2.3 Structuring the Center for Success

Delegation and staffing during the life cycle of an ERC is an issue of fundamental importance. The related questions of how much to delegate, what management and operations functions to delegate, and how best to accomplish this distribution of responsibilities should be addressed in the planning stages of the ERC and on into the initial stages of funding and implementation of the ERC proposal. The center's structure will directly influence the center success on research, education, and industrial participation.

2.3.1 Deciding How Much to Delegate

When an ERC is funded by NSF it is probable that there will have been a personal prime-moving force who has initiated the application and gathered the research team. It is equally probable that the initiator will have a large and well-funded research group, or it is unlikely that the application would have been successful. But it is apparent that the duties of the Director of an ERC are sufficiently challenging that they are very difficult to combine with those of a successful and busy PI or research group leader unless the person concerned is adept at delegation. For this reason the first, and one of the most important, choices that a founding Director will make will be the extent to which s/he delegates responsibilities within the center as it begins its progress towards its first date with destiny at mid-Year3. If the Director delegates too little, s/he risks eventual "burn-out" and the loss of his/her own research program and even the center itself. If s/he delegates too much, s/he is likely to lose control of the center and jeopardize its ultimate success. The founding Director should assess the importance of all the potential roles within the center and decide which to delegate and which to retain. Three major factors that influence the Director's choice are: 1) the peculiar strengths of his/her center team, 2) the overall interests of the center and, finally, 3) the meshing of his/her own research interests with the welfare of the center. In any case, the Director's research must fit integrally within the scope of the center's research or it may be seen as a conflict of interest and a threat to the cohesiveness of the center. Such conflicts are viewed as serious by NSF, and must be resolved quickly.

If the Director chooses to retain control of administrative and routine personnel matters, s/he will drown in details as the center grows to encompass about 100 people. If the Director retains direct, personal control of financial matters, s/he can use this control to steer the center in detail, but s/he will be held responsible for every fiduciary ripple and s/he will encounter resentment when support is withheld or withdrawn. Experience teaches that, given the efficiency of sole autocratic command, a researcher can control and steer a research group of about 40 with some help from experienced staff and postdoctoral fellows. Therefore it is critical that the Director rely on and distribute responsibilities amongst her/his leadership team, beginning with the Deputy Director and Administrative Director. One approach is to have all of the administrative staff report through another designated individual (Deputy Director, Executive Director, or Administrative Director).

Sometimes just as important as the degree to which the Director delegates responsibility within the center are the mechanism(s) of delegation. This delegation should be done very carefully because its consequences for the smooth operation of the center are likely to be quite significant. Everyone involved in an ERC must realize that the whole exercise is driven by the center's vision and strategic plan. The administrative function is only an "engine" (albeit an essential one) to facilitate the realization of the vision and, as such, it will always be secondary to the program activities of the center.

There is general agreement among ERC Directors that the following responsibilities should not be delegated.

- Major resource allocation and budget decisions, including fiscal oversight
- Major realignment of center administrative and research structure
- Final decision on hiring (and termination of) faculty and key staff
- Final selection of companies to recruit as members
- Formal contacts with NSF to address major issues
- Policy interactions with department heads, college deans, and university top administrators
- Negotiations with lead university administrators for commitments of resources
- Integration of the ERC's annual report to NSF
- Responsibility for the integrity of the ERC's reporting systems.

2.3.2 Staffing the Center

2.3.2.1 The Executive Team

An important early decision must be the type of supervision and reporting to utilize for management of the center. There is clearly a limit, which is dependent on the personality and policies of the Center Director, to the number of center employees who can take detailed direction from this one source. The ERC Director can be aided in the complex center leadership role by selecting a Deputy Director who is capable of sharing the leadership and management responsibilities in the ERC. Some centers also have the Deputy Director share in overseeing many of the operational aspects of the center, such as directing specific research areas, accessing new facilities, allocating resources, negotiating with university administrative personnel, spearheading industrial interaction and technology transfer, and supervising administrative activities. It is also common for the Deputy Director to assist the Director in organizing and preparing the center's NSF annual report and site visit.

