EXECUTIVE SUMMARY

The Committee of Visitors (COV) met on June 22-24, 2011 to review programs in the Electrical, Communications, and Cyber Systems Division (ECCS) in the Directorate for Engineering. The review covered the three years of FY08-FY10. During the review, the COV evaluated 180 jackets (proposal actions) that were randomly selected over the three-year time period. Oral presentations of the programs and processes were provided by the Division Director, Dr. Robert Trew, and Program Directors. The 2008 COV report and the Division response to that COV were also provided, and we were given access to a wide range of statistical information and summaries. The COV report follows the new NSF template for FY11 COV Reviews. Part I addresses the quality and effectiveness of the program's use of merit review process, Part II addresses the selection of reviewers, Part III concerns the management of the program, while Part IV answers questions about the portfolio of awards. The COV also responded to questions under Other Topics regarding agency-wide issues that might be addressed by NSF to help improve the program's performance.

Research supported by the Division is critical to our international competitiveness in engineering science and technological innovation. The Division's proactive engagement in cross-disciplinary research initiatives with other NSF Divisions and even other agencies (e.g. DOE) have helped diversify the research breadth of ECCS and have inspired new research frontiers including science and engineering beyond Moore's law, flexible electronics with primary application emphasis on revolutionizing healthcare, the efficient generation and management of energy from the environment, the continuous pursuit of cyber-physical systems to enable solutions to several of the NAE Grand Challenges, and enhanced access to the radio spectrum (EARS). The Division is also to be complimented for its continued successful management of the Foundation-wide NNIN program, that has had a tremendous impact on education, research and technology transfer.

The COV was very impressed by the active and thoughtful management, organization and new initiatives of the ECCS program. We commend the Division Director on the outstanding team he has assembled. The teamwork and strategic coordination involved in the management and operations of EPMD, CCSS and EPAS by the Program Directors is impressive, effective, and visionary. All processes are well managed, staff morale is high and the leadership and enthusiasm of the Division Director and all the PDs help keep ECCS at the forefront of engineering science. The balance and breadth of the award portfolio is excellent, with a diverse awardee and reviewer base, and proposal dwell time well below foundation goals. The Division has also responded to the previous 2008 COV by increasing the average award size to >$300K.

The COV identified some areas that if not addressed in coordination with the Directorate and indeed NSF as a whole, may impact the Division's ability to maintain excellence going forward. Many of these areas are not under the direct control of the division, and include -

Low award rates: The COV is concerned that the increasing number of proposals (1400 annually) combined with low award rates (16% funding rate for unsolicited proposals) could impact the quality of proposals and reviews. If award rates continue to decrease, faculty may react by writing even more proposals, instead of developing and proposing their best ideas. Selection of the best proposals will be difficult, because review panels may also be influenced by low awards rates. Moreover, faculty workload may reduce the quality of engineering science, education, and broader impact in the US, particularly with the increased budget pressures at the state and federal levels.

The previous COV recommended that the annual award amount be raised to avoid underfunding research. Therefore decreasing award amounts to increase the funding rate is not

a good strategy. Ideally, additional funding would address the low award rate, since high-quality proposals are currently rejected, and because NSF Engineering sees the most proposal pressure at NSF. Should this not be possible, it is vital that the division, the Directorate for Engineering and NSF act in a strategic and coordinated way. The COV supports the plan of ECCS to monitor progress in other areas of NSF Engineering to move towards a single grant deadline per year, or even to limit the number of proposals a PI can annually submit to any division within engineering.
This is all the more important because faculty workload may influence the quality of engineering science, education, and broader impact in the US, particularly with the increased budget pressures at the state and federal levels. NSF can help by understanding the drivers for the proposal pressure, and by educating universities, PIs, and reviewers that high-quality ideas and broader impact (appropriate to the funding level) are the gold standard at NSF.

Division workload and continuity: The significant growth in workload (from proposal pressure and the need to support interdisciplinary proposals) is stretching the ECCS PDs, whose number has not increased commensurately. Therefore, to maintain excellence in management and merit review it would be helpful if the number of ECCS program directors and science assistants increases – even if only a modest increase of one additional program director. It would also be very helpful for continuity and planning if ECCS had a Deputy Director, as is the case for other divisions within engineering.

