CHAPTER 7

THE NSF AND ERC INTERFACE

7.0 THE NSF AND ERC INTERFACE

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7.1 INTRODUCTION

This chapter of the Manual will address management issues regarding NSF's administration of the Engineering Research Centers (ERC) Program and its interface with the ERCs themselves. A brief overview of the ERC Program's goals and key elements, as well as an overview of the management system designed to fulfill the Program's goals, will be provided. The chapter will discuss the roles and responsibilities of the ERC Team Leader, who is NSF's manager for the overall ERC Program, and those of the ERC Program Directors (PDs), who play an integral part in the oversight of individual ERCs. Since the inception of the ERC program, different PDs have developed a variety of approaches to providing guidance to the centers under their purview. Therefore, this chapter will conclude with a presentation of effective strategies for oversight of ERCs by NSF during the different stages of their life cycles, as well as strategies for ERCs to use to develop effective relationships with the ERC Team Leader and their particular PD.

7.2 NSF PROGRAM MANAGEMENT

7.2.1 The ERC Program

The goal of the Engineering Research Centers Program is to build partnerships with academe and industry to focus on next-generation advances in complex engineering systems important for the Nation's future. ERCs develop and support cross-disciplinary teams which pursue knowledge, technology, and education to strengthen industry and the Nation. (See Chapter 1, Sec. 1.2, for a more detailed description of the ERC Program.)

The focus on an engineered system, strategic planning, cross-disciplinary research, and the integration of research and education, are some characteristics that distinguish an ERC from other federally funded research projects. The ERC Program management at NSF has defined a set of key features which are used as guidance for the ERCs on how to develop their centers; these features also form the basis of the ERC performance review system. They are:

- A guiding vision to produce (a) advances in a complex, next-generation engineered system* and (b) a corresponding new generation of engineers with the depth and breadth needed for leadership throughout their careers in a global economy;
- A strategic plan to realize the vision through the integration of research and education;
- A research program promoting synthesis of engineering, science, and other disciplines, and spanning the continuum from discovery to proof-of-concept;
- An education program that integrates research and education, offering to both graduate and undergraduate students a team-based, cross-disciplinary environment to work on research projects in collaboration with industry, including curriculum innovations for students at all levels;

* An engineered system is derived from a number of components, processes, and devices that are integrated together to serve a function. Analysis and modeling of the individual components of a system, without their integration into a complex engineered system, is not sufficient for the research program of an ERC.

- A partnership with industry and other interested partners in planning, research, and education to strengthen the ERC and achieve a more effective flow of knowledge into innovation to benefit the Nation;
- A cohesive team effort that integrates diverse engineering and scientific backgrounds with industrial views, which also is diverse in gender, race, and ethnicity;
- A dynamic, flexible program of outreach involving faculty and students from other universities and colleges in ways that will enhance the capacity of the ERC to fulfill its vision and develop connections with the community in its field;
- Leadership, management, and an infrastructure of space, experimental facilities, and enabling equipment to support the complex goals of an ERC;
- A commitment from the academic, industrial, and other partners to substantially leverage NSF's funds and sustain the ERC during and after the period of NSF support; and
- A synergy of perspectives from science and engineering, research and education, academe and industry, yielding collective properties that are greater than each could achieve alone and greater than the current state-of-the-art and practice.

7.2.2 The Mode and Duration of NSF Support

ERCs are selected as a result of entry into a competition. Candidate ERCs undergo an extensive review process that includes panel review and site visits. Once an award is made, NSF administers each ERC through a Cooperative Agreement, which serves as an instrument for transferring NSF funds to the university to support the ERC. The Cooperative Agreement lays out NSF's expectations about the center's performance, its goals, and NSF's general operating requirements for this award. This document also sets limits to changes in the scope of the award that can be proposed by the NSF Program Director for that center. The Cooperative Agreement also sets out a schedule for the ERC's reporting requirements, as described in Section 7.4, "Reporting."

For ERCs awarded through 1996, the new ERC begins operation under a Cooperative Agreement for an initial five-year period, renewable in the third and sixth years. If a center is successful at both the third and sixth years, the ERC will have a total life-span of 11 years, with support phased down in Years 10 and 11, as illustrated in **Figure 7-1**. If a center's renewal request is not successful, phase-down support will be provided at a reduced level to complete the last two years of the Cooperative Agreement. Beginning with the class of 1998, ERCs will have a potential life-span under NSF support of 10 years, with interim renewals and phase-down support beginning after the sixth year. ERCs are expected to be self-sufficient after the end of the term of the agreement. Groups from mature ERCs may join with other investigators to form a new center with a new vision and enter an ERC competition.

7.2.3 Leadership of the ERC Program

The ERC Program is led by an ERC Team Leader, who is also the Deputy Director (Centers) of the NSF's Engineering Education and Centers (EEC) Division. S/he leads a team of ERC Program Directors (PDs) and the ERC Program support staff in fulfillment of the goals of the ERC Program. With the concurrence of and in consultation with the EEC Division Director, the

ERC Team Leader sets policy as well as operational and review procedures for the Program to ensure that it can fulfill its goals and continuously improves. S/he manages the ERC budget ($52 million in FY 1997) and its allocation to centers according to performance and need. The organizational structure of the ERC Program management, located within the EEC Division of NSF's Engineering Directorate, is depicted in **Figure 7-2**. The structure of the ERC Program involves periodic competitions to establish new ERCs; a reporting and database system for ongoing centers; a center-level performance oversight system; a program-level evaluation system; and responsibilities for publications, annual meetings of all ERCs, plus competitions internal to the ERCs for supplemental funding to encourage educational, summer Research Experience for Undergraduates Programs, and connectivity between the ERCs and other investigators.

