42.35 standard. The spectrometric sensors provide gamma and neutron source identification, thus discriminating among natural background, special nuclear materials, and industrial or medical isotopic radiation. The resulting system provides a unique and highly effective detection system for radiological and nuclear countermeasures. As team leader, the Gordon Center won a $4.5 million Department of Homeland Security (DHS) contract to develop the ASHERD prototype. The prototype was developed, tested against other similar systems, and was one of the winning prototype instruments. With the ASHERD device developed, a new team led by Raytheon Company (a Gordon Center industrial partner) proposed the Advanced Spectroscopic Portal (ASP) program. This team won a second contract to produce the ASP for U.S. ports of entry. This second contract was a production contract from DHS for approximately $400 million. Currently, The ASP is being used by DHS in the New York City Port Terminal in Staten Island for cargo screening. As part of the cost of a nationwide detection system, Homeland Security documents show the agency might spend more than $1 billion on cargo-screening equipment alone.

**ERC FOR EMERGING CARDIOVASCULAR TECHNOLOGIES (ERC/ECT) – Duke University** *(class of 1987; graduated 1998*)
**Award Number and PI: 8622201, Olaf Von Ramm**
**Product/Process Successes**

**Implantable Defibrillators:** At the ERC for Emerging Cardiovascular Technologies, which graduated in 1996, research in antiarrhythmic systems was aimed toward developing high-

technology devices to halt or prevent ventricular fibrillation, the primary cause of sudden cardiac death. About 400,000 people succumb to sudden cardiac death annually in the United States alone. The ERC judged in the late '80s that if only 10% of these individuals could be identified to be at risk and have devices implanted, the potential U.S. market for these devices would be close to a billion dollars per year and the international market potential would be several times larger. Two of the ERC/ECT's major research breakthroughs in antiarrhythmic systems--improved electrodes and biphasic waveforms–were transferred to the implantable defibrillator industry. Both of these developments reduce the energy needed to defibrillate. This single improvement results in five distinct advantages over previous implantable defibrillator technology: (1) reduced tissue damage; (2) reduced device size, allowing for easier implantation; (3) reduced time to charge the device, thus decreasing the time the body is without blood flow during the arrhythmia; (4) extended battery life; and (5) a wider range of patients treatable with implantable defibrillators. Biphasic waveforms have been adopted by the implantable defibrillator industry. Two companies, Intermedics and Ventritex, working with ERC/ECT researchers, took the research in biphasic waveforms to the stage of clinical testing. Two other companies, Cardiac Pacemakers, Inc. (CPI) and Medtronic, Inc., developed their own biphasic waveform circuitry based in part on this ERC/ECT research. Intermedics also brought to clinical trials the improved electrodes developed by the ERC/ECT. Today, implantable defibrillator companies continue to build on the Center's findings and modify their defibrillators accordingly.

**Portable Defibrillators:** The same improvements in sensors and electrodes that the ERC/ECT's work brought to internal defibrillators have also made external (portable) defibrillators, used to help people who suffer heart attacks in public places, easier to use and less expensive (about $3000 per unit). A more efficient and effective power source for delivery of the shock permitted miniaturization of the devices.

**3D Ultrasound:** The ERC achieved several breakthroughs in sensing and image processing that made three-dimensional ultrasound possible. At the time, this technology was 5-7 years ahead of acceptance by the medical community and insurance companies; now it is ubiquitous, partly as a result of early championing by the ERC/ECT through a startup. The worldwide market for this equipment is estimated at $2.7 billion per year.

**Startup**
**Volumetrics Medical Imaging:** In 1990, two ERC faculty formed this startup to build and sell then-revolutionary real-time 3D ultrasound equipment. Volumetrics' machine used parallel processing of ultrasound signals to obtain multiple images simultaneously, allowing doctors to view an organ from four or more perspectives at once. Eventually Royal Philips Electronics (the Netherlands) pursued purchase of the company, but backed out. In 2004 Philips settled a breach-of-contract claim by Volumetrics out of court for EUR $145 million (USD $185M). Volumetrics no longer has products, but still patents and licenses the 3D ultrasound technologies.

**CENTER FOR NEUROMORPHIC SYSTEMS ENGINEERING (CNSE) – California Institute of Technology** *(class of 1995; graduated 2006*)
**Award Number and PI: 9402726, Pietro Perona**
**Product/Process Successes**