In most centers, the Director and Deputy Director(s) are assisted by an Administrative Director who is in charge of many of the day-to-date operation tasks (Section 2.3.2.3 and Chapter 6), an Industrial Liaison Officer responsible for the implementation of the industrial program (Section 2.3.2.5 and Chapter 5), and an Education Coordinator or Education Director who leads in the implementation of the education and outreach efforts (Section 2.3.2.4 and Chapter 4). In addition, some centers have Associate Directors who oversee specific areas of research (Section 2.3.2.2 and Chapter 3).

2.3.2.2 Research Management

Chapter 3 deals specifically and in detail with research management in an ERC. However, management of this activity is central to the overall management and direction of an ERC and impinges on the success of every other area of center activity. The discussion here addresses research management in this broad context.

An ERC is an excellent power base because it represents a large amount of research money, and it will attract those who are interested in wielding financial power. The Director of an ERC must make a choice as to whether s/he will become the sole power broker, the leader of a small and select coterie of power brokers, or the arbiter of power who balances the process for the good of the center. A lesson learned from the management of research centers is that even the most promising center, founded on the most talented team of researchers, needs a constant flux of new people and new ideas to keep its edge. All centers try to stay ahead of the curve by recruiting excellent graduate students and postdocs, but very few give newly recruited faculty members senior positions with real access to center resources (especially if they are from outside the university). For this reason, the Director of an ERC may resolve to build an effective faculty intake mechanism into the center, select the new team members with great care, and choose research management structures that allow the newcomers to share power and resources on an equal footing with all other participants. The intent here is to ensure that the ERC survives beyond the 10-year time horizon by accommodating growth and preventing stagnation.

Rather than making all research management decisions personally, an ERC Director may find it more useful to maintain the vitality of the center by making sure that all ideas that serve the vision have an equal chance of implementation. It is certainly not the intent of the ERC Program to provide 10 years of high-level funding to a Director and an unchanging group of researchers, however capable and even brilliant they may be. Thus, a new Director must decide whether s/he will retain complete personal control over research management, set up a closed system of research management involving a select group of insiders, or augment the closed system with strategic planning and revitalization mechanisms that involve the whole center. Perhaps there is no choice to be made by a new Director, in the initial stages of the organization of an ERC, that will affect the center more than this pivotal decision. It is, however, advisable that the important decisions on strategic planning and research goals are made with the support and agreement of the Deputy Director and the key research faculty.

Research in an ERC is inspired and directed by the center's vision, as articulated by the Director and Deputy Director and supported by its members. The practical vehicle for the realization of this vision is the strategic plan, and the mechanism for its execution is the structure of thrust areas and testbeds found in all ERCs. As was described in Section 2.2, the Directors of most ERCs maintain firm control of the center-level strategic planning process; most decisions in research management are made by these Directors with the advice of a small inner circle of senior center researchers who comprise an executive committee. In some cases, periodic retreats or cyber sessions for the input of ideas have been employed as a means of involving more center members, and these have been proven effective in facilitating the development of a "center" perspective. But generally the responsibility for the planning and management of research remains centralized.

The complex research tasks and the associated reporting requirements of the ERC Program review process virtually demand that each center must appoint a leader for each research thrust area and that someone, usually the Director--often with the aid of the Deputy Director--must combine these reports with those of the education and technology transfer programs to produce the annual report. These thrust area leaders also provide a necessary management interface between the Director and the rest of the center's executive team and the faculty researchers, with responsibility for the detailed planning of research within each thrust. It is important to begin with the right number of research thrust areas. The "right" number may differ from center to center and field to field, and may also change across time. However, in general the fewer the research thrust areas, the easier it is to manage the research program.