This structure has been developed over time through a continual process of center-level and Program-level performance/outcome assessments in light of the Program's goals. Adjustments in the goals and operating procedures of the Program have been made with input from the ERCs, the individual ERC PDs, representative of the ERCs' industrial partners, and oversight committees. The strength and continuing evolution of the ERC program are dependent upon this interaction.

The ERC Team Leaders, Program Directors, and ERC Program staff who have contributed to strengthening the Program through this process over the years are listed in Appendix C.

7.2.4 Oversight and Performance Review System

The ERC Program has developed a performance review and oversight system which is designed to assess the quality of ERCs, strengthen centers as they strive to fulfill the Program's goals, and phase out support to groups that are unable to develop an effective and high-quality center. Development and implementation of the ERC performance review and oversight system is the responsibility of the ERC Team Leader. The goals of the ERC Program and the key features of the centers (detailed above) serve as anchor points in the oversight. **Figure 7-3** shows the structure of that system.

The starting point in this system is the interface between the ERC and the lead ERC Program Director. Each ERC is assigned a lead Program Director. The lead ERC PD has the responsibility for implementing the Program's oversight and performance review system. The lead PD is assisted by at least one supporting ERC PD in some cases, a larger group of NSF PDs is involved to support the disciplinary breadth of the ERC. Together, these PDs comprise the Program Director Oversight Team. The purpose of this team management approach is to support the NSF performance oversight system and to help a particular ERC develop a national leadership role in its field.

In forming these oversight teams, the ERC Team Leader ensures that the lead and supporting PDs have among them the following characteristics:

. Commitment to ERC Program goals and experience with the ERC program (required of

both lead and supporting PDs)

- Technical depth plus experience with interdisciplinary research management
- Commitment to integrating research and education
- Experience with management of industry/university collaboration
- Knowledge of the technology transfer process
- Both PDs have a special section of their performance plans devoted to fulfilling ERC Program goals.

The performance review system for an individual ERC begins with the submission to NSF of an annual report of progress and plans. This report is the basis for a review of performance and plans by the ERC's peers in academe and industry, carried out through a site visit. The members of the site visit team are selected by the lead ERC PD with input from the other members of the PD oversight team and the ERC. The visit is led and facilitated by the ERC PD. The site visit team produces a written analysis of the strengths and weakness of the ERC with suggestions for improvement, culminating in analyses of each center's performance in relation to the key features of the ERC Program. At the conclusion of the visit, the ERC PD writes a recommendation to the ERC Team Leader regarding future funding and development of the ERC.

To support this system, the ERC Program provides the ERCs with uniform guidelines for the annual report and for the development of a data base of quantifiable indicators of inputs and outputs of the ERC. Both are submitted annually to NSF. These reports and data submissions become part of a larger ERC Program information system.

The role of the ERC Team Leader and the lead and supporting ERC PDs in carrying out oversight of a given ERC will evolve as the center matures. To begin the oversight process for each new class of ERCs, the ERC Program holds a New Centers' Orientation Meeting at NSF. The ERC Program staff brief the new centers' leadership teams on how to develop the key features of an ERC, the review process, etc. The ERC Program Director Oversight Teams work with the new Center Directors to help them further refine their strategic plans for research. By problem-solving together, PDs and CDs begin to develop a working relationship upon which they can build. Knowing the key features of the ERC Program, the PD(s) can offer advice to the Center Director regarding strategies to build an effective ERC, develop a cohesive cross-disciplinary team, build a strong partnership with industry, integrate research and education, and stimulate a new paradigm in the engineering education culture at the host institution. The PDs can thus help to stimulate an environment in which both industry and the ERC's students are an integral and valuable component of the ERC's research team.

Soon after an ERC is established, the lead PD (and possibly other oversight team members) will make an informal campus visit to the ERC. The PD will provide development guidance and work with the Center Director and other key members of the ERC's leadership team to review the center's early development plans for the research, education, and industrial collaboration components as well as its planned administrative infrastructure.

Optimally, the PD(s) will attend the ERC's first industrial advisory board meeting, at which the PD(s) can explain the philosophy of the ERC Program to the industrial affiliates and help the

Center Director establish an effective and active industrial collaboration program. The PD(s) will help the Center Director convey to the industrial affiliates that the Program's goal is to create a long-term collaboration with industry, and not just a job-shop. The PD(s) will help the industrial affiliates understand the benefits of a systems-level, long-term approach to research. The PDs will also explain the importance of continuing the research out to the proof-of-concept stage in testbeds, in order to put the ERC's vision for a next-generation engineered system to the test of reality and produce a greater understanding of the barriers and opportunities ahead. The ERC PD will explain to the industrial affiliates that NSF expects them to participate as full partners in the ERC, carrying out their own annual analysis of the center's strengths, weaknesses, opportunities, and threats to success (SWOT). This analysis is to be conveyed to the ERC leadership team and to the NSF site visit team. The PD will attend one Industrial Advisory Board meeting per year to continue this process.

During the first two years of the center, the Program Director Oversight Team serves as a development advisor, facilitator, and coach. In this phase of an ERC, the lead PD and supporting PDs provide the Center Director with guidance to strengthen the ERC's development based on their ERC Program experience and the input from annual peer reviews. By the critical third-year review, however, the role of the Program Director Oversight Team changes to that of a judge of the center's abilities, effectiveness, and achievements. (Discussion of the PD's role with regard to site visits in particular is presented in the following Section 7.3.2.) The basis for this judgment is the site visit reports, calibrated by the experience of the PD with several centers in the ERC Program. The oversight team is responsible for benchmarking an ERC's progress towards fulfilling the goals of the ERC Program. The lead PD coordinates the third- and sixth-year renewal reviews to determine the effectiveness of NSF's prior investment in the ERC and the advisability of future investments. The lead PD, in consultation with the other members of the oversight team, will make recommendations to the ERC Team Leader about the center's continuation, budget growth, and renewal or phase-out after its third- and sixth-year reviews.