**Microsoft Products Include DigitalPersona Technology**: With real and fast-growing concerns about identity theft, security of intellectual property, and even cyber-terrorism, computer security is a major focus of governments, businesses, and individuals alike. Microsoft Corporation is now

shipping new products that contain security technology developed by DigitalPersona, a Caltech Center for Neuromorphic Systems Engineering (CNSE) start-up company. DigitalPersona, founded by former CNSE students Vance Bjorn and Serge Belongie in 1996, developed "U. are U." fingerprint identification technology, winning the coveted Best of Comdex award for computer peripherals in 1997. The new Microsoft products incorporating this technology are: Optical Desktop with Fingerprint Reader, Wireless IntelliMouse® Explorer with Fingerprint Reader, and Microsoft® Fingerprint Reader. Password management is a growing problem for many computer users, at home and at work. People often have to keep track of many different passwords and user names in order to get secure access to check e-mail, shop at favorite web sites, and use bank accounts or company databases. The new Microsoft products introduce biometric password management using the DigitalPersona Password Manager Software, which includes the novel DigitalPersona IDentity Engine that makes fingerprint recognition fast and reliable. The new products aim to reduce password fatigue by making it more convenient to open password-protected pages while continuing to insure privacy and security. The fingerprint reader is specifically designed to be intuitive and reliable. The fingerprint recognition technology allows people to log on to the PC, switch between users, and access favorite online sites at the touch of a finger. It is expected that this technology will soon become ubiquitous wherever people use computers.

The company, DigitalPersona, is a spinoff of the Caltech ERC, founded by ERC alumni and faculty. Their award-winning products are seeing rapid adoption in the computer interface peripherals market by industry leaders such as Microsoft Corporation.

Development of these new computer-interface devices required the collaboration of an interdisciplinary team of researchers in electrical engineering, robotics, image processing, computer science, biology, and product design.

**CENTER FOR NEUROMORPHIC SYSTEMS ENGINEERING (CNSE) – California Institute of Technology** *(class of 1995; graduated 2006*)
**Award Number and PI: 9402726, Pietro Perona**
**Product/Process Successes**

Microsoft's new Fingerprint Reader, based on technology developed by a CNSE spin-off, makes it possible to replace passwords and switch users with the touch of a finger.

***IUCRC / PFI specific comments***

The IUCRC and PFI programs represent partnerships that are more focused on meeting industry interests and fostering economic and human resource development through innovative research and technology transfer. The following examples highlight these features.

***Highlight (nugget) examples:***

**CENTER FOR IDENTIFICATION TECHNOLOGY RESEARCH (CITER) – West Virginia University**
**Award Number and PI: 0342713, Larry Hornak**
**Product/Process Successes**

Researchers at the Center for Identification Technology Research (CITeR), an NSF Industry University Cooperative Research Center based at West Virginia University, are putting tools in the hands of practitioners in government and industry to dramatically improve homeland security. CITeR's focus is on the advancement of the state of the art of biometric automated systems able to rapidly authenticate visually the identity of an individual. The capability of biometrics to identify a person with their actions is absolutely central to enhance homeland security and defense. Two recent highlights from the center are particularly noteworthy. In the first breakthrough, CITeR demonstrated that perspiration can be used as a measure of liveness detection for fingerprint biometric systems. This dramatically reduces the potential for spoofing biometric devices, a major vulnerability in the industry. This research, in addition to enhancing security, is spinning-off start-up companies and reaching out to the public through many news venues. In another highlight, CITeR's Multibiometrics (MUBI) Tool and Program for the Rate Estimation and Statistical Summaries (PRESS) are being used by DoD and DHS to rapidly and effectively implement biometric systems. PRESS is a software system that allows a user to assess how well the system under test is functioning based on empirical testing. This allows testers of biometric systems to more quickly understand their performance, enabling a more rapid deployment of systems.

**BERKELEY SENSORS AND ACTUATORS CENTER (BSAC) – University of California--Berkeley**
**Award Number and PI: 0318642, Richard Mueller**
**Product/Process Successes**

Researchers at the Berkeley Sensors and Actuators Center (BSAC) at UC Berkeley have developed a tiny sensor that includes an ad-hoc wireless networking system that can sense a local environment and relay that information remotely. This "SMART DUST" project has enormous potential benefit for industrial and security applications. The Co-Director of the award, Kris Pister, was awarded an Alexander Schwarzkopf Prize for Technological Innovation.

**POWER SYSTEMS ENGINEERING RESEARCH CENTER (PSERC) – Cornell University**
**Award Number and PI: 0118300**, **Robert J. Thomas**
**Product/Process Successes**

PSERC has made significant contributions to understanding and developing solutions to electrical

power system reliability issues. PSERC researchers, working through the Consortium for Electric Reliability Technology Solutions, are developing solutions to transmission reliability concerns and are assisted the US DOE in the blackout investigation. The center is providing resources to assist people understand blackouts. PSERC created the "Blackout of 2003" web page, which has become a recognized portal to information about the blackout, ongoing investigations, and power systems in general. One of the researchers from this award, Thomas Overbye, was also awarded an Alexander Schwarzkopf Prize for Technological Innovation.

***RET / REU / BBSI specific comments***

To address the workforce pipeline, the REU and RET programs have a long track record of excellence highlighted in the following examples. (Nuggets for the BBSI were not available to the COV.)