Several centers cite difficulties in terminating existing projects. Most report that they depend ultimately on the Director to make these hard decisions, but such ERCs have closed research management structures that may require that the research committee vote against one of its own members. A number of centers often take input from the Industry Advisory Board (IAB) on the relevance/quality of projects heavily into account in deciding whether to continue them. Site visit recommendations are another source of input**.** It is easier to terminate unsuccessful lines of research if there is a detailed strategic plan with milestones; this makes it apparent when a project is going nowhere and/or no longer fits within the strategic plan. Open channels of communication, with emphasis on the ERC research as a team effort, help to soften the blow. Nonetheless, it is important at the outset of an ERC for the leadership team to articulate both the requirements for retaining financial support during the life of the ERC as well as the process to terminate, such that all involved perceive the process as fair. Many ERCs also provide support to the graduate student(s) involved for at least one semester after termination and try to accommodate them within other ongoing projects.

2.3.2.3 Administrative Management

Because an ERC with NSF funding and average industrial, state, and university support constitutes a roughly $10 million/year enterprise, a centralized and proficient administrative structure is mandatory for effective organizational and financial responsibility. Therefore, an important leadership role in the center is the Administrative Manager or Director (AD), who is responsible for general management of the day-to-day operations. The selection of a capable AD is one of the most important administrative decisions a center must make. This position is discussed in more detail in Chapter 6.

The Director and the AD typically work very closely together; the smaller the administrative staff, the more this tends to be the case. The position of AD requires a strong generalist, and selection of the right person is critical. These individuals play a key role in the overall success of the centers. It is essential that the AD understands fully the vision of the center, its ideals, and its intended impact, and that s/he be treated as an equal partner in bringing them to fruition. The AD accepts the responsibility of implementing the center's vision in a manner acceptable to the university's and NSF's bureaucracy. Therefore, mutual respect must be present between the Director and AD, with the Director articulating the concepts and ensuring buy-in and the AD providing a reality check on what is possible and identifying ways to implement the concepts. (Again, see Chapter 6 for a full discussion of this function.)

It must be noted, however, that the Director is ultimately responsible for any administrative lapses that may occur; consequently, it is important to maintain supervisory oversight and control of office management functions. One potential problem is that major budgetary/accounting problems may arise in a center from a variety of causes. Therefore, it is advisable for the AD to have significant expertise in budget management/monitoring and databases. If this is not the case, an additional person with this critical expertise must be added to the team and must also work close with the Center Director, at the expense of adding administrative costs.

The decision to hire specialists for other functions will affect the center in various ways. If an assertive accountant is hired, the finances of the center will be well managed; but at an extreme, account management may not be as flexible as the Director needs. If the industrial interface is handled by administrative staff on a part-time basis, the Director will be the *de facto* salesman for the center. If, on the other hand (as in most centers), an aggressive Industrial Liaison Officer is hired, the industrial interface will burgeon and there will likely be a strong technical connection with industry through the PIs. If the details and the policy of interdisciplinary education in the center are managed by a part-time faculty member as Education Director, students will tend to be trained in their home departments and assembled in the center for occasional seminars and NSF site visits. But if experienced specialists are brought in to be responsible for University Education and Precollege Education (as currently required), these vital areas of the center's activities will be competently planned and carried out, engaging students at all levels integrally within the center, Therefore, care needs to be taken when hiring specialists to ensure that

they are capable of and willing to work in a collaborative open environment and can avoid ÃƒƒƒÃƒƒ‚ÃƒƒƒÃƒƒ‚€Ãƒƒ…¡Ãƒƒ‚¬ÃƒƒƒÃƒƒ‚€Ãƒƒ…“turf" wars.

The administrative infrastructures of centers thus range from a few people gathered tightly around the Director to small armies of specialists working for the benefit of the center, and each choice that is made will affect the kind of center that will emerge at the critical third- and sixth-year review milestones. The choices made in setting up the infrastructure of the center are matters of policy, and not of financial expediency, because at least two of the key responsibilities (technology transfer and education) may become largely self-funding. The administrative structure of the center must be set up thoughtfully by the Director, who must ensure that all major policy matters remain firmly under the control of center leadership and are complementary to the primary objectives of the center.