7.3 THE SITE VISIT

7.3.1 General Description of the Current Process

Each year, every ERC in its early and middle stages of development is visited on-campus by a panel of reviewers from academe, industry, and government who represent peers of the center. The site visit team is facilitated and led by the lead ERC PD, accompanied by other members of the Program Director Oversight Team and EEC Division staff. Site visits normally last two days, although site visits during Years 3 and 6 last three days. As described above, the site visit is an integral part of the performance review system. A site visit report, written by the non-NSF site visitors, critiques the ERC's scientific and technical progress and its education and industrial programs and management systems.

From the ERC's perspective, the site visit involves all the center's participants (faculty, staff, and students) in telling the story of the ERC as an integrated composite of the center's research projects and other activities. It brings together all the ERC participants in a common cause. The

site visit's presentations also expose all ERC personnel to the progress made across all fronts in the ERC. The site visit should present all facets of the ERC that distinguish it as a center (an integrated unit), as opposed to a series of single-investigator programs strung together. The Center Director is expected to provide an overview presentation of the center's vision, strategic plan, and ancillary programs. Technical presentations by thrust area researchers provide site visitors with a summary of progress to date and plans for the coming period. There are presentations on the education and industrial liaison/technology transfer programs, as well as leadership, management, and the infrastructure of the ERC. There is a poster session for the students to present their research to the site team and visiting industrial representatives. There is also a series of private sessions with the site team. A session for site visitors to meet with the ERC's graduate and undergraduate students is held, in which reviewers can talk informally with students (with no ERC faculty present) to assess the impact of the ERC on their education and to gain input from them on how to strengthen the ERC. A private session with industrial representatives of the ERC's member companies is scheduled also, in which the reviewers discuss the outcome of their previous SWOT analyses and discuss strategies for addressing concerns, as well as any opportunities industry would like to see addressed in the future. This session is followed by a dinner with the site team and the industrial partners of the ERC to continue the dialogue established in the morning. There is a private session for the site team with the faculty of the ERC to explore the role of the faculty in the ERC and their relationship to the management of the ERC. A session with the university's upper administration is held to probe their commitment to the ERC, their support for its infrastructure, and the impact of the university's tenure and reward policies on ERC participants. To conserve time, some of these sessions can be held during lunch. However, dinner time should be reserved for the site team itself to meet in executive session.

Exhibit 7-1 outlines the main sessions which should be included in the ERC site visit. The detailed topics of presentations, their order, and any additional sessions to be included, will be worked iteratively between the NSF PD and the Center Director, as described below. However, a suggested agenda for the site visit, in both a two-day and three-day format, has been developed by NSF and is shown as Attachment 7-1.

It should be noted that the agenda should not include "extracurricular" activities such as building dedications, etc., that would involve the site visit team members and/or NSF staff.

7.3.2 The NSF PD's Role in the Site Visit

Responsibility for the agenda for the site visit ultimately rests with the Center Director and his/her ERC team. NSF provides the overall structure and some guidance and advice; however, the Center Director needs to determine how best to represent the entire ERC during the site visit's limited time. In discussing the agenda with the Director, the PD will indicate what ought to be considered the primary objectives of the site visit, given the past progress of the center. All programs of the ERC should be represented during the visit. The agenda should be finalized at least one month prior to the campus visit.

NSF selects the site visitors. Before selecting the site visit team members, the PDs determine the

appropriate scope of visitors needed to review the ERC's current and planned programs. The site visit team will consist of scientific and technical peers, some of whom have relevant experience in either academe or directed research projects in government or the private sector. There should be an appropriate balance of disciplines and a balanced representation of academic and industrial personnel. In selecting the site visit team and preparing for the visit, the PD is expected to:

- choose critical and technically competent site visitors (suggestions from the Center Director are welcomed);
- screen visitors for obvious conflicts of interest (as defined by NSF) or for lack of commitment to ERC goals. (Conflicts, according to NSF are: close personal friends of ERC participants, co-authors within three years, recent graduates of the program, individuals whose professional fate lies with one of the ERC faculty, etc.);
- listen to concerns the Center Director may have about conflicts of interest of potential visitors and weigh them against NSF conflict-of-interest rulings and the need for an effective review team;
- assign report-writing responsibilities to reviewers;
- select a hotel near the ERC campus for the site team; and
- submit a list of reviewers to the ERC Senior Program Assistant 6-8 weeks before the visit.

NSF's ERC Senior Program Assistant is responsible for distributing the ERC's Annual Report (which is sent to NSF four weeks prior to the site visit) to the site visit team and NSF staff attending the review. To prepare for the site visit, the Senior Program Assistant will:

- complete a work order five weeks before the visit, in order for the NSF travel contractor to make the travel arrangements for the site visit team;
- secure meeting rooms for the briefing and other evening meetings of the team at the chosen hotel in the ERC's city;
- send the report and review materials to the reviewers and NSF staff attending the visit three weeks before the visit;
- fax the final list of reviewers to the center's administrative officer three weeks before the visit; and
- check with reviewers, two weeks before the visit, to be sure travel arrangements are underway.

Site visitors need to be able to arrive before the site visit in time for a briefing on the review task ahead, held the night before the first day of the visit. They need to be able to participate in an evening meeting on the first full day of the visit and be prepared to stay throughout the duration of the meeting on the second day. The purpose of the initial team meeting is to brief the review team on the goals of the ERC program, introduce the visitors to one another, exchange preliminary insights into the strengths and weaknesses of the center, and assign team members sections of the report for which they will be responsible. The PD needs to make sure the visitors understand the concept of the ERC and how it differs from unlike traditional investigator grants.

