A Primer for Successful Center Initiation and Operation:

Research Center Considerations

1. Introduction

In today's research environment, much of the advances and discoveries occur at the intersections between technical disciplines. Therefore, opportunities are needed to engage faculty from diverse disciplines to focus on a common research challenge. The research center is an ideal organizational structure for supporting and facilitating multidisciplinary research and education activities. Centers provide the capability to address research problems that extend beyond the scope and resources of single- or several-investigator projects. They do this through ample funding, infrastructure support and industry and government participation. They also bring visibility to the institution and the participating faculty, which can be leveraged to attract additional research funding in the area. The College has a number of outstanding examples of this type of activity.

This primer is intended to provide a brief overview of the rationale and processes for creating externally funded research centers in the College of Engineering (CoE). It describes the many elements and issues that the Principle Investigator (PI) needs to consider in proposing and operating a research center. In addition, using the NSF Engineering Research Center (ERC) as the model, it provides specific guidance on how to initiate a center proposal, detailing the support available to CoE faculty who undertake the development of center proposals.

2. What Constitutes a Research Center?

A university research center can take many forms, depending upon the particular research activity, sponsor requirements, and funding levels. It can be a tightly (or loosely) organized group of faculty/research staff that have come together to conduct research in common or intersecting areas of interest. It can have varying degrees of organizational complexity ranging from a low key industry liaison program to a highly structured NSF Engineering Research Center (ERC). Finally, it may consist of multiple organizations with one of the organizations taking the lead. The more sophisticated research center has the following traits and characteristics:

- Generally supported under a federal agency program
- Greater than five researchers (faculty and research scientists)
- Supports inquiry, e.g., NSF ERCs, but may be mission driven, e.g., DOD centers
- Potentially less individual freedom and flexibility
- Highly multidisciplinary
- Strong emphasis on technology transfer
- Stronger requirement for system integration
- May have a system testing capability or a technology integration demonstration
- Has active participation of industry and/or government personnel
- Formally organized supporting infrastructure

There is an increase in organizational complexity and overhead as one moves from a single PI research activity to a center research activity. This is illustrated in Figure 1.

Perhaps the best description of the key elements that make up a research center is contained in the National Science Foundation's expectations for an NSF Engineering Research Center. Each NSF ERC should have the following elements:

- A long-term strategic vision
  - An emerging engineered system with the potential to spawn a new industry or transform a current industry
  - To strengthen the diversity of US engineering and scientific workforce
- Strategic plans to realize the research, education and diversity goals
- Research program
  - Multidisciplinary, fundamental science and engineering research
  - Advancement of enabling technologies
  - Testbed validation
- Partnership with industry
  - Formulation of research program
  - Cost share requirements
  - Technology transfer (IP, bylaws)
- Education program
  - Curricula
  - Development of ERC culture, i.e., team work and system thinking
- Pre-college (K-12) outreach
- Diversity outreach program

3. Things you need to consider when Initiating a Research Center Proposal

Motivation for starting a center

There are many things that need to be considered when contemplating a research center proposal. The first place to start is with the motivation for a center. Why create a center in the first place and what is the objective of the center? Do the objectives fit the mold of a research center? The following are a list of driving forces for starting a research center.

- You have identified a grand vision
- The field you're in is *intrinsically* highly interdisciplinary (physics, EE, chemistry, materials science, biomedical…)
- A center-level activity is needed to drive the field forward and to realize its potential
- All major players in your field have a center, so you're almost compelled to have a center in order to compete
- You have a highly collaborative environment
- Your concept consists of large experimental systems, permanent staff and multi-PI programs

- The scale of your research is such that single investigator or small group projects are not sufficient to accomplish your goals.

As an example of the attributes of a successful center, the following is Ken Wise's appraisal of the state of microsystems research in the CoE just prior to his team's bid for an NSF ERC:

Faculty and researchers had formed a cohesive group that enjoyed working together. They shared complementary interests in similar technologies. They had proven individual track record, as well as a record of accomplishments as a group (very important). On top of this, they had what they felt was a great topic and challenge to merge MEMS, micropower circuits, and wireless technology. They knew and were able to push the key buttons at NSF in terms of societal impact. The proposal was well articulated and persuasive. The testbeds were well thought out and were aimed at breakthrough developments. They had a good staff and organizational support to underpin the effort. Finally, their program was nearly a perfect match with the NSF mission statement for ERCs. (Ken Wise, WIMS ERC Director)

The proposal process can be arduous and lengthy

However strong a proposal may look at the outset, it's a long haul, up to two years, and the team needs to have the strength, conviction and commitment to endure the process. Below is a chronology of the NSF ERC proposal process for the WIMS ERC