2.3.2.4 Education and Outreach Programs

One of the three pillars of the ERC Program, education is an element with which most centers feel that they have had great success. This success may reflect the national need for education of interdisciplinary team-oriented PhDs more than it does the effective policies and programs implemented by individual ERC Directors, but in any case it is a very fertile area that may come to dominate the future of individual ERCs and figure even larger in the priorities of the ERC Program itself. In the past decade, the National Academies of Science and Engineering and NSF joined with other professional groups to rethink engineering education at all levels.[1]

Education at all levels is a lot like gardening, in that it is labor intensive and requires great patience and commitment. Hence, it is an area of responsibility which an ERC Director must delegate to one or more full-time professional Education Directors. This responsibility is shared in a wide variety of ways across different centers. There is often one Director responsible for University Education and one for Precollege Outreach; in other cases there is an overall Education Director (often a faculty member) assisted by one or more Education Coordinators. In an area such as education, in which the ERC can facilitate but not dictate, the Center Director must work with the Education Director in setting up the college program structures. The Education Outreach Director is usually responsible for leading programs that include outreach to undergraduates from other universities and community colleges, as well as outreach to secondary school teachers and K-12 students. At the precollege level, many center faculty and students become involved in local science fairs, both as mentors or judges, and in community events such as science museums.

An experienced Education Director should know the center's students well enough to flag cases in which the student is confused and/or troubled by conflicting demands of the center and of his/her home department, or by any of the myriad problems that beset the engineering acolyte today. Because a mature ERC may involve 40-60 undergraduate and 60-80 graduate students, the Education Director cannot involve himself in either their individual or collective supervision. For this reason it is advisable to appoint an education committee of faculty, whose chairperson works closely with the Education Director to liaise with the students. In this way each student knows that the center provides a professional and a faculty member that they can contact with any problems.

All contemporary ERCs develop mechanisms for evaluating and assessing their education programs. Several have professional staff dedicated to this effort, which is a specialized discipline in itself. For more details, see Chapter 4, Education Programs.

The ERC Program strongly emphasizes education and is proud of the accomplishments of the ERCs in education at all levels. Although sustaining education programs after graduation can be a challenge, as the ERC moves to self-sufficiency after 10 years individual ERCs may find a very successful interdisciplinary education program that is relevant to industry to be an asset in their continuity.

2.3.2.5 Industrial Liaison/Technology Transfer

Industrial associates in a number of ERCs contribute to the finances of an ERC in a myriad of ways. Membership in an ERC at various levels requires a fee ranging from $1,000 to over $100,000 per year. NSF values these industry contributions and often uses the amount of cash fees collected from industry by a center as a “thermometer” of the health of its industrial program. NSF also requires a significant portion of these industry fees to be unrestricted funds (as opposed to directed funds for a particular thrust or project). However, these funds are still considered program income and thus cannot be treated as “gift funds.” Funds raised with these fees can be lumped into a common ERC pot, or some ERCs elect to keep industrial member fees separate from thrust area-related research. In addition, in most ERCs industry can directly support a specific research endeavor; but this activity will operate independently of the thrust area work and is dependent only on its own budget. In some cases, research activities

with industry require utilizing ERC resources to leverage industrial participation.

When considering the center's funding profile, it is important to maintain balance. For example, if most of the center's funding is from NSF, then the relevance to industry is somewhat suspect. Within industry, it is best to develop a diversified portfolio of partners ranging, if possible, horizontally across various industries and vertically from raw materials producers to parts suppliers to system manufacturers. If all the outside funding is from one industry, then there is a certain vulnerability if that particular industry goes through a bad patch. A balance between state and various federal government agency and industry funding is desirable because no one sponsor or sector then has an undue influence over the activities of the ERC. Maybe more important than all of these is to ensure the industrial advisory board has a balanced representation between small businesses and large corporations. Small companies may represent an important source of revenue beyond the 10-year NSF time horizon.