As the site visit proceeds, the PD will facilitate the site visit, guiding reviewers on how to apply

their expertise to the task at hand in relation to the ERC review criteria. The PD may respond to questions about past performance but should not insert his or her opinion in such a way as to bias the judgment of the reviewers. The ERC needs to structure the agenda and presentations to allow sufficient time for questions.

Staying on schedule is a joint responsibility shared by the PD, the Center Director, and the ERC's team of faculty and staff. The PD and the site visit team need to respect the agenda; if a major concern is raised, it may be possible for the PD and Director to discuss the concern in detail off-line while the rest of the program continues. The logistics of the site visit (faculty class schedules, administrators' schedules, catering arrangements, etc.) must be considered when a change in the agenda is made.

During the site visit, the site visit team has four private sessions, one each with industry, students, the faculty, and the university's upper-level administrators. In the session with the ERC's industrial affiliates, the NSF PD will explain that the purpose of the session is to gain their input, as joint investors, on both the strengths and weaknesses of the ERC. The meeting with the students is intended to be an honest and frank discussion to ascertain whether the students are receiving a systems-level, cross-disciplinary engineering education experience involving close collaboration with industry. Students are urged to be active team members in the ERC's programs. The purpose of the meeting with faculty is to give the site team members a private time to explore the impact of the ERC culture on the faculty and the effectiveness of the ERC's management system from their perspective. In the meeting with university

EXHIBIT 7-1
REQUIRED SESSIONS DURING ANNUAL ERC SITE VISIT*

PRE-REVIEW

. Orientation briefing of site visit team by NSF

DAY ONE

. Overview by Center Director
- center vision, mission, and goals
- strategic plan for research, education, and technology transfer
- value added to knowledge and technology
- industrial collaboration
- leadership, infrastructure, management, and financial management

. Briefings on:
- research progress, outcome, and plans
- industrial collaboration strategy and results
- education and outreach goals and accomplishments
- center management and infrastructure

X. Poster Session for students to present research

X. Lab Tours can be combined with the poster session or even some of the research presentations.

X.

. Private sessions
- with industrial participants followed by a dinner if it fits in the schedule
- with ERC students
- with faculty at lunch
- with upper-level administrators (Dean, Provost, and/or President)

. Executive sessions (interspersed during the day on the 3-day visit and in the evening on the 2-day visit)
- develop initial consensus on center strengths and weaknesses
- identify important issues needing clarification

DAY TWO

. Meeting with university administrators during breakfast

. Interactive session with center management team, must be completed by 10:30 am.

* Site visits in Years 3 and 6 are three days long. Presentations on research, lab and poster sessions, and the private session with students are extended. (See Attachment 7-1.)

- Report-writing session (10:30 am to 3:30-4:00 p.m.)

POST-REVIEW (Optional)

- NSF Program Director(s) discuss concerns/problems with ERC management

administrators (department chairs, deans, provosts, presidents, etc.), the PD will work with the university officials to ensure that commitments made to the ERC Program for infrastructure to support the ERC are fulfilled and that the administration is facilitating the cultural and administrative changes normally needed for a strong ERC. The Center Director may or may not attend this session.

For a regular two-day annual review, all technical sessions and nearly all of the other sessions must be completed by the end of the first day in order for the site visit team to begin their analysis of the strengths and weaknesses of the ERC in the evening of the first day. No topics critical to meeting the ERC key features should be left for the second day of the program.

During the site visit, there are several executive sessions for the site visitors. The purpose of these meetings is to discuss the progress of the visit, to begin to generate a consensus on the strengths and weaknesses of the center, and to determine if there are important issues that are still needing clarification. The lead PD, with assistance from the other members of the Program Director Oversight Team, coordinates the site visit team's executive sessions and guides them through the complex analysis of the ERC programs. The lead and supporting PDs facilitate critical but constructive discussion among team members about the center's strengths and weaknesses. The PDs facilitate and guide the discussion for two purposes: (1) to help focus and structure the visitors' opinions and judgments in accordance with the ERC assessment criteria, and (2) to ensure that they concentrate on both the strengths and weaknesses. These discussions distill any outstanding issues that can be discussed with the Director and the key members of the ERC team on the last day. Under no circumstances will the NSF staff participate in the writing of the report.

The final day of the visit is used for: (1) meeting with the administration during breakfast, (2) an interactive session with the Director and key members of the ERC leadership team, and (3) an executive report-writing session. The interactive session is an opportunity for the PDs and site visitors to provide the ERC team with feedback on the strengths, weaknesses, key concerns, etc., of the site team. This is the final opportunity for the site visit team to gain clarification on key issues raised by the visit. This interactive session should be a dialogue between the site team and the ERC team. At times, the site team may meet alone with the Director or alone with the other members of the ERC team.

The site visit team's report writing session is a four-fold process: (1) to discuss outstanding issues and achieve consensus, (2) to write the report based on that consensus, (3) to read the report aloud to confirm the consensus, and (4) to modify the report as needed. The role of the PD should be to focus the group to gain a consensus; the report does not represent one reviewer's opinion. The reviewers discuss whether any of the center's weaknesses represent a serious threat to its success and whether the center is missing any important opportunities. The team then formulates its recommendations for continuation or phase-down, the budget level, etc. The site visit team will make recommendations about how to address weaknesses or take advantage of known opportunities. By the end of the site visit, the report should be well structured in terms of content, and for all practical purposes it should be complete. The NSF is transitioning to a system with which the report is developed on a WWW-based template that makes it

simultaneously accessible in real-time to all site visitors, facilitating the editing process. The completed report instantaneously resides at the ERC Program's private Web site. If the need arises and the budget allows, at least the lead PD can stay for an extra half-day to discuss with the ERC any important problems identified.