***Highlight (nugget) examples:***

**NANOSCALE SCIENCE AND ENGINEERING FOR MATERIALS SYSTEMS AND MATERIALS PROCESSING – Clarkson University**
**Award Number and PI: 0453404, John Moosbrugger**
**Product/Process Successes**

The REU site, Nanoscale Science and Engineering for Materials Systems and Materials Processing at Clarkson University, has designed program activities "to promote graduate school and research, as a career path for the participating students and to expose the students to the broader field of nanoscale science and engineering, which has been established as a national priority for research and development."

**RESEARCH EXPERIENCES FOR UNDERGRADUATES IN JAPAN IN ADVANCED TECHNOLOGY – Washington University**
**Award Number and PI: 0243809, Shirley Dyke**
**Product/Process Successes**

Research Experiences for Undergraduates in Japan in Advanced Technology at Washington University provides an opportunity for students to engage with technology globalization. The objective of the program is to "entice students' interest in the study of advanced technology as well as to foster and nurture future Japanese and US cooperation in and sharing of innovative technological research." This award also addresses the broader impact by the inclusion of a well-recognized HBCU (FAMU).

**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.*"**

**Overall Division Comments:**

EEC is structured to integrate comprehensive research programs with the interests of a broad range of stakeholders (i.e., industry, K-12 students and teachers, undergraduate students, etc.) . The Centers address the integration of research and education through undergraduate and graduate courses, REU, etc., as well as K-12 STEM education. The IUCRC and PFI programs do an exemplary job of cultivating a broadly inclusive science and engineering workforce when one considers the inclusion of institutions from states that have traditionally received relatively less federal research funding. The REU, RET, and BBSI programs are exemplary in expanding the scientific literacy of a broader demographic of U.S. and permanent resident students and teachers.

**Items for improvement:** It is difficult to assess the impact of EEC programs on the scientific literacy of all citizens due to a lack of quantitative metrics. Perhaps coordination with EHR programs may be a fruitful partnership.

***<u>Centers specific comments</u>***

The examples below highlight how some of the ERCs are partnering with K-12 school districts in developing programs for both students and teachers to increase the quantity and quality of the STEM pipeline.

***<u>Highlight (nugget) examples:</u>***

**ENGINEERING RESEARCH CENTER FOR COMPUTER-INTEGRATED SURGICAL SYSTEMS AND TECHNOLOGY (ERC CISST) – Johns Hopkins University**
**Award Number and PI: 9731748, Russell Taylor**
**Product/Process Successes**

**A Summer Robotics Camp**
Attracting a broad diversity of students into science and engineering studies is crucial to the nation's economic future. The key is sparking their interest at an early age. In 2003, the National Science Foundation-funded Engineering Research Center for Computer-Integrated Surgical Systems and Technology (ERC CISST), at Johns Hopkins University in Baltimore, provided funding, organizational, and logistical support for the first Summer Robotics Camp conducted for middle school-aged children at nearby Woodlawn High School. The children who attended came from very diverse racial and ethnic backgrounds and from public, private, and home schools across Baltimore City and County. Eighty percent of the children attending the camp were minority students. They were exposed to robotics construction and theory through a problem-solving application that taught them basic programming, electronic theory, soldering, and mechatronics. According to C. Anthony Thompson, Woodlawn's principal, "The summer camp was a huge success. The camp was able to provide a low-cost, one-week experience that showed impressionable middle school-aged children the benefits of seeking an education in an engineering-related field." The children enjoyed the camp immensely; some even signed up for a

second week. Ninety percent of the 96 children attending the camp said they would like to attend any camp offered the second year. The 2003 summer camp was such a success that the Office of Science of Baltimore County is funding similar summer camps in environmental science and forensics at Woodlawn, targeted again at middle school-aged children. The summer camps of 2004, including another robotics camp supported by the ERC, will be used as a baseline model within the county to provide a summer enrichment program in science and technology.

The summer activity offers an exciting introduction to real-world science and technology to a group of students-largely urban minority middle-schoolers-at a time when they are open to new interests and seeking career direction. The program also has become a springboard for similar informal-education programs offered more widely by the Baltimore County government.

**ENGINEERING RESEARCH CENTER FOR EXTREME ULTRAVIOLET SCIENCE AND TECHNOLOGY – Colorado State University**
**Award Number and PI: 0310717, Jorge Rocca**
**Product/Process Successes**