1. College level Pre-Proposal November 1998
2. NSF Pre-Proposal (1 of 89) January 1999
3. NSF Full Proposal (1 of 29) August 1999
4. NSF Site Visit (1 of 7) January 2000
5. Final Panel Presentation March 15, 2000
6. Recommendation for Funding (1 of 2) March 22, 2000
7. Start of Project September 1, 2000

Benefits of conducting research in a center mode

A research center has certain benefits that accrue due to the nature of its mission and structure. They are:

- Center mode of research generates unique opportunities, and an unsurpassed environment for interdisciplinary education
- A stable funding source for long-term fundamental research vs. piecemeal project based contracts/grants
- A grand research program with a system-level strategic vision and plan vs. a collection of disjointed projects
- An environment for multidisciplinary education and research
- A world-class infrastructure to support cutting-edge research activities
- Possibility to establish a new research field
- Impact on education (courses, students, and outreach)
- Potential to transform industrial practice

- Great visibility for student recruitment
- Attraction for industrial sponsors
- Prestige to the college and university

Industry partners also benefit from center participation:

- Provides the opportunity to network with competitors and suppliers on neutral ground.
- In case of federal funding, offers a way to leverage their research contribution.
- Provides a good source of new hires on a "try-before-you-buy" basis.
- Opportunity to try out new codes/equipment
- First look at new technologies and intellectual property

Federal partners benefit as well:

- Excellent leveraging of federal money usually in partnership with industry
- Addresses (typically) broader disciplinary or multidisciplinary research
- Is a stronger "sell" to their bosses than for single investigator programs.
- Simplifies procurement process (as easy to fund a large program as a small one)

There is also a downside to research centers

However, along with the glory come some additional burdens that may tarnish the glamour of a prestigious research center such as an NSF ERC. Faculty are encouraged to carefully consider the following limitations, drawbacks and obligations that come with the glory. If you're not willing to tackle each of the challenges below, you're not ready for a major center.

- Not every faculty member likes to work in a center mode, or has a working style amenable to center-mode research.
- Junior faculty need to use the center as a basis to blaze new trails for which they gain major credit, and yet must exercise care not to use center support as a substitute for getting independent outside support.
- Personal interactions and group chemistry are very important. They can make or break a center.
- A large administrative effort (at times prohibitively large) is required to coordinate research programs across different departments, colleges, and universities
- NSF requirements for reports, site visits, K-12 outreach, diversity, and technology transfer activities place a heavy administrative burden on the leadership team
- A top quality educational program is mandatory.
- In-depth testbed activities are essential. These may detract from basic research activities
- Ten $300k/yr grants are *not* equal to one $3M/yr Center grant. In general, the latitude granted in single PI grants is greater than in a center funding environment

You also need to consider the "end game"

One unique aspect of most federal center programs is that in addition to a beginning, the centers have an end, and the consequences of a finite lifetime need to be addressed before the center

begins. Centers will only be awarded to groups of faculty that have demonstrated success in getting their ideas funded and in attracting both federal and industrial support. Since you had a substantial program going into a center, you will want to ensure that at the end of the center program you still have a base program that can survive and flourish beyond the life of the center. The figure below shows the phases of an NSF ERC during its 11-year lifespan. The message is that you need to plan now for "life after death" (Figure 2).

Is there really a pot of gold at the end of the rainbow?

So, with all the caveats on forming a research center, why go for it? Below is the justification used by a College ERC proposal team in their decision to try for an ERC, that they were subsequently awarded.

- We wanted to make an impact
    - We had no industrial program
    - We were having minimal impact on education
- We wanted to diversify our funding sources
    - Research in microelectronics/MEMS takes $$$
    - Our NIH funding was well advanced in years
    - We didn't trust (or like) DARPA funding
    - NSF represented a largely untapped resource
- We wanted longer-term funding with which to address entire systems

Was it worth it? Here is their assessment 5 years after the initial award:

- Has the ERC made impact in education? *Yes!*
- Has the ERC improved our industrial ties? *Yes!*
- Has the ERC allowed time for longer-range thinking? *No!*
- Has the ERC provided "financial freedom"? *No!*
- Has the ERC made my life more comfortable? *No!*
- Has the ERC allowed us to make greater impact? *Yes!*
- Has the ERC been worth it? *Yes!*

After all, nothing worthwhile is ever accomplished without a struggle. Otherwise it would have been done long ago.

4. Getting Started

If you're still reading, then you've probably decided that the effort is worth it. So, where do you start and what should you expect? The following is a list of conditions that you need to meet in order to be competitive.