Center Director support and buy-in to the industry program is essential to its success, especially in the case of Gen-3 ERCs, which have additional requirements to stimulate startups, entrepreneurial activity, and other "innovation ecosystem" drivers. In the past, there has been a wide range of performance across the ERCs in this program element, which was so pivotal in the original funding of this program by Congress and by NSF. But as ERCs, and their industry programs in particular, have matured, those industry programs and their best practices have come to be very effective in enabling technology transfer and providing critical feedback and guidance to the ERC program. It is, therefore, extremely important that the Center Director, working with the center's Industrial Liaison Officer or Innovation Director, takes advantage of the center's relationships with its Industrial Advisory Board and the many communication mechanisms available through those relationships. The industrial collaborations are one of the key features that will enable the ERC to live beyond its 10-year financial time horizon of NSF funding.

The Director also must motivate the center's PIs to participate in the process of selling the center's technology. Because the Director must be personally committed to the process of technology transfer, s/he should take a very active role in company recruitment (also vital to center funding), in interacting with the IAB members, and in developing opportunities for joint research with sponsoring companies. S/He will also hire an Industrial Liaison Officer or Director of Innovation from outside of the academic framework and will give this employee the freedom to build strong relationships on an ongoing basis with companies interested in the center's technology. It is important in all of these instances that the ERC director also facilitates interactions between the ILO and Intellectual Property offices and Contracts & Grants offices at each institution. The development of a working Industrial agreement as well as the transfer of IP is based on the interactions that occur among these three groups—i.e., the ILO, IP offices, and industries—and represents a critical path to future successes.

2.3.3 Developing and Maintaining a Diverse Team and a Climate of Success for All

Developing a diverse team of researchers and staff represents a formidable challenge for an ERC, given the demographic distribution that currently exists in academic engineering. It is an important topic because some of the metrics that the ERC reports on an annual basis are directly related to the diversity of the culture within the ERC. In the diversity area, it is important that a Director form an initial research team that is competent and represents a distribution of team members with different demographics and backgrounds. This distribution is important to infuse new/different ideas and thoughts into the research and developmental areas, rather than relying on a monolithic culture with a myopic research focus. Diversity within the ranks of the primary investigators also sets the tone for future students recruited into the center, helping to ensure that "success for all" is ingrained in the ERC culture. While this may be the first important diversity decision a director may make, the second is wisely choosing the Education Director(s) and, in many cases, a Diversity Program Director. In some centers the Education Directors, both University and Precollege, have improving diversity as an integral part of their education program responsibilities. Where both Education and Diversity positions exist, they collaborate in developing and pursuing the center's diversity goals.

Candidates for both these positions need to be chosen with several important attributes in mind. These include: understanding the challenges facing engineering students and faculty from diverse backgrounds; being willing to make bold changes to promote a heterogeneous environment; and having established relationships needed to "grow" a diverse program within the ERC. The Diversity Director (or Education Director responsible for diversity programs) will first be faced with issues of working with Principal Investigators (PIs) to increase diversity within the graduate and postdoctoral sectors. This is challenging because most PIs typically use a narrowly focused process for selecting graduate students and postdocs. The Diversity Director may find more willingness on the part of the PIs to begin increasing the diversity of the undergraduate student population within the ERC, since these students

feed the pipeline for the graduate and postdoctoral programs.