**Light and Optics Workshop for High School Teachers**
The ERC for Extreme Ultraviolet Science and Technology (EUV ERC), headquartered at Colorado State University, considers highly interactive workshops for teachers to be one of the most effective ways to raise the science and engineering literacy of a large number of students. When teachers are educated in engineering design and in the inquiry-based scientific process, they can pass on the excitement and power of science and engineering to their students. The EUV ERC presented a highly successful workshop to 23 middle school teachers from Pueblo, Colorado, in 2004. The Pueblo School District serves a large minority population. In January 2005 the Center ran a second workshop aimed at 16 high school teachers. It featured 13 challenging experiments involving basic concepts in lasers and optics designed to be performed using only equipment and materials commonly found in a public high school classroom. The workshop encouraged a constructivist approach where a physical phenomenon related to light was demonstrated and participants were asked to explain the fundamental concept through experimentation and discussion. Alternatively, predictions were solicited and then verified or disproved with experiments. These were highly effective and popular approaches that elicited participant discovery. Gaps in knowledge were quickly exposed and filled. Ultimately, we provided teachers with sequences of questions and discussion points, which, in combination with experiments, can successfully lead students to discover the nature of physical phenomena in light/optics.
Quotes from 2005 High School Teacher Workshop: “The workshop was very useful. It provided a way for me to use hands-on activities to teach light and optics within a limited budget. This type of information is extremely useful to me as a teacher.” “I was forced to come up with hypotheses just as my students are.” “These activities make me think in ways I want my students to think.” “The workshop gave me a better way to explain concepts to my students.” “I leave with a clearer understanding of concepts that I only poorly knew of before.” “The demos were within our budget capabilities and time limitations.” “The best part of the workshop was the hands-on approach.”

This annual workshop is aimed at middle and high school teachers from a district where a high percentage of students are Hispanic or Native Americans. The impact of the project is highly leveraged in that teachers acquire new knowledge and powerful teaching tools that can stimulate the interest of hundreds of students in science and technology and potentially affect the career choices of many students from underrepresented groups.

***IUCRC / PFI specific comments***

The IUCRC and PFI programs supported a broader range of institutions, particularly in the EPSCoR states, thus impacting diverse geographic and demographic groups. More than 15% of the institutions supported by the IUCRC program are from EPSCoR states, and approximately 35% of the institutions supported by the PFI program are from EPSCoR states. Both organizations have also made impact in terms of investment in underrepresented groups. At least 10 PFI awards have been made to underrepresented groups as lead institutions. Also a number of awards have been made to community colleges as lead institutions. The committee found that being able to determine the broad base impact and contribution of these programs on individual PIs and individual programs was difficult as data collection procedures did not provide proper resolution. The data that was provided shows that the total number of awards to female and underrepresented groups are relatively high. The data collection procedures should be improved to highlight the full ramification of these programs on female and underrepresented groups. For example, data collection procedures should highlight the number and the success (based on quantifiable metrics) of programs performed by the individual grantees targeted to underrepresented groups.

***RET / REU / BBSI specific comments***

The REU/RET/BBSI programs directly increase the number and diversity of students in the pipeline and increase the likelihood that these students will achieve a STEM-related degree. The REU program has been shown to enhance the interest of program participants in continuing to a PhD from 25% pre-program to 48% post-program.

***Highlight (nugget) examples:***

**WHAT'S ENGINEERING RET – Carnegie Mellon University**
**Award Number and PI: 0338760, John Bares**
**Product/Process Successes**

The RET program at Carnegie Mellon states: "The end goal of the CMU research is to develop our nation's intellectual capital; enabling American students to compete in the global innovation ecosystem where thinking and problem-solving are the 'new basics' of the 21st century." The CMU Robotics Academy curriculum is being used in over 4000 schools nationally. The new CMU/LEGO co-branded curriculum will support the next generation LEGO Mindstorm robot.

**RESEARCH EXPERIENCE FOR TEACHERS IN AREAS OF INNOVATIVE AND NOVEL TECHNOLOGIES – Drexel University**
**Award Number and PI: 0227700, Mun Young Choi**
**Product/Process Successes**

Another RET program at Drexel resulted in partnerships with the School District of Philadelphia and the Franklin Institute (Philadelphia Museum of Science) to propose expansion by the Commonwealth of Pennsylvania of experiential learning programs to 200 K-8 teachers every year for three years. Other Drexel faculty are working with RET fellows on developing a FIRST robotics program, a NASA GLOBE project, and an NSF project on wireless communication.

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

**Overall Division Comments:**

The EEC programs, in general, have made a tremendous impact on transforming university culture to support undergraduate and graduate student training in interdisciplinary research. The centers programs, in particular, have influenced investments in major shared equipment infrastructure – in terms of acquisition, maintenance, and management of these facilities. Centers have also stimulated and reinforced multi-disciplinary education. They have also cultivated important relationships with various stakeholders such as industry, the K-12 community, etc., in terms of transferring technologies and developing human resources to support the high tech enterprise. By stimulating the development of a professoriate with expertise in engineering education, EEC programs have had important effect in developing the human infrastructure necessary to maintain our nation's competitive edge.

**Items for improvement:** The impact at grantee institutions has been positive, but the broader and long-term impact is less certain.

***Centers specific comments***

Significant funds for acquisition of major equipment and facilities are not directly available through Centers funding. However, designation as an ERC or NSEC has led to leveraging both institutional and external support for infrastructure. This has been further enhanced through effective use of NSF supplements to attract significant matching state and private funding for investment in facilities and infrastructure. In addition, Centers have often served as a clearinghouse for collection and dissemination of scientific and educational information related to their respective missions.

