Section 4.8: Strategies and Lessons Learned

There are several key features of a successful ERC Education Program. The program must be recognized as a critical part of the organization, and this should be reflected in the center organizational chart and budget. Personnel with the appropriate credentials and background must be recruited, and must also be considered part of the center Leadership Team and included in all leadership activities. There are prescribed components of every ERC (e.g. REU, RET, Young Scholars for Gen-3) but centers are encouraged to develop and to adapt these to meet their institutional requirements. Given the 10-year life span of a center under NSF funding, education programs should be dynamic. It is to be expected that NSF's education priorities may shift as new opportunities become available during the lifetime of the center. Centers must be both flexible enough to meet new challenges, and also proactive in identifying new opportunities to make an impact.

ERC students need to go beyond the traditional engineering training by having opportunities for leadership and professional development (for example in innovation, creativity, and global awareness). Center faculty must buy into this and support student's time in these value-added activities outside of lab/research time.

As the ERCs have evolved to date, education program developers and staff have devised a number of strategies and learned lessons that have benefited the centers' education programs. Many of these are summarized below.

4.8.1 Engineering Education Program Planning and Direction

- Funding for education should be consistent with its high priority among NSF ERC program goals. The explicit financial support of the Center Director is crucial.
- In planning an education program, the center must align its vision and goals with the center's strategic plan and objectives.
- The choice of an Education Coordinator/Director will determine the success of the education program. The University Education leader may be part-time but the Precollege leader should be full time. Someone who is interested in mentoring students and working with REU students must be a member of this team. The positions should be viewed as professional, with appropriate flexibility, autonomy, and status.
- An Education Advisory Committee should be established to give center faculty a mechanism to provide input into center education programs and to provide support for them.
- Adequate ERC core funding must be provided to the education program. A collection of supplemental grants alone does not make a coherent program, as not all funding opportunities will fit in the education strategic plan and only those that do fit should be pursued.
- It is prudent to develop an education program in phases that are implemented over several years, beginning with programs for graduate and undergraduate students in the center's home institution(s).
- Strategic planning for education must consider the impact of the 10-year ERC life cycle. As a center "graduates" from NSF support, the Education Program's continuation depends on institutional support (including cash), motivated faculty, commitment to the goals of the education program, and a strong, evolving research program.
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As the center matures, the education budget should include increasing contributions from sources such as industry members, NSF supplemental funding, and private foundations. Opportunities should be pursued to leverage the NSF funds using non-federal ERC funds for matching.

- A strong relationship with the personnel of the NSF ERC Program leadership, and especially with the center's Program Director, will greatly enhance a center's education program.

4.8.2 Students

- ERC faculty and staff should cooperate with the department and college in recruiting graduate students as broadly as possible (such as at professional meetings, by word of mouth with colleagues, and via the internet).
- Financial support for graduate students can be obtained from a wide variety of sources, including grants from NSF, industry, private foundations, and federal and state agencies.
- Outreach to graduate students at institutions that are not part of an ERC can best be obtained by forming collaborations with the faculty and staff of those institutions. Both domestic and international collaborations are vital.
- An important required feature of ERCs is the Student Leadership Council, which gives students a collective voice in the center's affairs and fosters leadership skills.
- Developing a feeling of “centerness” among students at geographically-distributed locations requires planning, regular opportunities to interact, and faculty support for time to do this.
- It is crucial to provide multiple and frequent avenues for students to interact with center industrial partners.
- Opportunities should be provided for students to gain an understanding of engineering in the global context.
- Centers have a mandate to provide students with specific training/experiences designed to help them become the creative innovators and technology leaders of the future.

4.8.3 Curriculum Development

- Establishing a new ERC curriculum is a challenging and complex task, involving coordinating many faculty members in an interdisciplinary research area.
- New degree programs, in particular, require substantial long-term institutional resources and commitment from all ERC partner universities.
- Inserting ERC-developed materials (modules, lectures, etc.) into existing courses is easier than developing new courses and over time can have greater impact.
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Find a vehicle, such as web delivery or a book, for wider distribution of course materials.