Understanding the broader impact merit review criterion: As is the case Foundation wide, there still appears to be confusion in the review base about what is meant by broader impact, and what high quality broader impact might look like. The PDs at ECCS and other divisions at NSF already inform panels in advance by directing them to appropriate web site locations. There is a need to continue and enhance these efforts by ensuring that every panel begins with a discussion of the merit criteria, including examples of what constitutes good “broader impact.”
The COV believes broader impact is very important for NSF funded proposals. It can be in many forms – such as effective outreach to K-12 or the public, increasing the number of women/URMs in ECCS at any level, technology or knowledge transfer to industry, solving a grand challenge problem that impacts other fields, or sparking new lines of experimental research which is motivated by theoretical breakthroughs. Perhaps a series of questions in the review form could prompt high-level critical evaluation of the proposal in terms of Broader Impact. (The COV has examples of such questions in the report). Such questions might help first-time panel members (25%) understand broader impact, while reminding senior reviewers to look for breakthrough, high-impact research with significant broader impact.

CORE QUESTIONS and REPORT TEMPLATE
for
FY 2011 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2011 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2011. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at <www.inside.nsf.gov/od/oia/cov>.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and (2) managerial matters pertaining to proposal decisions.

The program(s) under review may include several sub-activities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the sub-activities of the program, with the latter requiring more time but providing more detailed information.

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

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

For section IV addressing portfolio balance the program should provide the COV with a statement of the program's portfolio goals and ask specific questions about the program under review. Some suggestions regarding portfolio dimensions are given on the template. These suggestions will not be appropriate for all programs.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in the integrity and efficiency of the ***processes*** related to proposal review. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. ***COV reports should not contain confidential material or specific information about declined proposals.*** The reports generated by COVs are made available to the public.

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

FY 2011 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: June 22 – 24, 2011
Program/Cluster/Section: Electronics, Photonics, and Magnetic Devices (EPMD); Communications, Circuits, and Sensing-Systems (CCSS); Energy, Power, and Adaptive Systems (EPAS)
Division: Division of Electrical, Communications and Cyber Systems (ECCS)
Directorate: Directorate of Engineering (ENG)
Number of actions reviewed: **Awards:** **58** **Declinations:** **119** **Other:** **3**
Total number of actions within Program/Cluster/Division during period under review: **Awards:** **1652** **Declinations:** **3189** **Other:** **1260**
Manner in which reviewed actions were selected: Random sample performed on new research actions only. Supplements, continuing grants, non-lead collaborative proposals, withdrawn proposals, workshops and travel support were removed from total population. Proposals related to IPA funds and resources as well as proposals from programs not lead by ECCS, including ARI & EXP were omitted from total population. Five percent random sample of new research action population resulted in 180 proposal actions.

INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

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

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

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The COV believes that ECCS is using appropriate review methods for proposals. During the period this COV reviewed (FY08-FY10), approximately 1400 proposals were submitted annually to ECCS. The COV studied 180 proposal e-jackets in depth, including single-PI proposals, CAREER proposals, Major Research Instrumentation proposals, GOALI and EAGER proposals, and evaluated the review methods used over this broad range of proposals. Most of these proposals were evaluated through panel reviews (≈5000 panel reviews and ≈ 70 mail reviews per year), with 1-2 grants per year reviewed through site visits for center programs. Three proposals were returned without review because they did not address the program announcement criteria. The COV concluded that the proposal review process is very appropriate, efficient and well-managed and commends ECCS for these efforts. In 2010, 84% of proposals were processed within 6 months, which compares very well with the 78% NSF-wide average. The proposal e-jackets which the COV examined were reviewed by at least 3 independent reviewers and then summarized by a member of a larger review panel. The e-jacket documents indicate that each proposal is considered in-depth, with considerable input from qualified reviewers, who were fair. It was also noted that ECCS has taken the lead in modifying the review process in research areas that attract a large number of interdisciplinary proposals e.g. by conducting joint reviews with EPMD and DMR, and EPAS and DOE. Finally, for EAGER and RAPID grants targeting high-risk and urgent research, the COV believes that it is important that these proposals be reviewed by at least 2 PDs as well as the ECCS Director, and that the review process be documented in the e-jacket system. The COV is very supportive of these grants.	YES