Upon return to NSF, the lead PD, in consultation with the supporting PD and any other members of the Program Director Oversight Team, will write a 1-2 page recommendation to the ERC Team Leader, based on the outcome of the visit, summarizing the strengths and accomplishments of the center and any concerns and recommending a course of action for the following year or relevant period. This summary is submitted during the week after the site visit and begins the official recommendation process. The PD and the Team Leader will discuss the report, any recommendations for improvement and actions to be taken, as well as any justifications for increased funding.

The ERC Team Leader is responsible for calibrating the numerous requests for increased funding across the whole ERC Program. The Team Leader makes a recommendation regarding continued support, increases in funding levels, or phase-down to the Division Director for approval. If it is a renewal recommendation, it is recommended by the Assistant Director for Engineering to the Director's Review Board. (Finally, it is sent to the Division of Grants and Agreements for implementation through revisions in the cooperative agreement. The PD may send the site visit report to the ERC Director for clarification and response before the process is completed . The Division of Grants and Agreements will send the site visit report and the cooperative agreement to the Center when the action is final, or may send it out after it is complete.

The above description of the PDs' responsibilities for the site visit applies across the whole life-cycle of an ERC. Ideally, in the first two years of a center, the lead and supporting PD will stay the extra half-day after the site visit concludes to discuss any concerns that the site visit team identified. In this capacity, the PDs will provide developmental advice but they should be careful not to usurp the role of Center Director. The PDs will assist the Director in problem-solving; they will not impose or dictate a solution. The Center Director is ultimately responsible for making decisions to address issues and/or problems identified by the site visit.

The role of the PD will shift during the life cycle of a center. As an example, in the first year the PDs will bring issues to the Director's attention; in Year 2 the PDs will continue to provide guidance; but by the third-year renewal, Year 3, the PDs will stand back from that advice and seek the judgment of the site review team about how well the center has addressed the issues, concerns, and weaknesses that previous site visit teams identified. The lead PD will make recommendations based on the center's performance and the value added by NSF's investment in the center.

After Year 3, the PD's focus will be to see how well the ERC is bringing to fruition the research, technology transfer, and education goals in its strategic plan. The lead PD will rotate site visitors and make changes in the Program Director Oversight Team to reflect the progress of the center and the evolution of its vision. Finally, as a center matures, the PD will encourage (and

eventually require) the Director to develop a strategic plan for the financial self-sufficiency of the center when NSF support ceases after Year 11.

7.3.3 The Center Director's and Administrative Director's Responsibilities in the Site Visit Process

The Center Director and staff play an important role in setting the tone of the site visit and communicating its importance to the center. The Director should talk with the lead PD about the function of the site visit (which may vary according to the progress and maturity of the center). If the Director has recommendations for site visitors, s/he should submit the names of these experts in the field to the lead PD. The Director should make the PD aware of potential conflicts of interest of selected site visitors. The Director should submit a draft agenda to the lead PD. Although the final responsibility for the agenda rests with the Center Director, it should result from an iterative process between the Director and PD to negotiate the details of the visit.

Although NSF coordinates the site visit team's transportation and lodging, the ERC's Administrative Director should provide the lead PD or the designated NSF staff member with a recommendation of a comfortable, clean, and safe hotel that will accept the government lodging rate and that is of a quality suitable for the visitors' professional stature. The hotel should have a restaurant and meeting rooms. The ERC staff is responsible for securing the proper campus facilities and equipment for the site visit. The ERC should: arrange to transport the site visit team to and from the hotel and on-campus meeting site; provide continental breakfast plus coffee/tea/juice, as well as coffee breaks and lunch (all days); arrange any special working dinners, provide computers with an internet connection for access to the WWW and printing capability for the site visit team's report-writing session the second day/or third day; arrange to have copying facilities accessible for the team; and coordinate transportation to the airport if necessary (for outbound flights only).

7.3.4 Overall Benefits of the Performance Review System to Centers and NSF

As a result of a study of the Program's performance review system, the ERCs concluded that annual site visits, accompanied by meetings with the industrial partners twice a year, continue to be beneficial to both the ERCs and NSF because they:

- help focus ERC faculty on the center's vision and strategic plan;
- help develop an ERC team approach to research;
- help achieve an integration of the different aspects of a center: research, education, and industrial collaboration;
- help strengthen the role of industry in the center and solidify the partnership between the faculty and industrial representatives;
- enable new industrial and academic site visitors to learn more about the ERC concept, increasing their potential interest in being collaborators and participants;
- educate students about the realities of proposing to industry and the government for research support;
- allow students to see the synergy and strategy of the center;

- provide a focus, through private interviews with students and industrial personnel, on how effective the ERC is in working with its "customers";
- provide an opportunity for NSF and industry to redirect and reinforce the center as it strives to meet its goals; and
- ensure that the center reaches and continually remains at the cutting edge in all aspects of its work.

7.4 REPORTING

The performance review system is based on annual reports which are used by both NSF and the Center Director as management tools. The reports are used to make assessments based on specified performance criteria for ERCs at various stages in their life cycle. As such, the system is a useful indicator of progress and outcomes; it also provides information to support a more qualitative review process. See Chapter 6 for additional discussion of the required reports.

7.4.1 The Reports

The *Annual Report* is prepared by each Center Director and submitted four weeks prior to the center's annual site visit and ten weeks before the funding start date. The length and content of this report are stipulated by uniform guidelines provided by NSF. These guidelines change periodically, so it is important to stay current with NSF requirements. The Annual Report provides a summary of past accomplishments and also presents future plans for the center. This is the official (legal) transmittal document from the university to NSF to request funding of the ERC for the next fiscal period. Therefore, it contains NSF 1030 budgets with official university signatures and the host institution's commitments to cost-sharing for the program. NSF now requires the report to include a certification of industrial membership and financial support by the University's sponsored research office.