- A new minor degree program must be especially well coordinated with the existing academic standards and structures of the university. The key to successful development is to build on student interest and enthusiasm.
- Involve students (undergraduate and/or graduate) in evaluating plans and implementing the new program.

4.8.4 REU Lessons Learned

- Use multiple methods to recruit diverse students into your programs.
- Be highly inclusive—leverage resources at your university (e.g., other REUs, honors programs, etc.), and at partner universities.
- Create strong two-way relationships with your industry membership.
- Search for ways to create community—find a way to showcase undergraduate research results.
- Mentoring is important, so explicitly train your mentors.
- Assessment and evaluation are absolutely critical, and it is strongly advised that you consider partnering with professional A&E teams (internal or external) to develop this. You need to establish the research questions from the onset and ensure that the instruments and analyses you have chosen will allow you to answer your research questions (this includes getting human subjects clearance so that you can publish your results).
- Key point to keep in mind: REU’s must be U.S. citizens or Permanent Residents (green card holders).

4.8.5 Precollege Programs

- Precollege engagement requires professional leadership and substantial resources in order to be effective.
- The precollege program should be included as a key component of the center and the Precollege Director should be included as part of the center Leadership Team.
- Center Directors should schedule regular times to meet with precollege personnel and promote inclusion of the precollege program in center activities.
- In order to promote and sustain a more diverse engineering workforce, the center should strive to create an inclusive and supportive work environment for precollege teachers and students.
- Sustained collaboration is the key to success in this part of the ERC's mission. By working directly with

schools, other ERCs, academic institutions, and companies in collaborative partnerships, ERCs can propagate their successes through first-hand human contact, which is the most effective channel for transferring educational know-how or technology.

- Don’t overlook campus outreach and recruiting professionals who often have budgets and staff, as well as expertise in community college recruiting.
- ERCs' collaborations with K-12 teachers and students are an important contribution to reforming science and math education at the precollege level and expanding the students’ pathways for engineering. Each ERC should determine what precollege offerings make sense in the context of its strategic plan, resources, and community relationships.

4.8.6 Sustainability

Studies and a recent survey of graduated centers have shown that successful continuation of education programming depends on several factors. Attention must be paid to all these characteristics from the outset. They must be nurtured and maintained throughout the life of the center to provide a platform for successful implementation of the strategic plan. Critical factors for successfully sustaining education programs post-graduation include:

- A full time (hard money) person to coordinate activities, who is prepared to seek funding from grants and other sources;
- Strong institutional support, including support for the ERC education culture as well as significant cash or other direct financial assistance (space, dedicated personnel, new department or unit, etc.);
- Champions of the education and preparation of students, both in industry and at the university level;
- Faculty and students motivated to continue and institutional incentives that further this motivation;
- A strong, continuing commitment on the part of center leadership to the goals of an ERC education program;
- Creative ways of packaging program elements that fit the type of activities industry is able and willing to support (i.e., lab training internships, design course support, graduate fellowships);
- A strong, evolving research program;
- Successful securing of alternate funding for education programs, including other NSF and federal agencies, state, industry, foundation, university and community support;
- Research that is able to evolve to remain on the cutting edge;
- Dedicated and paid personnel in place to develop, coordinate, and run the programs but also willing to seek funding from grants and other sources;

- Degree programs (minor, major, certificates) and courses that were established during the NSF-funded years;
- An effective transition strategy that builds on and enhances the center's strengths;
- Broad involvement of faculty, staff, industrial partners and university administration in transition planning;
- Institutional factors—degree of university commitment, whether the center is a prized asset and whether policies are supportive of cross-disciplinary research and education;
- Active industrial support and continuation of industrial membership and Industrial Advisory Board guidance;
- Industry becoming involved in the cost of student training (i.e., funding a training laboratory, supporting short courses that are also used for industry, student fellowships, research assistantships, design course support, and awards); and
- Effective implementation of a realistic transition strategy that builds on and enhances the center's strengths.

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