Notable examples of significant investments in physical facilities and infrastructure are highlighted below.

***Highlight (nugget) examples:***

**CENTER FOR BIOLOGICAL AND ENVIRONMENTAL NANOTECHNOLOGY (CBEN)– Rice University**
**Award Number and PI: 0118007 & 0647452, Vicki Colvin & William Marsh**
**Product/Process Successes**

**International Council on Nanotechnology (ICON)**

Visit the ICON website.

The current and prospective industrial partners of the Center for Biological and Environmental Nanotechnology (CBEN) have strongly encouraged the Center to go beyond the traditional structures of an industrial affiliates program to create a more inclusive and international group. Their enthusiasm has prompted CBEN to develop a program that welcomes not only corporate members, but also government, non-governmental

organizations (NGOs) and other academics. This broader partnership is vital to the core mission of the Center of creating a sustainable nanotechnology industry that requires meaningful and organized interactions among stakeholders.

At their request the International Council on Nanotechnology (ICON) has been launched. The mission of this organization is to assess, communicate, and reduce environmental and health risks associated with nanotechnology while in turn maximizing its benefits to society. To realize this vision, ICON seeks participation from a diverse group of parties including industry, academics, government officials, and representatives of environmental organizations. Its activities span technical research in nano-cell interactions, policy projects such as development of nano-material standards and terminology, and social studies of risk perception and communication. By pooling the resources of the nanotechnology industry, governments, and academia, ICON can cost-effectively provide a wide range of synergistic projects that serve the interests of all stakeholders. While CBEN plans to manage and launch this group, they will involve and use the expertise of all academics involved in these issues. There is widespread enthusiasm for this organization, which will create new knowledge of use to government and industry researchers and serve as a central clearinghouse for information related to health and environmental aspects of nanomaterials. By catalyzing the formation of ICON, the Center is taking the first, early steps to ensuring that CBEN creates a legacy that lives beyond its ten-year NSF funding cycle.

**GEORGIA TECH PACKAGING RESEARCH CENTER (PERC)– Georgia Institute of Technology**
**Award Number and PI: 9402723, Rao Tummala**
**Product/Process Successes**

**State-Industry-University Partnership Builds Leading-edge Plating Facility**
The Georgia Tech Packaging Research Center, an Engineering Research Center (ERC), in partnership with ATOTECH USA, NSF, and the State of Georgia, recently completed the design, development, installation, and process qualification of a $1.3M large-area (300mm) plating system used for laying down conductive, metallic layers on packaging components for the ERC's 300mm-compatible System-on-a-Package (SOP) Fabrication Facility. The core of this partnership is the development of equipment, chemical baths, and processes needed to realize the Center's SOP concept. The new facility, the first 300mm one of its kind in the academic world, serves both research and education missions. In research, it makes possible the ultrasmall and fine pitch interconnections needed for the first demonstration of wafer-level packaging at the nanoscale. In addition, the new facility makes possible rapid fabrication of the Center's convergent system testbeds and prototypes. In education, it allows students to learn the Center's SOP technology from design to fabrication to test through the Design-Build-Operate (DBO) course, a groundbreaking, hands-on undergraduate course developed by the Center. The Center's industry members and other universities will use the facility to explore new frontiers and to fabricate leading-edge prototypes, as part of the Center's long-term self-sufficiency strategy.

A primary goal of the Engineering Research Centers Program is to develop an interdisciplinary culture in academe where students can gain the full range of the engineering experience, from fundamental inquiry to design, to build. This facility provides a resource for both research and education not only to Center-affiliated faculty and students but also to users from industry and other universities.

***IUCRC / PFI specific comments***

In the IUCRC program, extremely small NSF investments have leveraged significant investments from private industry to develop a research infrastructure (i.e. advanced instrumentation, testbeds, and experimental tools) in more than 150 universities in the US.

The PFI program is providing an exceptional service in developing facilities and cyberinfrastructure. Examples for facilities include the Marine Research and Education facility in "Creating New Economic Opportunities in Downeast Coastal Marine By Enhancing Marine Education and Research Capacity," and the Northwest Ohio Partnership for Alternative Energy Systems. Examples of cyberinfrastructure include ToolingNet and the Techfinder portion of "Creating an Entrepreneurial Program in a Rural Setting", and the " Louisiana Technology Incubator for Entrepreneurial Success (TIES).

## PART C. OTHER TOPICS

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

***Centers specific comments***

The ~$10M loss of funding for the ERC program in 2007 and 2008, and the reduction of the number of ERC's from 20 to 15, does not seem consistent with the success of the Centers and their strong connection to addressing national competitiveness (e.g., ACI, Gathering Storm). With the increase in NSF's overall budget, the COV recommends an increase in the ERC program budget to fund a steady number of 25 ERC's, along with an appropriate increase in program staff.