2. Are both merit review criteria addressed a) In individual reviews? Yes, most reviewers discussed both merit review criteria of intellectual merit and broader impact in their reviews. A small number of reviewers focused mainly on technical details of the proposal, without commenting on education, outreach or diversity or likely technological impact. b) In panel summaries? Yes – the panel summaries discussed both merit review criteria of intellectual merit and broader impact. c) In Program Officer review analyses? Yes – the Program Director review analyses were comprehensive in terms of addressing both merit review criteria and placing the proposal in context. Comments: As is the case Foundation wide, among some reviewers there still appears to be confusion about what is meant by broader impact, and what high quality broader impact might look like. ECCS and other divisions at NSF already inform panels in advance by directing them to appropriate web site locations. There is a need to continue these efforts of panel training by ensuring that every panel begins with a discussion of the merit criteria, including examples of what constitutes good "broader impact." Some examples where reviewers appeared inexperienced included one reviewer who could not decide if international experience/collaboration should be counted as Broader Impact or if "Good outreach activities, but already underway" deserved recognition because it was "not clear what the impact of this program will be." In one case, the reviewers did not seem to appreciate proposals that had great outreach, with specific programs involving undergraduates and minorities. In contrast, a proposal that had more vague ideas was praised e.g. mentioning a $100 Million University-wide program dedicated for K-12 outreach, but where the PIs individual effort was not well explained. The COV felt that it was important that reviewers be aware that Broader Impact cannot be outsourced. In the opinion of the COV, broader impact is very important for NSF funded proposals. It can be in many forms – such as effective outreach to K-12 or the public, increasing the number of women/URMs in ECCS at any level, technology or knowledge transfer to industry, solving a grand challenge problem that impacts other fields, or sparking new lines of experimental research which is motivated by theoretical breakthroughs. The quality, focus and benefit of broader impact might be discussed in the reviews. NSF should decide if outreach needs to be novel and what effort is appropriate for particular types of proposals (e.g. single-PI versus center). The COV believes that it is more important that outreach be effective. Perhaps an expanded set of example best practices would help for each proposal type, or a series of questions that prompt high-level critical evaluation of the proposal in terms of both Intellectual Merit and Broader Impact. The COV had some suggestions for how panels might be better prepared to evaluate broader impacts (discussed in detail in Section II, Question 1). Such preparation might help the first-time panel members (25%) understand broader impact, while reminding senior reviewers to look for breakthrough, high-impact research and significant broader impact.	YES

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The majority of individual reviews were detailed, and many contained a substantial amount of useful advice for the PI (e.g. references that the PI did not appear to be aware of, or detailed technical comments about the proposal). The reviewers grappled with some issues, such as how an understanding of basic engineering science enables new technology, and how technology enables progress in engineering science, and the coupled roles both play. The participation of broad area experts on a panel, from both academe and industry, could help to bring a big-picture perspective to a review panel, complementing first-time panel members. In some cases, the reviewers appeared from their comments to be unsure about how to handle interdisciplinary proposals. ECCS is addressing this by helping to steer a proposal to the right program, and by running cross-division panels between DMR and EPMD or between EPAS and DOE. The COV commends ECCS and strongly supports these efforts. In general, whether the PI was productive in the past (either as a student or faculty member) was not a large factor in the reviews.	YES
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Yes – in most cases, the panel summaries focus on the most important points raised in the reviews and provide a clear statement to the investigators why the proposal is being recommended or declined. In some cases, the panel summary contained additional information or resolved issues between two differing reviews. However, in a few cases, a single negative review of an otherwise excellent-rated proposal resulted in a proposal being declined. In such cases, it would be good for both panel summary and review analysis to address the broad range of ratings, taking a clear position why the panel feels that the negative review cannot be discounted. This could reduce the number of excellent, forefront, high-risk, proposals that are declined.	YES
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: The review analyses and context statements prepared by the program officers were typically very detailed and helpful in understanding the in-depth nature of the review of each proposal received by ECCS. Most proposal reviews had a small range of ratings, so the case for funding (or not funding) was clear. The COV has a suggestion for overall proposal rating nomenclature in the Review Analysis. In at least one case, proposals were referred to as “non-	YES

competitive" in the panel summary or the PD's Review Analysis, in comparison just to the top proposals in the group. Perhaps the classification "Do Not Recommend," "Recommend" or "Highly Recommend" should be used uniformly for consistency.	