- A compelling idea that almost sells itself

- Recognized national leadership in research in your area (as evidenced by MURIs, NIRTs, IUCRCs, etc.)
- A grand vision for your idea
- A critical mass of active faculty in the proposed area
- Strong industry support
- A team of 3-6 people with a vested interest in the success of the concept, and another 10-12 who would be interested in participating
- Dedication on the part of the core group to the center proposal as the highest priority for a semester; practically full-time for the lead PI
- You have already begun to put together the team and the plan and have started on a draft proposal well before the BAA is announced
- The capability to adjust the concept once an appropriate agency and mechanism are identified
- Non-participating colleagues willing to carry out a "team" review of the proposal
- Experienced administrative support, primarily for budget development, secondarily for proposal integration and paperwork

The leadership team should designate one individual to be responsible for each of the major elements of a center proposal such as 1) the technical proposal, 2) budget, 3) educational program, 3) outreach program, 4) industry and technology transfer program, etc. In this way, the faculty leadership is engaged in all aspects of the proposal and the workload is distributed.

Given that you've met the conditions above, what should you expect? That's easy, a one to two year-long "campaign" consisting of meetings, workshops, and company visits to formulate the vision and recruit company members. The College is prepared to assist you….. read on.

5. Assistance with your Research Center Proposal

The CoE recognizes that to be successful with a major center proposal, extraordinary effort is required on the part of the leadership team. Faculty leaders must be knowledgeable and involved in all aspects of a center research proposal; technical program, educational program, industry program, diversity and outreach, etc. However, it is not likely that they will have all the knowledge and talents to assemble the non-technical components of a successful proposal that are so critical to its success. Further, faculty should be encouraged to invest the bulk of their energies into assembling an outstanding technical proposal. To this end, the CoE has developed a support structure for assisting faculty in assembling proposals. The amount of assistance will depend on the opportunity, the strength of the concept and leadership team and the number of proposals competing at one time. In the end, while portions of the proposal preparation may be done by others, it is up to the PI to ensure that all the elements of the center are conceptually and practically integrated. Nevertheless, the following is a summary of the assistance that can be provided to center proposal efforts.

1. *Budget and administration*. The CoE will assign an experienced administrator to assemble the budget and the administrative shell. These are critical elements of any proposal and can consume a significant amount of time and energy. The CoE has assembled a short "Budget Guidance" document (see appendix) to assist the PI and

administrator in setting up a complicated, multi-year budget that is characteristic of center grant proposals. It is also imperative that the PI work closely with the administrator to ensure a successful outcome.

2. *Project management*. The CoE will work with the PI to identify and appoint a project manager who will be assigned to do the legwork for the PI in pulling the various parts of the proposal and budget together. Tasks the project manager would conduct include: chasing down information on co-PIs; biographies, sub-project write-ups and budgets, setting up and adhering to proposal and budget preparation timelines, making contacts with companies that may participate in the proposal, proofreading, etc.

3. *Outreach*. Strong outreach programs are a must for a major center proposal and PIs generally need help in creating these programs. While the outreach activity needs to become an integral part of the Center with substantive faculty participation, the greatest amount of help is needed in creating the outreach program during the proposal preparation process when the PI has multiple demands on his/her time. The CoE has created an Outreach Design Team to provide support to research centers by designing and preparing the outreach component of the center proposal and to help launch the outreach program once the project begins. The team will provide the following to the center proposal leadership:
    o evaluate the specific needs and outreach objectives of the opportunity (e.g., identify sectors of the public that the center wants to reach, identify topics that the center wants to address, etc.)
    o work with project leadership to identify candidate strategies and programs that constitute the outreach activities
    o design an outreach program that is tailored to meet the needs of the project
    o facilitate contact with the communities (K-12, undergraduates, public schools, general public, etc.) that the center wants to engage
    o describe existing outreach programs within the CoE and help coordinate these activities with other activities inside and outside of the CoE
    o provide guidance on NSF's outreach and "broader impact" criteria requirements and limitations
    o help to identify outreach program director candidates
    o provide guidance regarding assessment tools for the program

    Outreach Design Team will be empowered by the center leadership to act on behalf of the center with regard to the outreach component.

4. *Industry Liaison and Technology Transfer*. Involving companies in a participatory or sponsorship role is often required for major center proposals. Also, a program to transfer the technology developed by the center to the private sector is an important element in a successful center proposal. The following individuals, Director for Research Relations, Director for Technology Transfer and Commercialization and the Industry Liaison Director (all from the office of the Associate Dean for Research and Graduate Research, ADRGE) will work with the center leadership to help identify companies and to make connections early in proposal process.