The NSF-wide decision to eliminate explicit statements of cost-sharing in the budget page has had a negative impact on the Centers' ability to develop both institutional and external (industry) commitment. A key benefit of the ERC or NSEC designation is the ability to leverage the award to obtain additional infrastructure funding; the cost-share requirement automatically raises the interest and impact of the Centers to a much higher level (e.g., at least VP for Research). For the Center-level and duration of funding, the COV recommends that a stated percentage (e.g., 10-20% was the prior requirement) of cost-share be required. In the near term, the ERC review process could require a statement of the level of institutional commitment and external funding.

***Education specific comments***

(See section C.4)

***IUCRC / PFI specific comments***

The IUCRC program management is excellent. The program manager not only runs a program that impacts economic competitiveness and technical workforce in the US, but also helps university PIs design successful management approaches that interface smoothly with industry. The high success ratio and quality of the program is due to extensive pre-screening through Planning Grants. The PFI program management is also excellent, particularly given the enormous breadth of the program. Responsibility for program management has changed from EHR to EEC to IIP in a relatively short time. The new program manager is considering strategies for fine-tuning this relatively new PFI program such as Letters of Intent, Letters of Commitment, Grantee workshops, and a Best Practices Document and Metrics. The COV strongly supports her vision for a more focused program in the future.

Both the IUCRC and PFI programs have moved to the IIP Division within the Engineering Directorate at NSF. This division should serve as a good home for these excellent programs. The COV is concerned that the PFI funding line responsibility is through the OIA, while the program management is through the IIP. This split responsibility might lead to inadequate resources for managing the program, limits on cross-collaborations with other programs in the IIP, and a disconnect for planning for the future. The COV recommends that the budget should be moved into IIP.

We emphasize the need for the PFI program to expand funding to allow for grantees workshops, developing metrics of success, and assembling highlight documentation in order to demonstrate the success of the program. The highlights presented to the COV for review suggest that the program is on track to meet a primary goal of stimulating "the transformation of knowledge created by the research and education enterprise into innovations that create new wealth, build strong local, regional and national economies and improve the national well-being".

***RET / REU / BBSI specific comments***

The EEC should make a concerted effort to increase the participation of students and faculty from community colleges. The COV wondered whether the program information for REU, RET, and BBSI sites is well suited to and promoted to community college students and faculty. In particular, many tribal colleges are community colleges that could increase diversity for these programs.

The REU program is a good example of collaborative research funding with DOD, i.e., with AFOSR. The COV recommends that opportunities for leveraged funding should be explored with other federal agencies, using this DOD collaboration as a model.

RET programs have done quite well at attracting racially diverse participants, but the percentage of women and younger participants in RET programs is surprisingly low. Women represent 75% of the K-12 teacher workforce, and 55% of high school teachers are women (National Center for Education Statistics), whereas only 48% of the participants were women.

In addition, with half of the teacher workforce leaving within their first five years, participation in RET programs might assist in retaining younger teachers and improving the quality of overall K-12 STEM instruction.

Although REU, RET, and BBSI research findings are being published in scientific and engineering journals, few journal papers have focused on the educational findings from these programs. Better dissemination of instructional materials developed in the RET and BBSI programs should be encouraged. RET participants might be encouraged to submit their materials to such dissemination sites as teachengineering.com and the ASEE K-12 workshops and technical sessions.

**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.**

***Centers specific comments***

Although the diversity numbers for ERCs are higher than the national averages for engineering, there is some concern that some of the Centers achieve these numbers through avenues that do not effectively address the issue of broadening participation. There are two issues at hand here: (1) diversity numbers and responsibilities are addressed almost solely through the inclusion of an HBCU, MSI, etc., and are not representative of each institution as a whole; (2) the HBCU, MSI, etc. participating institutions may not be strategically integrated into the research and leadership roles.

The COV recommends that the lead institution of each Center take responsibility to manage the diversity strategy plan and that the annual site visits evaluate the significance of the diversity efforts. Delegation of this responsibility solely to the MSI is discouraged. The emphasis must also be on growing the pipeline, not simply moving the same cohort of students from underrepresented groups around. Nevertheless, the ERCs represent the best practices within NSF, with respect to diversity. In many of the newer ERCs, diversity has been internalized in this way. The COV recognizes that in many cases, institutional barriers must also be overcome.

Transition of Centers to self-sufficiency – It is expected that much of the research has opportunities for funding sources after Center graduation. The self-sufficiency issue is one that is mostly a concern for significant multi-disciplinary, systems-level efforts and for education/outreach infrastructure. The COV recommends that Centers develop a strategic plan after year 4 (renewal year) to identify which core functions should continue after Center graduation and how these functions could be implemented across the institution (e.g., college of engineering). The key would be models that can be expanded beyond the specific ERC theme. The continuing impact of the graduated Centers should be assessed.

***Education specific comments***

(See section C.4)

***IUCRC / PFI specific comments***

U.S. students need to compete globally by being *more* inventive and innovative than others, as our current population will not allow us to compete based on sheer numbers of technically-educated people. To maintain our economic competitiveness, we also need to attract more under-represented groups to science and engineering. Both of these goals will require structural and cultural changes at universities, as well as implementing innovative approaches for producing the entrepreneurs of the 21st century.