The Annual Report describes the Center's vision and strategic plan, scientific and technical progress, administrative structure, and educational and industrial programs, as well as providing statistical information about the program. The report currently is submitted in hard copy to the PD but will soon be submitted electronically through the NSF "Fastlane" system or the ERC Program's WWW-based system. In Years 3 and 6, the Annual Report becomes a progress report and renewal proposal, stressing the center's accomplishments as they relate to the performance goals of the Program, and its plans for the next five years. The evaluative benchmarking of the center's achievements will determine its future funding levels.

The *Indicators Report* prepared by the center's Administrative Director (AD) is submitted annually. This report provides quantitative information from which NSF is able to determine ERC progress as well as answer questions from within NSF and from Capitol Hill about the performance of the ERC Program as a whole. Its files and content are structured as per uniform instructions provided by NSF. The Indicators Report is filed with NSF in electronic form via a World Wide Web site provided and maintained by NSF (see Chapter 6, Section 6.7.1.7). It is submitted to an NSF Analyst on staff in the EEC Division in the late summer or early fall

(depending on the instructions provided by the Analyst). The data submitted in the files are required to be aligned with each ERC's annual report data, representing a 12-month period. Each Indicators Report includes: personnel demographics; data on publications, patents, and invention disclosures; industrial participation demographics; budget/allocation data; and text files about technology transfer and important developments/accomplishments of the center. The data contained in the Indicators Report are used by NSF and the center to assess the center's performance.

To file the Indicators Report via the NSF Web site, each ERC AD has a login and password to the site. After logging onto the Web site, the AD creates the report on a secured file server at NSF by completing templates designed by NSF. The ERC AD may edit the report as many times as s/he would like until its status is designated as "submitted." From that point on, the report can only be viewed, not edited, by the AD. The 1996 submission of the Indicators marked the first on-line electronic submission to NSF by ERCs. It is envisioned that the Annual Report, too, will be created and submitted in this way in the future.

The Cooperative Agreement for the ERCs specifies that each host institution must submit an annual *Federal Credit Transaction Report* (FCTR). This report is submitted directly to NSF's Division of Grants and Agreements.

At the conclusion of each Cooperative Agreement (which is to say, at the end of an ERC's life cycle under NSF support), both a *Final Report* and NSF Form 98A are prepared by the ERC under guidelines from the ERC Program and submitted to NSF.

7.4.2 The Centers' Use of NSF Reporting System

About 85% of ERC Directors report that they use the NSF reporting system in some way. The most common uses of the Annual Report and Indicators Report are to:

- accumulate information and data on the Center;
- assess the ERC's scientific and technical progress;
- provide a structured time review (check-point) for progress on the strategic plan;
- utilize as a planning tool based on findings of review;
- provide motivation to mobilize faculty, staff, and students;
- provide a means to engage industrial affiliates; and
- serve as a basis for evaluation of investigators leading the projects and provide internal performance-based criteria for continuation of project funding.

The process of preparing the Annual Report stimulates analysis, both prospective and retrospective, of all aspects of the ERC. In so doing, this process sharpens the center's strategic plan and helps identify the ERC's weaknesses and needs. The Annual Report deadline (and the internal deadlines set by the Center Director) have a strong focusing effect on the ERC team. As one Director notes, the team pulls together more strongly knowing they are under the NSF deadline "gun."

7.4.3 Performance and Reporting Criteria: Impact on the ERC

NSF's performance and reporting criteria have direct and indirect impacts on all the centers. Most directly, the continued funding of a center by NSF is dependent on its ability to perform against the criteria set by the ERC Program. Indirectly, the reporting processes and the criteria by which the center will be judged require the Director to analyze the center's strengths and weaknesses and make the necessary corrective decisions, however difficult that may be. The oversight system requires that the ERC's vision remain focused. For new ERCs, the performance criteria form a basis for establishing center programs in education and industrial collaboration. The reporting process prompts a self-analysis and forces the Director and faculty to focus on all the ERC programs and how they integrate into the center. Directors have reported that the performance criteria serve as a "big stick" (PD to Director and Director to faculty). The performance criteria allow benchmarking of the center's success and help the Director assess current and future faculty participation in projects. The performance criteria also force the Director and his/her research team to delineate focused and exploratory research.

7.4.4 Effective Reporting Strategies

In the process of reviewing the structure of the site visits, NSF also periodically reviews the documentation used in the reporting system. Although the performance criteria cannot be eliminated and a critical review of all programs must occur annually, nevertheless there are strategies that will allow for a more successful process. First, the PD and Center Director should carefully read the guidelines for reporting. The Director should discuss any concerns about these guidelines with the PD. Next, the Director should convene a meeting of the ERC faculty prior to writing the Annual Report. In this meeting, the Director should develop an environment and an expectation that the ERC faculty will share in both the risks and the rewards of the center. Further, the faculty should participate in the writing of the reports rather than leaving it all to the Director and his/her administrative staff. Finally, it is essential that the report present a center view and not an amalgamation of project progress reports.

7.5 COMMUNICATION/INTERACTION

In order to facilitate interaction between the NSF Program staff and the ERC Directors and staff, NSF holds an ERC annual meeting in Washington, DC, in the fall of each year. NSF began these meetings during the first year of the program to develop an *esprit de corps* across the ERCs and facilitate their mutual sharing of challenges and solutions. This two-day meeting also gives NSF a chance to update key personnel from all the ERCs on the status of the Program and the status of the Foundation's budget, as well as to discuss critical issues for ERCs and new directions for the Program. The staff of the ERCs take advantage of this meeting to schedule informal meetings with their peer group (Center Directors, Administrative Directors, Industrial Liaison Specialists, and Education Coordinators). These informal meetings have resulted in the development of a strong bond among ERC personnel across the ERCs. The annual meeting gives PDs and Center Directors a platform for personal interaction and it ensures at least two in-person contacts between NSF and ERC staff (the other being the site visit) every year.