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The COV believes that in the vast majority of cases, the combination of 3 reviews, panel summaries, and context statements is helpful to the PI in understanding the funding decision. However, as previously noted, when there is a large spread of ratings among panel reviews and a declination results, it is important that the panel summary explain in more detail how the final recommendation was reached.	YES
7. Additional comments on the quality and effectiveness of the program's use of merit review process: ECCS does a very good job with merit review, particularly given the high-level of proposal pressure in the division.	YES

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

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: In general, the COV was very pleased that ECCS continues to be able to identify and attract qualified experts as panelists. Reviewers come from all states in the US, with a higher rate of female (15%) and minority (8%) participation than in EE faculty as a whole (9.7% and 3.6% respectively). Overall, a quarter of the ECCS panelists are new to the task. These first-timers bring fresh perspectives and insights to their panels (while also becoming familiar with NSF and what it takes to write a good proposal). The one-in-four proportion seems about right to us. Approximately 9% of reviewers come from business, state, local and foreign institutions. In a few cases, reviewers had limited background in the research areas of the proposals they were evaluating and were explicit in stating their lack of familiarity with an area. We also noticed that reviewer ratings for a small number of proposals varied widely. We believe that this disparity sometimes reflects differences in expertise and experience among the reviewers. With the volume of proposals that NSF Engineering, including ECCS, handles annually, some degree of inconsistency is inevitable. The COV has some suggestions that ECCS can consider in the context of NSF-wide improvements in panel preparation, since this issue spans all divisions at NSF – * New panelists could be offered some training in advance of arriving at NSF — perhaps NSF could conduct webinars for this purpose. All panelists could benefit from good examples of broader impact appropriate for the proposal type. * The COV found an insufficient number of reviewers from industry in the e-jackets we were given. At least one representative from industry on most panels can add breadth and perspective and help determine impact. Some COV members believe that the interest of industry in academic interactions and professional activities has increased in some research areas. Therefore, it might be possible to attract more industry panel members. For example, COV members can suggest some individuals with experience with ERCs, STCs etc . * Metric grading might help panel members e.g. for Intellectual Merit, some questions could be asked in the "proposal review shell" that are appropriate for the type of proposal (single-PI, center, group, CAREER etc) For example, for Intellectual Merit: Is the proposal high risk, high reward, at the forefront of engineering science? Does the PI have a track record as a graduate student or independent	YES

researcher for tackling and succeeding in challenging research? For Broader Impact, one could ask about the quality, scope, and benefit of broader impact. For example, one might expect one (or all) of the following from a single-PI (center) proposal: Will the area/field change as a result of this research? Will this award result in significant and effective mentoring of women or minorities working in STEM? Will this award result in an increased understanding of STEM by the general public? Will this award result in technology transfer to industry? Will this award solve a grand challenge problem? Does the PI have a track record of achieving broader impact in her or his prior work? Will this award impact other fields? etc. * The COV recommends that NSF consider designating an experienced and broad expert member on each panel who would be specifically responsible for discussing broader impact and intellectual merit and who could help the panel in their deliberations (perhaps that expert member would not be assigned specific proposals to review). This might help to balance in-depth technical reviews with broader impact and high-risk, and place proposals in context. * Finally, we remark that accurately assessing the expertise of reviewers is difficult with the information provided to us. We suggest that in future if NSF wants a detailed assessment of the reviewer expertise, the e-Jackets should include brief résumés of reviewers, preferably in the standard NSF 2-page format for academic reviewers.	
2. Did the program recognize and resolve conflicts of interest when appropriate? Comments: From our review of the e-jackets, the COV believes that the program recognized and systematically documents any conflicts of interest e.g. by recording them in the Review Record and Review Analysis.	YES
Additional comments on reviewer selection:	