Some ERCs have developed the view that overcompensating at the undergraduate level will help recruit more diverse students into the graduate curriculum of the ERC. This may be especially true for programs focused at the K-12 levels, with the drawback of a significantly long time horizon to have an impact on the ERC's diversity. Nonetheless, the K-12 student population may represent the most important impact an ERC can have on diversity. It is here where engineering has fallen short—i.e., not doing an adequate job of attracting a diverse population to engineering studies and careers. One ERC uses the concept that educating K-12 students about entrepreneurial concepts might encourage more diverse students to enter engineering studies. Here, it may be important to educate the K-12 students on the life-long career benefits an engineering degree offers. One fact that has been useful is that the number one degree of CEOs in S&P 500 companies is typically engineering, not business. Therefore, if you want to be a CEO, a pathway to that goal is through engineering. Second, engineering represents a truly enjoyable experience that has lifelong rewards, and YES, it is fun to be an engineer. For the latter, it is important for the Center Director working with the Diversity Director to develop a climate that is inclusive and enjoyable for all. To that end, it is not sufficient simply to conduct research but it is also necessary to develop a climate that supports an "engineering family" type of environment.

2.3.4 Managing Research at the Interface of Disciplines

One of the distinguishing features of the ERC Program, an area in which it was a pioneer in contemporary academe, is its emphasis on cross-disciplinary research. In most cases the complex systems nature of the research naturally requires the ERC to be highly multi-disciplinary. Individual ERCs have devised many ways to facilitate cross-disciplinary interactions among the faculty. In a number of centers an absolutist approach is taken: i.e., projects without cross-disciplinary interactions will not be funded through the center's resources, or else the evaluation criteria for project continuation will include cross-disciplinary collaboration. In other centers the requirement is not so absolute for all projects, although there is a strong preference for cross-disciplinarity, and a strong message is given that collaboration is necessary if the ERC is to be successful.

Other mechanisms that are employed to encourage and facilitate these interactions include:

- specific requests for collaborative research to meet an identified need;
- special center funds made available for cross-disciplinary projects and proposals;
- inviting researchers from a range of fields to center research meetings and retreats;
- structuring center research so that project teams cannot complete their assigned projects without obtaining assistance from other teams;
- developing a set of "end-to-end" demonstrations, within and between research clusters, that illustrate how the tools and methodologies work together; and
- engaging in design activities with center industrial affiliates (which commonly involve participants from more than one project or research thrust).

2.3.5 Acquiring Facilities

Operating a well-run ERC involves bringing together the necessary resources, including not only personnel but also facilities and funding. Facilities required to carry out the ERC's research mission include so-called "signature space" for housing the center administrative offices, conference room(s), and general space for center-supported activities such as a computer laboratory, student library, and lounge where faculty, students, and staff can gather to discuss their work. Distributed laboratory space is necessary for developing basic materials, device, and system-level competencies. Usually the Dean of the College of Engineering and the Chairs of the individual departments make the signature space available to the center. Individual laboratory space is usually made available to faculty on a have-need basis. Some centers have succeeded in obtaining new buildings or significant expansions to existing buildings. Space is perhaps best negotiated at the time the final proposal is submitted to the NSF.

2.3.6 Some General Guidelines for Center Management

The three pillars of the ERC Program are research, education, and technology transfer. However, it is clear that the first (research) is a *sine qua non*, in that the educational and/or technological advantages are derived from the research program. Also, all ERC Directors quickly come to understand that NSF site visit teams have been

instructed by NSF to view research as the first preference "gate" when assessing the extent to which an individual ERC has succeeded in its mission. Thus, research project choices represent a key component of a successful ERC.

Investing center resources in specific research projects must be guided by the strategic plan in which the center is united. When that critical time of each year rolls around in which decisions have to be made about how resources should be allocated to the various thrust areas, the Director will find himself or herself in a situation that will be dictated by choices s/he has made at the outset. Either there will be a clearly stated strategic plan that makes the finance committee's job possible, or there will be a struggle for funds and the Director will have to make all of the final decisions. If there is a clearly stated strategic plan, the Director should be vigilant to discern the real authorship of key inputs to that plan. The strategic plan of a center can be manipulated by a small group of faculty with preconceived notions of what direction they want the center's research to take or, at an extreme, by a single strong personality, often the Director, who simply tells the troops that this is what s/he has decided. The smaller the coterie of influential insiders, the more NSF money there is for each individual in that group. But NSF Program Directors and site visitors can detect such a situation fairly easily and will not tolerate it. ERCs have failed to win renewal because their research program lost its cohesiveness and collapsed into a collection of loosely connected single-investigator projects. It is important to always have pathways back to the larger picture defined theoretically by the unified strategic plan, as visualized in the classic ERC 3-plane chart (see Figure 1).