ERC Directors and staff routinely use a variety of mechanisms to communicate with their PD and other staff members in the EEC Division. Mechanisms for interaction include phone, fax, email, and personal visits. The most widely used is a combination of email and phone calls. Center Directors report that the type of mechanism used to communicate with NSF depends greatly on the issue at hand. They find email to be the most efficient when they need quick and/or concise answers to basic questions. Dialogue over the phone or personal visits with the PD are more useful and effective for substantial discussions about a center's strengths/weaknesses, plans for the future, or plans for addressing issues raised by a site visit or by NSF. The way in which Directors interact and communicate with their PD is determined in part by both parties' individual working style and personal preferences. Directors and their deans are welcome to visit NSF and the ERC Program staff in Washington.

Communication and interaction between PDs and Center Directors varies over the life of a center and across centers. It is typical for the PD and Director to have more frequent contact when NSF establishes a new ERC and prior to a center's third- and sixth-year reviews. Once a center has established its infrastructure and is on its way to maturity, the PD's communication with the Director may be less frequent. Data from a survey of Center Directors shows the following PD/Director interactions per year:

Contacts per year	1-5	6-10	11-15	16-20	21+
% of respondents	21%	21%	42%	5%	11%

The number of interactions ranged from a low of 1 per year to a high of 24 per year. (The center with 1 contact was a center where there was more frequent contact between the ERC PD and the Administrative Director.) Communication between the PD and the Deputy Director and/or Administrative Director supplements these contacts. On average, Center Directors estimated that NSF initiated interaction with them just under half the time. Across the spectrum of responses, the high for Director-initiated interaction with NSF PDs was 95% and the low was 15%. Generally, the survey data show that the level of interaction between NSF and the centers finds a center-generated equilibrium; those with low interaction don't want more, and those with higher interaction have sought it.

Communication between PDs and Center Directors is important for many reasons. One reason is that an ERC is likely to have more than one PD in its lifetime. Of the 19 respondents to the survey, only 21% reported that their ERC had had one PD throughout its life as an ERC. Close to half the centers (48%) have had two PDs; 5% have had three; 5% have had four PDs; and fully 21% have had five PDs. Only 16% of respondents noted anything other than smooth transitions between PDs.

In addition to the Center Director, other administrators from the host universities also communicate with NSF. Most times this communication is between contracts and grants officers at the university and the NSF Division of Grants and Agreements. These contacts are for a variety of reasons such as: Cooperative Agreement modifications; requests for rebudgeting not covered under "expanded authorities"; pre-award communication to establish the Cooperative Agreement and its terms/conditions; and requests for change of Director at the ERC. The lead

NSF PD interacts with staff in the Division of Grants and Agreements to facilitate the processing of the ERC awards and to respond to any specific questions the DGA staff may have about a particular recommendation.

The ERC Team Leader sets the tone for the style of interaction between the PDs and the Centers and encourages both parties to strive for the type of communication and interaction discussed above. If, at any point, after exhausting all modes of communication a Director is unable to make contact with the center's PD, then he/she should notify the ERC Team Leader. In a more general sense, if after several months an ERC Director concludes that the communication and interaction with the PD is not satisfactory, he/she should discuss this with the Team Leader.

Based on the survey of ERC Directors, it is clear that there are opportunities to improve the frequency of PD/ERC communication. A few PDs need to respond in a more timely manner to their messages (phone, fax, or email). The system of Program Director Oversight Teams is being modified to give the supporting and other associated PDs the more meaningful role outlined in Section 7.2.4. PDs are expected to visit their centers during the year, outside of the site visit, for a candid look at the center's daily functioning. Center Directors are encouraged to visit NSF when they are in the Washington area on other business and to touch base with their PD and the ERC Team Leader.

NSF, for its part, also communicates with others who are involved with ERCs. Periodically, the Team Leader and PDs will meet with a representative group of industrial advisory board members from the various ERCs to receive feedback on the progress of the ERC Program in general. NSF wishes to gain industry's insight on issues that transcend individual centers and that affect the Program at large. NSF also has met with representatives from among the engineering deans of ERC host institutions. Such meetings allow NSF to gain a different perspective on the Program's progress in achieving its educational goals. Deans are encouraged to come to NSF individually to meet with the ERC Program staff to discuss the center □ especially in situations where the dean has concerns about the ERC.

On behalf of the ERCs, NSF publishes a booklet of descriptions of each ERC in hard copy and on the ERC Program's Web page. In addition, it publishes summaries of center output in program areas such as education and technology transfer. A summary of each annual meeting is prepared and distributed. Such publications not only increase the ERCs' awareness of each others' activities; they also provide industry, other programs within NSF, and other federal and state government agencies with a detailed description of the nature and achievements of these centers.

7.6 PROGRAM-LEVEL EVALUATION

In 1986, the General Accounting Office began a formal assessment of the then-new ERC Program's progress to date toward fulfilling its vision and goals for the ERCs and the overall Program. Its findings were published in 1988. In 1989, the National Academy of Engineering (NAE) carried out a study with a panel of experts from academe and industry, and published its

findings in the report, "Assessment of the National Science Foundation's Engineering Research Centers Program." Both studies found the Program to be well structured, on its way to fulfilling the vision of the ERC Program, and possessed of a strong oversight and management system.

Now that the oldest centers have been in operation for more than a decade, in 1995 the ERC Program itself commissioned three studies to gain information about the value added and impact of the Program. In addition, this information contributes to the continuous improvement efforts of the centers. The following is a brief summary of each of these studies.