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

MANAGEMENT OF THE PROGRAM UNDER REVIEW
1. Management of the program. Comments: The COV was very impressed by the active and thoughtful management, reorganization and new initiatives of the program. We commend the Division Director on the outstanding team he has assembled. The teamwork and strategic coordination involved in the management and operations of EPMD, CCSS and EPAS by the Program Directors (PDs) is impressive, effective, and visionary. The staff morale is high and the leadership and enthusiasm of the Division Director and all the PDs help keep ECCS at the forefront of engineering science. The increase in average award size to >$300K is very important for maintaining the ability of faculty to do forefront research (in particular experimental) and the COV commends ECCS for this decision. We note that the PDs and panelist's workload has experienced a constant increase over the past decade, from 600 proposals in 2001 to 1400 proposals submitted in 2010. Many of these proposals are interdisciplinary, and require extra time to review. This significant growth in workload is stretching the ECCS PDs, whose number has not increased commensurately. Therefore, management of the program and effective merit review would benefit if the number of ECCS program directors and science assistants increases – even if only a modest increase of one additional program director. It would also be very helpful for continuity and planning if ECCS had a Deputy Director, as is the case for other divisions within engineering. The COV suggests that ECCS and NSF Engineering try to understand from submission data what is driving the dramatic increase in the number of proposal submissions. Is higher funding abroad causing the need U.S. researchers to submit more proposals in order to try to attract comparable funding to compete? Or is the increasing complexity and cost of advanced research driving the increased number of submissions? Are universities expanding the number of engineering faculty? Are more schools supporting research programs? Or perhaps faculty require more students in order to pursue interdisciplinary problems? Understanding the drivers will allow ECCS and NSF to take appropriate actions to maintain excellence in Engineering Science in the US, at a time when international competitiveness makes this imperative. The COV is concerned that the increasing number of proposals could influence the quality of the review process. It is vital that NSF and the Directorate for Engineering act in a unified and strategic way to address this issue, given that NSF Engineering sees the most proposal pressure at NSF. If increased funding is not available to increase the very low 16% funding rate (which would be ideal), then NSF ECCS may have no choice but to somehow restrict the number of proposals it receives in order to preserve its high quality review process. In that event, the COV supports the plan of ECCS to monitor progress in other areas of NSF Engineering to move towards a single grant deadline per year. The majority of the COV also supports the option of preliminary proposal review by three PDs, and rejection of poor (non-competitive) proposals. Finally, the COV supports a limit to the number of proposals a PI can annually submit to any division within engineering should the NSF Engineering chose to move in that direction (since a uniform policy across engineering would be needed, implemented in consultation with NSF leadership). If award rates continue to decrease, faculty may react by writing more proposals, instead of focusing on their best ideas. Panels will be difficult to run because conflicts of interest will make it difficult to find panel members and because of work overload. Thus, it is vital that the quality of the review process at NSF be maintained, through

appropriate proposal management and panel member training.

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

The ECCS Division is commended for its excellent responsiveness and strategic pursuit of emerging research opportunities and partnerships. Its proactive engagement in cross-disciplinary research initiatives with other NSF Divisions and even other agencies (e.g. DOE) have helped diversify the research breadth of ECCS and have inspired new research frontiers.

The Division has articulated a compelling vision and rationale for its planned future programs, which include but are not limited to - a) science and engineering beyond Moore's law; b) flexible electronics with primary application emphasis on revolutionizing healthcare; c) the efficient generation and management of energy from the environment; d) the continuous pursuit of cyber-physical systems to enable solutions to several of the NAE Grand Challenges; e) enhanced access to the radio spectrum (EARS).

The Division appears to be successful with their funding of Early-Concept Grants for Exploratory Research (EAGER), as evidenced by the fact that several of the funded projects were subsequently picked up for continued funding by the Semiconductor Research Corporation, while other EAGERS resulted in successful full proposals to NSF.

The Division is to be complimented for its continued successful management of the Foundation-wide NNIN program, that has had a tremendous impact on education, research and technology transfer (examples are given below).

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

Comments:

The ECCS Division relies on very comprehensive, inclusive, and effective planning and prioritization processes to inform and guide the development of its research portfolio. Program Directors identify emerging research areas and organize workshops to discuss opportunities and funding challenges. Included in these discussions are the academic community, industry, NAE, NAS and all relevant federal research agencies. During the FY 2008-2010 period, 50 such workshops were held.

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

Comments:

Previous COV Main Concerns/Recommendations in bold):

1) Limited funding means the ECCS program is not very deep in its coverage of topics. If funding limitations cannot be addressed, there is a serious risk for emerging areas that could contribute significantly to NSF's new initiatives and NAE's Grand Challenges.

The COV applauds the ECCS Division Director and PDs who have been aggressive and creative in pursuing ways to increase ECCS funds (e.g., cross-disciplinary collaborations with other Divisions, securing EFRI topics and collaborations with other federal and non-federal agencies (e.g., SRC)). The ARRA funding helped to address this issue in the short term.

2) Award size lags behind research costs. It is imperative that funding amounts be increased, at least to the extent of keeping up with rising costs of research.

The ECCS Division is in the process of raising the annual award amount of to ~$120K.

IV. Questions about Portfolio. Please answer the following about the portfolio of awards made by the program/s under review.

<table>
<tr><th>RESULTING PORTFOLIO OF AWARDS</th><th>APPROPRIATE, NOT APPROPRIATE, OR DATA NOT AVAILABLE</th></tr>
<tr><td>1. Does the program portfolio have an appropriate balance of awards across disciplines and sub disciplines of the activity?