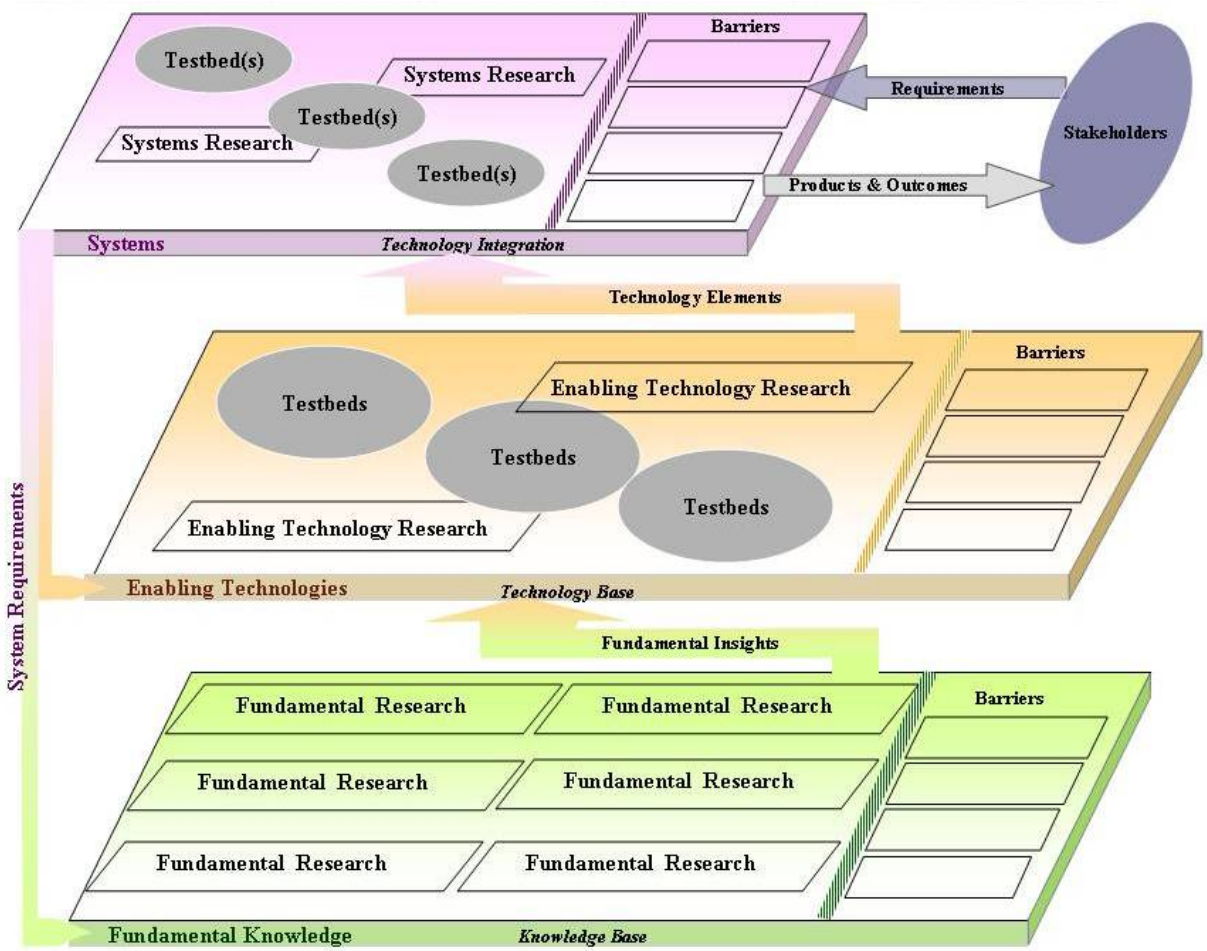


Figure 1. An ERC's strategic framework can be visualized via the 3-plane chart that connects the fundamental research, enabling technologies, and systems levels of the center's work.

