Dr. Pramod Khargonekar
Directorate for Engineering
National Science Foundation

Dear Pramod,

This letter is to summarize the Engineering Advisory Committee (AdCom) recommendations in response to the Committee of Visitors report on the Division of Education and Engineering Centers (EEC). This report was given to the AdCom prior to the April 2014 meeting, and was discussed at that meeting. Subsequently, I have written a summary of the AdCom recommendations below, circulated that summary to the AdCom members, received their agreement, and submit this collective view of the Engineering AdCom to you. We specifically look for action to be taken on the recommendations around Engineering Education and plan to send a copy of this letter to the NSF Director to be sure these views are heard at the highest levels of the Foundation.

First, the Engineering AdCom thanks the COV committee members and accepts the EEC COV report. The report indicates that the EEC Division is well-managed, follows appropriate protocols for proposal evaluation support and management, and is overall well aligned with the NSF goals of providing critical research support in a cost-effective manner.

The bulk of this letter will address specific recommendations suggested by the COV and modified by the AdCom relative to one part of the EEC portfolio—that of Engineering Education. Context for these recommendations matters, so I will repeat a bit of the context cited in the COV report.

As quoted from the most recently issued NSF Strategic Plan for 2014-2018, on Page 4, **Strategic Planning In a Dynamic, Global Context**:

> "*NSF has the responsibility to be a steward of the Nation's research and education enterprise in the midst of changing conditions that materially affect its success. … New opportunities are emerging and technologies are arising across all disciplines. … NSF maintains a strong focus on carrying out our mission in a way that is sufficiently flexible to meet the changing requirements of the research and education enterprise as well as to address emerging and pressing societal challenges. At stake is the competitive strength of the Nation in the coming decades. NSF is not alone in this view."*

Among Key Strategic Goals in the 2014 NSF Strategic Plan:

"Investing in the development of the next generation of researchers, scholars, and knowledge workers is one of NSF's most important approaches to transforming the frontiers of science and engineering…. NSF supports research and development on

STEM education and learning to prepare a diverse, globally competent STEM workforce and a STEM-literate citizenry."

These two statements are very high-level aspirations for support for STEM education as a whole and engineering education in particular. Clearly NSF makes major investments towards improving STEM education primarily through the EHR Division. The Engineering AdCom (and the EEC COV) appreciates the separate, but complementary work that the EEC does in engineering education relative to the EHR responsibility for broader STEM education. The AdCom feels that allowing specific focus on engineering education within the Engineering Directorate creates a mechanism for addressing the unique characteristics of engineering relative to other sciences, partnerships with CBET, CMMI, ECCS, and IIP Divisions, and provides an opportunity for engaging prospective students of science and engineering that basic sciences alone may not provide. We think the Engineering Education portion of the EEC portfolio is not only important, but needs to grow. Partnership with EHR and agencies outside of NSF is critical, but recognition of the distinctive characteristics of engineering and in many cases the opportunity that engineering presents to draw in students who might not see themselves as traditional scientists, is vital.

Engineering education, largely through colleges and universities, is decentralized though there have emerged widely accepted models of what engineering education should look like, enforced in some cases by accreditation agencies like ABET. While that decentralized approach can foster innovation and diversity, from many perspectives it has not, at least not in forms that have transformed engineering education across all institutions. In looking at critical leverage points, an increased NSF role in engineering education might take advantage of this decentralized landscape and provide some clear objectives relative to affecting the landscape. Further, linking NSF action with some of the hundreds of colleges of engineering and thousands of engineering faculty in the US is an important element in disseminating not just NSF-discovered innovations, but local innovations that are unknown beyond the bounds of their current locus of practice.

Based on the COV recommendations, the Engineering AdCom recommends:

1. The EEC take a leadership role in engineering education, recognizing that many aspects of engineering education activities within EEC may intersect and complement STEM education activities performed by the Education and Human Resources Directorate and thus should be coordinated with EHR partners. We recommend that the EEC engineering education effort remain inside the Engineering Directorate for reasons articulated above.
2. EEC in cooperation with EHR and other Engineering Divisions, should conduct a "Gap Analysis" to assess what needs to be done in engineering education, where and how engineering education and engineering education research needs are being accomplished today, and what gaps and overlaps exist that either leave critical needs unsatisfied, or alternatively result in duplicative work. This analysis should not merely look at the present, but anticipate the future—perhaps the next 10 years—as needs and expectations for engineering education will likely change substantially over that time.

3. Possibly the most difficult part of a 'gap' analysis of this sort will be to name a small number of key goals for engineering education as a whole. These may already be available and accepted from prior work (e.g. NAE or prior NSF reports) and that work may not need to be replicated, but if gaps are to be identified they need to be referenced to expected or hoped-for outcomes. For example, engineering in general has not been able to attract women or traditionally underrepresented students in proportion to their college attendance. If among the expected outcomes of engineering education is to be able to provide talented and diverse domestic engineers in the numbers needed, the failure to do this may prove one of the larger gaps identified. A comparison of these stated goals with those of the EHR Division and the EEC engineering education effort may illustrate the significant similarities and differences where they occur.
4. This "Gap Analysis" and a comparison to NSF skills, abilities, and resources, as well as work contributed by those outside of NSF, should suggest where and how NSF intervention could have the most impact and contribute significantly to the kinds of innovations identified. For example, it is quite possible that successful innovations that directly address some of the key gaps identified in #2 have already been piloted successfully, but they have not seen widespread use, nor given past history, are they likely to. This dissemination issue could be one NSF is well-equipped or could become well-equipped to address.
5. The AdCom also recommends that EEC and the Engineering Division begin to plan for ways to respond robustly to the gaps identified in the work of #2. It is possible that a concentrated program like an Engineering Research Center (ERC) on a key aspect of the engineering education challenge would be critical. In anticipation of that possibility, we should begin to identify reallocation opportunities to redirect resources toward critical education actions identified.

Doing something new will require EEC (or EHR) to redirect funds from other research programs and/or be supplied with additional funding. To leverage its own resources, EEC should pursue cooperative relationships with other internal NSF organizations and external resources such as industry groups and engineering professional societies, among others. However, significant investment in this area by NSF is a visible indicator of priorities. A plan based on a hope for resources to be gathered from voluntary external sources is equally symbolic and will be read as a view that action in engineering education is an option to be invested in when and where convenient, not a critical element of future economic growth of the country.

Much of the current EEC $125 million budget is expended on cross-functional research to support other divisions within the Engineering Directorate such as ERC, NCN, REU, RET, among others. This leaves very little funding available for engineering education and engineering education research. About $10-15 million is expended on engineering education and research through the EEC. The AdCom believes the budget at EEC is inadequate to meet the NSF's Strategic Goals in the area of engineering education.

The NSF through EEC and EHR can be a key player in engineering education, but will need sufficient funding, people, and support to fully leverage the investments of the past that have provided an excellent basis for guiding engineering education today and innovating for the future.

I realize that in making these recommendations the Engineering AdCom is challenging the size of the current total resource pool as well as allocation of these resources among competing needs. Education has enormous leverage in terms of time and resources, but the 'payback' is not immediate and is not always easily quantified. Unfortunately, that last feature can make it easier to postpone investments in education even if the leverage would argue for the opposite.

We, the Engineering AdCom, are ready to help in any way we can promote these recommendations and help implement them.

Sincerely,

Patrick Farrell
Chair, NSF Engineering Advisory Committee
Provost, Lehigh University