Comments:
The new ECCS organization appears to have helped balance awards across the three ECCS program areas. The award rates for all proposals are:
<table>
<tr><td></td><td>2008</td><td>2009</td><td>2010</td></tr>
<tr><td>EPMD</td><td>22%</td><td>28%</td><td>21%</td></tr>
<tr><td>CCSS</td><td>26%</td><td>29%</td><td>17%</td></tr>
<tr><td>EPAS</td><td>25%</td><td>37%</td><td>19%</td></tr>
</table>
** Data from EIS Web, Funding Rate by Program

(Note that the 2010 award rates for unsolicited proposals are closer to 16%, when omitting supplements, workshop and student travel funding). The number of proposals received by each of these program areas was reasonably well balanced over the 3-year interval, ranging from a low of about 250 to a high of about 550 in EPMD.
While the number of submissions to EPMD were nearly one and one-half times larger than those sent to CCSS and EPAS, i.e., 664 vs 454 and 426, the funding rates are very close, i.e., 27% vs. 24% and 24%. This proximity suggests that attention has been directed to achieving a balance across the disciplines.</td><td>YES</td></tr>
<tr><td>2. Are awards appropriate in size and duration for the scope of the projects?

Comments:
The COV praises ECCS for increasing the unsolicited proposal award size as recommended by the previous COV, which is now approaching a target of $120K/year. (Some COV members noted that theory grants did not require such a high funded level.) This annual amount is sufficient to support one graduate student for the usual three-year extent of an ECCS award. This annual amount (or even less) can adequately support world-class theory efforts. For experimental research programs that use large facilities, or advanced probes, in important areas of science with significant international competition (and large potential future economic impact), it is not clear to the COV that even the $120K/year award amount can fund a world class, internationally-competitive program that can be innovative and impact frontier engineering science.
In the case of Ph.D. students, a number of panelists felt that the 3-year award length is not sufficient to support the typical four-to-five year duration</td><td>IMPROVED</td></tr>
</table>

of the Ph.D. program. Supplemental funding can be requested for graduate students that can help to address this issue. CAREER awards are set at $400K for 5 years. A majority of COV members recommend that CAREER awards be increased to ≈ $100K/year so that awardees can be internationally competitive. In summary, the majority of the COV suggests that better research might result if specific awards were increased in duration or funding. However, this would lead to an undesirable decrease in the funding rate for the Division because the total funding is fixed. The system as presently configured seeks a balance between many metrics and it does, in fact, do a very good job of accomplishing this. Limitations can only be overcome, while simultaneously maintaining the balance, by an increase in funding.	
3. Does the program portfolio include awards for projects that are innovative or potentially transformative? Comments: The COV found that the ECCS Division has been very successful in making awards that are innovative or potentially transformative. Although every project is innovative in some way, in a bigger picture some seem evolutionary rather than revolutionary. However, targeted funding through programs such as RAPID and EAGER (open to submissions all year) are very effective in quickly identifying opportunities and harnessing them. Directed programs such as EFRI, MRI, NERCs etc are also instrumental in helping awardees push the envelope. The NNIN is a highly commendable investment which establishes a broad network of state-of-the-art facilities that create the needed infrastructure and enhance the chance for transformative research. Identifying intelligent system-wide optimization as one of the critical enablers within the 4th generation smart grid development is an excellent example of the transformative component NSF could bring to bear on an issue of great national significance. Creating new programs such as Bio-Flex is a laudable attempt in the right direction to spur transformative and timely research. GOALI is another encouraging and laudable approach to promote cross-fertilization between academia and industry. The COV feels that the issue of increasing the percentage of transformative, highly-innovative awards needs to be addressed at the proposal submission stage. That is, if measures are taken to assure fewer – but higher quality - submitted proposals, then presumably, a higher percentage of awards will be innovative or potentially transformative. The possible steps in this direction are indicated elsewhere in this report. For example, by limiting the allowed number of annual submissions for an individual PI, or proposal submission windows, or adding additional panel training, metric grading and senior advisors, the committee feels that average award quality will increase.	YES
4. Does the program portfolio include inter- and multi- disciplinary projects? Comments: ECCS is to be commended because there appears to be an increase in the relative number of inter- and multi-disciplinary awards. The COV believes	YES

that this is a healthy trend for ECCS and compliments ECCS management for its proactive efforts to increase this class of awards. The program portfolio has an appropriate balance of inter- and multidisciplinary projects. Of 298, 398, and 292 awards EECS made in 2008, 2009, and 2010, respectively, funding was contributed by other programs in ENG, other Directorates, and other agencies to 61, 67, and 53 projects, respectively.