5. *Support from the State of Michigan* is often an important element in leveraging funds from the federal government. The ADRGE will work with the Office of Government

Relations and the Office of the Vice Provost for Research to secure cost-sharing commitments from the Michigan Economic Development Corporation (MEDC). The PI does not need to be involved in this activity other than to provide budget and proposal information to the ADRGE.

6. *Red team reviews*. These reviews are organized by the ADRGE and are conducted by a panel of faculty peers, (from within the sub-discipline of the proposal or with Center proposal or Directorship experience), to evaluate the status of the proposal when it is 4-6 weeks from submission.

7. *Graphics*. Outstanding graphics can help a proposal. The PIs will be provided with access to graphics capabilities in order to write the most competitive proposals.

8. *Best practices*. PIs can benefit greatly by following "best practices" that capture time-tested and successful structures and approaches rather than re-inventing them with each new submission. PIs are encouraged to read the NSF best practices manual for Engineering Research Centers (http://www.erc-assoc.org/index.htm).

6. Proposal Submission and Follow-through

The proposal leadership team has the ultimate responsibility to submit a quality document by the deadline. Because these proposals are highly complex and will require substantial internal as well as external resources, the PIs must begin *far ahead* of proposal deadlines. Figure 3 provides a very rough timeline that should be used as a guide for planning proposal submission.

In addition to the intensive preparation and hard work required to win an ERC, a continuing high level of effort is required after the award is made. Table 1, below, provides a more detailed list of center proposal elements and their timing prior to proposal submission. These are general considerations for a large research center, i.e., an NSF Engineering Research Center. The elements presented in Table 1 should be revised to be responsive to the particular solicitation being addressed.

Appendix A - Budget Guidance Document

After deciding that it is worth the effort to submit a proposal for a major research center, you will need to create a reasonable budget. The following are some recommendations for developing the budget.

- Read and Reread the guidelines. They will state what your maximum request is expected to be and what the sponsor is expecting (and not allowing) to pay for. In addition, certain elements other than research are generally required, e.g. education program, partner institutions, etc. and these must be either explicitly included in the budget or a discussion must appear in the budget explanation page explaining how they will be supported using leveraged funds.
- Keep in mind that non-traditional (including A-21) expenses *are* sometimes permitted. For example, necessary administrative support is an allowable expense and should be included.
- Make sure that the amounts budgeted for various efforts are reasonably balanced. Major center proposals have components not only for research, but education and outreach, industry relations and tech transfer, administration, and possibly more. These can and should be part of the Center proposal, but in reasonable proportion to one another and the total budget. For example, if administration is 50% of the budget - there's a problem.
- Leverage other resources when possible. UROP and SROP can provide undergraduate support in the academic year and summer, respectively. Center supplements are generally available and should be used for REU programs, RET programs, equipment needs, etc. Maximize industry and RIP funds (if appropriate).
- Include reasonable increments for salary, tuition, materials and supplies, and travel. Don't forget to include a larger increase for identified faculty or research scientists if a promotion is expected during the project.
- Sub-awards are fully expected on projects of this type. Generally, the rules for adding sub-awardees after the project is awarded are more relaxed, however, there must be an identified budget for sub-awards. Remember that only the first $25,000 of any individual sub-award (including extensions, etc.) bears indirect costs.
- By the time of submission, the distribution of funds among the faculty/departments (sub-accounts) and RIP funds must have been determined. While it is not a firm agreement per se, should something change before the proposal is funded, the impact could be minimized. Guidelines for "Managing Sponsored Activity with Subprojects" are available from the ADRGE.

Keeping these tips in mind, we have found it helpful to develop a budget which includes your "wish list" for the research center and then to reduce and reallocate, or seek other sources until the maximum permitted by the sponsor is reached (a sample spreadsheet developed for this is available upon request). For example, if you think that 50 GSRA's, 15 faculty, 20 research scientists, 2 administrative staff, 4 post-docs, materials/supplies, travel, 2 sub-awards, etc. is what you'll need, then put it in the budget as a starting point and adjust when you see how far off from the target total you are. Having a "difference from target" in the budget development process has been found to be incredibly helpful. Start high and adjust accordingly.

Remember there will be several iterations before a budget is finalized. As the technical proposal develops it is critical to discuss any potential budgetary impact with the administrator and make adjustments as on the fly.

We have also found that it is helpful to talk with the program director for the agency as well as existing center directors. They are able to provide budget guidance and an estimate of the average breakdown of resource allocations.

This really can be an enjoyable process since these types of proposals are great for open-minded and wide-eyed visionaries! Start early - communicate often!