The IUCRC and PFI programs are attracting a high number of participants from under-represented groups relative to other NSF programs by providing a new and stimulating environment for participating in innovation, and by promoting university-wide changes beyond

the traditional classroom. Therefore, these programs are key for meeting the challenges outlined in the ACI and Gathering Storm reports, and ***the COV recommends that these programs be augmented and the successful aspects (e.g., diversity participation, academic culture change and innovation) be replicated***.

Additionally, to support fundamental invention, the fundamental research supplements should be continued and enhanced.

***RET / REU / BBSI specific comments***

The RET program does an excellent job of meeting the stated program objectives. The program is to be commended for identifying the need to strengthen continuing ties between the K-12 teacher and college faculty following completion of the summer program and the need to strengthen community college participation.

The objectives of the BBSI program are also well met. The program is enhanced by leveraging the program funds through collaboration with NIBIB.

The REU program is also achieving the stated objectives and has excelled in collaborating with others (e.g., DOD) in panel review and funding.

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

***Centers specific comments***

The Centers program should promote their efforts both within NSF and to other agencies (e.g., NASA, DOE, DOD, DOL, DHS), to achieve recognition for the "best practices" that have been developed. ERCs are one of the few examples of a successful systems-level tie to industry. The presence of a critical mass of faculty, students, and industry collaborators can be leveraged in working with other funding groups with complementary expertise (e.g., EHR). The COV recommends the development of a strategy to identify synergistic areas, such as REU, summer institutes (e.g., BBSI), education, recruitment, technology transfer, and then implementation through (1) NSF-wide coordination committees (2) inter-agency working groups (modeled on the NNI) to address "mega-community" problems such as K-12 STEM pipeline, underrepresented groups (including domestic PhD students), and technology transfer and commercialization.

One important aspect of assessment of the Centers is the statistics collected through EIS on participants, reviewers, and awards. Unfortunately, the current method of EIS data collection does not appear to correctly capture the relevant ERC program data. For example, none of the ERC diversity data is collected because the awards are Cooperative Agreements. Since NSECs are distributed across multiple program elements, the coordination on the statistics for these Centers may be even more challenging. The COV recommends that the EIS system be modified to more accurately represent the desired program data. For example, the current ERC and RET program data collection is much more informative, accurate, and relevant.

***Education specific comments***

(See section C.4)

***IUCRC / PFI specific comments***

Late-stage innovation and technology transfer is covered very well through for example the SBIR programs ($100M). In comparison, medium-stage invention/innovation is covered through the $20M assigned for all other IIP programs (GOALI, IUCRC and PFI). This budget should be further augmented - particularly in response to the ACI and Gathering Storm reports.

True early-stage invention/innovation stimulates disruptive technologies and must also be supported. NSF has a structural impediment for early-stage invention/innovation. Mechanisms for supporting early stage, truly-transformative, invention/innovation need to be developed. The COV recommends special review panels, since many sub-discipline reviewers will tend to understand and favor incremental proposals.

To successfully navigate the workforce and innovation challenges of the 21st century, NSF needs to even more strongly advocate for cultural change at the university level, using the successful ERC, IUCRC and PFI programs as examples.

***RET / REU / BBSI specific comments***

Programs are needed to enhance the opportunity for pre-service teachers to learn about engineering in the context of STEM education.

The organization/location of NSF programs related to engineering education is confusing to some faculty, sometimes resulting in lost opportunities to submit proposals or submission to the wrong division. Some programs are located in EEC (ENG) and others are located in EHR.

NSF should consider pursuing leverage opportunities with industry/foundations (NSF-CFA) and government (DOD, NASA, DOE, DOL, DHS).

The NAE report *Raising Public Awareness of Engineering* points to the need for an engineering public relations campaign. This need is related to the NSF outcome goal for learning: "Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens." Related is the need to educate guidance counselors. NSF should collaborate with the National Association for College Admissions Counseling and the American School Counselors Association. In addition, NSF should seek ways to influence the education programs that produce guidance counselors so that they will recognize the characteristics indicative of engineers and become knowledgeable about the requirements for engineering education.

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

**Overall Division Comments:**

The new objectives for EEC (2020) are written in terms of human capital outcomes such as K-12 pipeline, retention, and increasing domestic PhDs. There seems to be a mismatch between the B1 NSF outcome goal on Discovery and the EEC objectives for 2020. The agency outcome goal for Discovery is not fully reflected in the EEC strategic plan. The objectives for EEC need to include both Discovery and pipeline issues.

***Centers specific comments***

The proposed new Gen-3 objectives – e.g., international component, small business interaction for technology transfer – are strongly in line with national objectives. These objectives have evolved from a careful, deliberate, and strategic process undertaken within NSF and by external groups, as documented in major reports such as the Gathering Storm, and as recommended through the ACI.