5. Does the program portfolio have an appropriate geographical distribution of Principal Investigators?

YES

Comments:

The geographic distribution of awards appears to be appropriate, reflecting the locations that have multiple institutions supporting engineering. The geographic location of the awards mirrors the locations of the submissions.

From FY08 through FY010, proposals were received from every state, and awards were made to investigators from 48 out of 50 states.

There appeared to be a general correlation between the distribution of proposal submissions and the distribution of awards for most states. The states that seem to have an unusually high proportion of awards for their population are places with an unusual concentration of research institutions (Massachusetts, California, Texas, NY); the states with an unusually low proportion of the awards are largely EPSCoR states.

6. Does the program portfolio have an appropriate balance of awards to different types of institutions?

YES

Comments :

ECCS appears to support an appropriate balance between various types of institutions. The COV noted that 2 and 4-year institutions receive relatively few research awards. This is to be expected because of the small number of Electrical/Computer Engineering Departments in 2 and 4-year institutions.

7. Does the program portfolio have an appropriate balance of awards to new investigators?

YES

NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant.

Comments:

The data for new investigator funding is:

New Investigator Awards	2008	2009	2010
# Proposals	481	558	548
# Funded	106	142	70

** Data from EIS Web, Committee of Visitors, Funding Rate Filtered for New Involvement

The number of new investigator proposals has been relatively constant over

the three year interval the COV studied. The number of funded new-investigators varies significantly. The COV speculates that the increased number of awards in 2009 may have been an artifact due to the national economic stimulation initiative in 2009. However, even given this, the decline in awardees in 2010 relative to 2008 is noticeable. The COV is uncertain as to the cause of this decline. Did the high-quality submissions from young faculty saturate due to ARRA?	
8. Does the program portfolio include projects that integrate research and education? Comments: Most proposals that COV viewed combine graduate education and research, and often also involve undergraduates, new classes or curriculum development, and K-12 outreach. Therefore the COV believes that the ECCS portfolio strongly supports the integration of research and education.	YES
9. Does the program portfolio have appropriate participation of underrepresented groups? Comments: In 2010, approximately 22% of all proposals submitted by women were funded and the same rate of funding was observed for proposals submitted by minorities. This is somewhat higher than the rate of funding across all proposals submitted to ECCS at large, which was around 20% (unsolicited proposals have a lower funding rate in all cases).	YES
10. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The COV is impressed with the responsiveness of ECCS to national priorities, which drive the research portfolio of ECCS within the context of the NSF mission of supporting basic academic research. Examples of ECCS programs that support national and international grand challenges are listed below - • ECCS has been successful in partnering in, and now leading new NSF Engineering-wide EFRI topics (Emerging Frontiers Initiatives) including "Mind, Machines, and Motor Control", "Photosynthetic Biorefineries" and "Flexible Bioelectronics Systems." These programs strongly support the National Academy of Engineering "Grand Challenges for Engineering" highlighted areas of solar energy, reverse-engineering the brain, engineering the tools of scientific discovery, restoring and improving urban infrastructure, advancing health informatics, and securing cyberspace.	YES