1. ERC-Industry Interactions
   The purpose of this study was to: (a) catalogue the types of interaction between ERCs and their industrial sponsors; (b) determine which types of interaction are most useful to industry; and ascertain how companies have benefited from their interactions with ERCs. The study also examined the process by which firms make use of results of ERC research. Representatives from companies with memberships in ERCs were surveyed about their interactions with centers and the results of the interactions.

2. Effectiveness of ERC Graduates in Industry and Other Sectors
   The purpose of this study was to conduct a comprehensive evaluation of the impact of the ERC approach to engineering education on the effectiveness of masters and doctoral graduates working in industry, academia, and other sectors. The intent is to evaluate the degree to which the ERC program is producing graduates who are different from and better than graduates without ERC experience.

The results of these first two studies have been compiled into a report for Center Directors and staff that includes lessons learned for improved center operations and outcomes. A second report is being prepared for the general public. The results of the studies are summarized in Chapters 4 (see Attachment 4-1 in particular) and 5.

3. Tracking the Impact of Self-sufficiency on ERCs
   The purpose of this study is to develop an understanding of (a) the conditions that occur during phase-down leading to the graduation of a center, (b) the extent to which graduated centers maintain their □ERC-ness□ after graduation, and (c) what happens when centers do not stay together. As □best practices□ for self-sufficiency preparation become evident, they will be shared with the ERCs. This project is intended for program management purposes, not for dissemination to those outside the ERC program.

7.7 EVOLUTION OF ERC PROGRAM MANAGEMENT STRATEGIES AND OPPORTUNITIES FOR THE FUTURE

NSF's management of the ERCs has evolved over the life of this program from one that was structured and directive to the ERCs to one that still depends upon an organized structure but now includes a much higher degree of feedback from the centers and a greater emphasis on guidance for development. NSF now has and promulgates a sense of the ERCs and staff as

comprising an interactive community, with an emphasis on teamwork between NSF and the ERCs, both individually and as a group.

NSF realizes that, in order to more efficiently manage this complex program, its management strategies need to constantly keep pace with the dynamics of the program itself. As an example, strategic planning evolved in the second year of the program, based on the advice of industry, to help ERCs focus on their deliverables and achieve integrated and directed research programs. NSF requires strategic planning on the part of all ERCs, and initially it was a difficult challenge for the centers. However, over time the ERCs and their industrial partners have mastered strategic planning as a new style of academic research management that has strengthened the ERCs and their parent universities. Now the more experienced ERCs help new ERCs gain this skill and the impetus for strategic planning no longer arises only from NSF.

New ERCs were given brief orientation sessions during the annual meetings. These proved to be too brief and intense. In 1996, the Program set up a special two-day session for new ERCs to come to NSF and work with the ERC Program staff to understand the issues involved in developing a strong ERC, as well as the reporting and review systems. This meeting succeeded in developing an *esprit de corps* across the new (1996) class of centers that normally takes a few years through the annual meeting process. They were called back to NSF six months later to present their progress in strategic planning to NSF and their peers in a working group format. The new practice will be continued for future classes of new centers.

In addition, in recent years NSF has changed the management of the annual meetings to reduce the reliance on a professional meeting manager, turning over the job of developing and managing the meeting to the ERCs and the ERC Team Leader. This change has produced meetings with a much higher participant satisfaction rating than before.

During the last few years, the ERC Team Leader has increased the level of involvement of ERC personnel in planning new directions for the Program and providing feedback about the Program's systems by means of periodic surveys and email queries designed to gain input before decisions are made. Part of this process is the inclusion of ERC staff members' experiences and input into the formulation of new ways of doing things. The evolution of email as a prominent means of communication has influenced directly this change in management style. This ERC-authored Best Practices Manual is itself an example of the trend toward more collective input into guidance for the ERCs.

In the near term, the reporting and database systems will be undergoing a major overhaul as the Program takes fuller advantage of the World Wide Web. ERC Annual Reports are very time-consuming to assemble and publish in printed form. As discussed in Section 7.4.1, in 1996 NSF began the development a format that enables these formal reports to be submitted electronically over the Internet directly into a database containing both text and numerical information. NSF expects that this new approach will make the preparation and dissemination of this material less costly and more efficient. Additionally, NSF expects to be able to conduct analyses of the textual data more readily than the current paper format permits.

In its first decade of operation, the ERC Program has validated the Foundation's strategic interests in fostering the integration of research and education, the formation of partnerships between universities and industry, the development of shared infrastructure, and the capacity of science and engineering graduates to contribute to the Nation. In so doing, the Program has had even greater impact to date than was originally anticipated. Indeed, it has become a model for the development of centers programs across the United States and around the world.

While various components of the ERC Program have been emulated by others, nevertheless it still fills a special niche. This unique status derives from the systems perspective of ERCs and from their research and education strategies, designed to produce fundamental advances that lead to further innovation in industry and a new generation of engineering leaders. Together, NSF, the ERCs and industry have developed and fulfilled a shared vision for long-term engineering research and education that enables next-generation technologies, productive engineering processes, and innovative products and services. Thus, ERCs contribute to industry's ability over the long run to create new shared wealth and rewarding employment opportunities, compete well in global markets, and generate products and services that improve the quality of life while avoiding harm to the environment. In the process, the ERCs have created a ripple effect at their home universities encouraging new ventures in interdisciplinary collaboration, a more open climate for collaboration with industry, and a groundswell of involvement of undergraduates in research. Through the establishment of a new generation of ERCs, the Program expects these impacts and others produced by the creativity of these new ERCs to bring yet another generation of benefits to the Nation.

ATTACHMENT 7-1
ANNUAL SITE VISIT REVIEW AGENDAS