**GEN-3 NEW FEATURES:**

- Direct engagement with small innovative firms to link scientific discovery to technological innovation
- Strategically designed education programs to produce more creative and innovative engineers
- Cross-cultural, global research experiences through partnerships with foreign universities or other means
- Long-term sustained partnerships with middle and high school teachers and students

The COV strongly endorses these new features. One critical issue is that the funding needs to increase appropriately to ensure that these new features do not become unfunded mandates. The ERC staff may also want to look into the IGERT at Georgia Tech that brings together PhD students, law school students and MBA students to train the students in what is needed for a successful technology transfer and business plan.

The proposed plan to establish smaller-scale, ERC-like groups at EPSCoR institutions is a positive strategy that addresses several issues: exposing a large cadre of previously non-ERC connected engineering students to the benefits of ERCs and stimulating interest in graduate programs; providing an opportunity for institutions in EPSCoR institutions to develop the necessary infrastructure (e.g., experiential and physical) for systems-level research and education. The COV strongly endorses the broadening of the impact of the ERC program (as also recommended in the 2004 COV) in terms of types of institutions, geographic distribution, and the **potential** for broader participation by diverse faculty and students through the establishment of this program. Since ERC's tend to reach out to K-12 students in their geographical region, this program would also have a positive effect on K-12 education.

Image of Engineering/Image of PhD -- Increasing domestic student recruitment depends on both

improving the image of engineers – e.g., helping society – and on the pathways after obtaining a PhD. For example, PhD's do not all end up in academia; creative, technologically excellent, global and business-savvy graduates are needed to develop and commercialize technology and to start and lead companies for the economic competitiveness of the nation. For broadening the image of engineers, the COV recommends that Centers add efforts in societal impacts and/or technology and public policy and in enhancing the ability of the faculty and students to communicate the contributions of engineers to the public.

***Education specific comments***

**Building the Capacity for the Scholarship of Teaching & Learning Through Increasing the Institutional Value for Engineering Education**

In order to achieve objectives 2 and 3 of the EEC strategic plan (i.e., undergraduate graduation rate, increasing domestic engineering graduate students), the COV recommends that EEC create programs to develop faculty who are both excellent educators and excellent discipline specific researchers. There is a risk that the current engineering education program request for proposals interprets research too narrowly and will force faculty, particularly those new to the professorate, to choose between education and discipline specific research as well as exclude those faculty interested in the broader scholarship of teaching.

To positively impact the value that institutions place on engineering education and the pursuit of the scholarship of teaching by its faculty, meaningful incentives must be provided by EEC. Incentives must include enduring programs that provide grants of sufficient number and size to enable broad based participation by faculty from a variety of institutions. Additionally, since many institutions do not provide financial support for engagement in educational conferences and workshops, a program is needed to provide mini grants (~$1K-4K) for educational conferences, workshops and sabbaticals with a requirement for some institutional match.

These recommendations will lead to a national faculty that participates more broadly in scholarly endeavors and serves as the key **human capital and infrastructure** to maintain America's competitiveness.

**Portfolio Allocation**

The current Education portfolio allocation between engineering centers and other programs is not consistent with the specific objectives enumerated and articulated in the 2007 EEC strategic plan. As a result, it prevents broad based participation of individual faculty from a variety of institutions. In particular, the engineering education program is inadequately funded and the COV recommends that the engineering education cluster budget be at least doubled as soon as possible.

**Centralized Structured Access to Program Products and Results**

A common outcome of many grants is that the results are not readily cataloged in an accessible central database. The COV recommends that the EEC consider developing a repository in cooperation with DUE for sharing education innovations and products developed by PIs.

**Program Management**

How are Education programs initiated and terminated? Should there be an external advisory mechanism to assist in these decisions between COV visits, or does the ENG Directorate's advisory board serve this function? Specifically, it is unclear why DLR program was terminated abruptly, especially when planning grant proposals were solicited during the last year. The COV recommends that a mechanism be established to evaluate and strategically direct the creation and termination of programs.

***IUCRC / PFI specific comments***

Metrics are now being used in the IIP Division Plan. Excellent start. Keep fine tuning to find best measures of impact related to program goals.

***RET / REU / BBSI specific comments***

The EEC focus on process and outcomes is commendable and consistent with similar initiatives in engineering education (ABET) and industry (ISO 9000).

**Phillips, Winfred** - Chair
University of Florida

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Textron

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From: Arun Majumdar [mailto:majumdar@me.berkeley.edu]
Sent: Tuesday, December 04, 2007 4:40 PM
To: Buckius, Richard O.
Cc: Culbertson, Joanne D.
Subject: EEC COV Report

Dear Richard,

The EEC COV report was discussed at the Fall AdCom meeting October 24-25, 2007. I am transmitting this report to the Directorate for your response and implementation.

Sincerely,

Arun

Chair, Advisory Committee (Fall'07-Sp'08)

NSF Directorate for Engineering