• The IEEE Spectrum list of the top 11 technologies of the decade has become a popular resource for what's "hot" in high-tech. These technologies include smart phones, LED lighting, multicore CPUs, drone aircraft, planetary rovers, and flexible AC transmission. Not all of these areas would necessarily be considered core to the ECCS mission, but there is, nevertheless, excellent correspondence with the division's programs—as represented by robotics, smart grid, intelligent systems, light-emitting devices and displays, and several other focus areas in the division. • A still-relevant article by John Gibbons of OSTP in Proc. IEEE (March 1998) listed "five key technologies to produce global economic transformation": computing, telecommunications, biotechnology, alternative energy, nanotechnology. The ECCS portfolio is well aligned with this list. This is hardly surprising for broad disciplines such as computing and telecommunications. Moreover, the COV thought that ECCS's recent emphasis on the remaining areas was commendable. In nanotechnology, ECCS is the single largest contributor to the National Nanotechnology Infrastructure Network, a tremendous resource for academic, government, and industry organizations nationwide (and to some extent internationally). • In February of this year, the President announced the Wireless Innovation and Infrastructure Initiative. This initiative includes ambitious goals for radio spectrum allocation, high-speed wireless access nationwide, and catalyzing innovation with a major investment in a Wireless Innovation Fund. NSF, including its Engineering directorate, will benefit from WIN funding, but it is important to note that NSF has been at the forefront of wireless and spectrum research for some time. In particular, ECCS is part of the Enhanced Access to the Radio Spectrum (EARS) cross-divisional NSF program, which is internationally recognized for its promotion of spectrum-related research and development. The COV strongly supports the continuation of the EARS program as included in the NSF budget. • The President announced the Advanced Manufacturing Partnership and the National Robotics Initiative during the COV meeting (June 24). In these fields also, NSF has anticipated the recent explosion of interest in robotics with an investment history that goes back decades. Today the ECCS portfolio includes potentially transformative projects in areas like control theory, intelligent vehicles, cyberphysical systems, human-robot interaction, and several other robotics-related research areas. Many of the above ECCS programs are joint activities with other divisions—a development COV views quite positively, as noted elsewhere. The recent reorganization of EECS has been especially productive in improving the organization's fit with recognized emerging technologies and national needs. The focus areas for EPMD, CCSS, and EPAS are broadly consistent with these priorities.	
11. Additional comments on the quality of the projects or the balance of the portfolio:	

OTHER TOPICS

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

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.

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

Quality of Merit Review

- Increasing proposal overload for panelists and PDs NSF-wide may strongly reduce the quality of merit review going forward. To address this issue, in the absence of an increased level of funding, the COV supports proposal and PI limits in ECCS and at the Engineering Directorate level, since implementing such limits at the divisional level alone would place ECCS at a strategic disadvantage. Any restriction in proposal submissions will need to be done in coordination with NSF leadership, to avoid the appearance of decreasing proposal pressure from engineering, when in fact NSF Engineering handles 25% of all NSF proposals.
- The COV strongly advocates that NSF work to develop an increased understanding in the community of what constitutes excellent broader impact (see Section I, Question 2, and Section II, Question 1 for specific suggestions).
- Additional informative questions under Intellectual Merit and Broader Impact might help panelists rate and rank proposals (see Section I, Question 2, and Section II, Question 1 for specific suggestions).
- Appropriate ECCS professional PD, DD support levels are required to best manage the program. A Deputy Director would be very helpful for continuity and for implementing long-term goals in ECCS.

How to Promote Interdisciplinary research

- ECCS should continue to lead in and grow interdisciplinary research and program structures that facilitate interdisciplinary research. The research community and young faculty in particular continue to move in this direction. NSF funding and broad/joint panels will need to support this.
- How to embed interdisciplinary research in NSF without the need for PD champions? Consider some restructuring that has broader (or new) divisions/directorates when funding is available, and gather input from US science and engineering faculty through workshops, NAE/NAS reports etc.
- Consider the possibility of mid-scale research that lies between centers and single-PI grants.

How to Sustain the Quality of Science and Education in the US at Internationally Competitive Levels

- Core programs must be sustained at an adequate level.
- The current method of adding new targeted but sometimes narrow initiatives does not maintain the overall health of US engineering leadership.
- We will likely need more multi-agency partnerships and coordination to adequately sustain a research area (while sustaining basic science and engineering without mission needs dominating the agenda).
- The COV is concerned that faculty workload may influence the quality of engineering science, education, and broader impact in the US. This situation may be even more challenging in the future with increased budget pressures at the state and federal levels. NSF can help by

understanding the drivers for the proposal pressure, and by educating universities, PIs, and reviewers that high-quality ideas and broader impact (appropriate to the funding level) are the gold standard at NSF. Quality, not quantity, matters, and methods to ensure this should be pursued.

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

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

- Explain to COV members that only a single report will be generated and nearly finalized at the COV meeting. Explain agenda better for first-time COV members.
- Assign e-jackets proposals earlier and post proposals and assignments at least 2-3 weeks before COV meeting.
- Send COV members a CD with all the materials on request.
- Allocate more time (at least 15 minutes) for Program Director presentations to allow them to present the major research breakthroughs from their programs.

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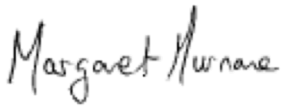

For the 2011 ECCS Committeee of Visitors
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