There are many kinds of problems that can lead to failure for an ERC. Difficulties in leadership and management (including financial management), problems in research planning and execution (including disintegration and failure to address its vision), and failure to engage with industry positively and in the proper ways are all sources of serious trouble. However, some problems are less programmatic in nature and can be ameliorated to some extent by specific actions of the Director. One issue that nearly all ERC Directors cite as a serious problem is the heavy workload placed on the Director. Regardless of the extent to which responsibilities are delegated, the Director is still almost always subject to potential burnout. One Director describes the problem as "a major flaw in the ERC concept"; even after serving for the entire NSF-funded lifetime of a center as an ERC Director, he has found no real solution to the problem. The most prevalent approach to reducing the excessive burden on the Director is sharing responsibilities with the Deputy Director. Delegation of the implementation of the ERC plan to carefully selected key staff members, including the Industrial Liaison Officer and the Education Director, also removes some pressure. Several Directors point to the enormous importance of having a highly capable Administrative Director who can handle many of the day-to-day operational tasks.

An ERC still represents a relatively new type of organization in academe, even though ERCs have now been around for more than 25 years. At each university where a new ERC is established, the members of the ERC faculty and staff generally have to feel their way along in forming a cohesive team because, typically, the university is not set up to service an ERC. Effective leadership from the Director is indispensable to this process. However, formal training in team-building and organizational interaction in this novel university setting can be highly effective in speeding the development of these skills.

Rewarding center participants for strong performance is an excellent morale-booster and an incentive for further success. Many kinds of reward are available for Center Directors to bestow. One of the most prevalent and effective is continued or increased research support, including seed funding; increased compensation is of course another mechanism. Additional travel funds for making presentations at conferences can be provided out of center

unrestricted funds, as well as scholarships and fellowships. Increased visibility and support for making presentations at program reviews is appreciated as a career-enhancer. Success should also, of course, lead to promotion and tenure for junior faculty in the center. Several of the centers nominate their deserving staff for university awards and undergraduates for university-sponsored and professional society awards. (For Directors themselves, nomination to membership in the National Academy of Engineering is an appropriate form of recognition; several Directors have achieved NAE membership.) Some ERCs find it important to build a culture that actively pursues awards for its faculty across the board, i.e., from junior to senior. Recognition in the center newsletter and at annual meetings is an intangible but appreciated honor. Finally, nothing replaces the personal recognition and appreciation expressed by the Director and other center managers for a job well done.

2.3.7 Evolving or Restructuring the Management Team

One ticklish area of delegation that should be mentioned concerns perhaps the ultimate delegation, that of the directorship of the center. Succession is an issue that many ambitious executives, in academe as well as business, find difficult to address. If one is performing well and enjoying oneself as a Director, it is perhaps counter-instinctive to make plans to replace oneself. Nevertheless, several ERC Directors have stepped down over the years, and three have passed away, two of them suddenly. As a responsible manager with a major investment of energy and commitment in the center, it is only prudent to provide a viable contingency plan for one's succession and thereby minimize the turbulence that would ensue in the event of the Director's departure. Of those who have established a plan for continuity of leadership, most have appointed a Deputy Director or an Associate Director (often for Research), who will take over the leadership role until a search can be organized to select a new Director (who may or may not be the Deputy). NSF now requires every ERC to have the Deputy Director position.

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[1] See, for example: National Research Council. *The Engineer of 2020: Visions of Engineering in the New Century*. Washington, DC: The National Academies Press, 2004..

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