

# Gen-3 Engineering Research Centers (ERC): Partnerships in Transformational Research, Education, and Technology

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## PROGRAM SOLICITATION NSF 13-560

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### REPLACES DOCUMENT(S): NSF 11-537

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National Science Foundation  
Directorate for Engineering  
Engineering Education and Centers

**Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):

May 30, 2013

**Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. proposer's local time):

July 30, 2013

**Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):

February 12, 2014

## IMPORTANT INFORMATION AND REVISION NOTES

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**Awards under this ERC Solicitation:** Awards may be made as Open Topic ERCs and/or Nanosystems ERCs (NERC). The actual number of each type of ERCs funded will depend on the scale and scope of the proposed centers, the availability of funds, and the quality of the proposals submitted. Unless otherwise noted in the solicitation, the term ERC will refer to both types of centers.

**Cost Sharing:** Cost sharing is required. However, inclusion of "voluntary committed cost sharing" is specifically prohibited in NSF's revised cost sharing policy, as stated in the NSF [Proposal and Award Policies and Procedures Guide](#). ERC proposals that include cost sharing amounts in excess of the specified formula described in this solicitation will be returned without review.

### ERC Solicitation Revision Summary

**Revisions in Gen-3 Key Features:** The solicitation contains revisions in the Gen-3 key features regarding the educational hypothesis, pre-college education partnerships, translational research in partnership with small firms, intellectual property, laboratory safety, and foreign partnerships.

**Proposal Submission:** Proposers must indicate which one of the two types of proposal submission tracks (Open Topic or NanoSystems), selecting only one, to which their Letter of Intent (LOI) and any subsequent proposal are being submitted.

**Preliminary and Full Proposals:** A brief seven page preliminary proposal will be submitted and reviewed. A full 25 page proposal may be submitted by invitation only after the review of the preliminary proposals is completed. The submission of the full proposal can be made only by the lead institution designated in the preliminary proposal. The full proposal page limit differs from the GPG limit (15 pages) and the prior ERC solicitation - NSF 11-537 (40 pages).

**Webinar:** The NSF ERC team is holding a webinar approximately one month after the release of the solicitation. In the webinar, key features and expectations of Gen-3 ERCs will be discussed. Participants will have an opportunity to ask questions after the presentation, during the webinar session. FAQs will be posted as needed.

**Feedback from NSF:** A proposing team may meet with ERC Program staff, via teleconference, only once during the preliminary proposal preparation phase, but only when the team's 3-plane strategic research plan chart is ready for NSF feedback. No further meetings with NSF staff will be allowed during the competition. To arrange this teleconference, send an email to [lpreston@nsf.gov](mailto:lpreston@nsf.gov) requesting the teleconference. Please include in the email, not as an attachment, a brief statement of the engineered systems vision of the ERC with sufficient detail to understand the research focus.

## SUMMARY OF PROGRAM REQUIREMENTS

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### General Information

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#### Program Title:

Engineering Research Centers (ERC)  
Partnerships in Transformational Research, Education and Technology

## Synopsis of Program:

The goal of the Generation Three (Gen-3) Engineering Research Centers (ERC) Program is to create a culture in engineering research and education that integrates discovery with technological innovation to advance technology and produce graduates who will be creative U.S. innovators in a globally competitive economy. These ERCs are at the forefront as the U.S. competes in the 21st century global economy where R&D resources and engineering talent are internationally distributed. Recognizing that optimizing efficiency and product quality are no longer sufficient for U.S. industry to remain competitive, these ERCs integrate transformational academic engineering research and education to stimulate increased U.S. innovation in a global context.

The ERC is motivated by an engineered systems vision and structured by a strategic plan that defines a research program to address barriers in the way of realizing the vision. The strategic research plan structures an integrated program of fundamental and applied research that feeds into proof-of-concept enabling and systems technology test beds.

The ERC education program is comprised of a university program and a pre-college program. The university education mission of an ERC is to prepare students for effective practice in industry and to enhance their capacity for creative and innovative leadership throughout their careers. The pre-college education mission rests on long-term partnerships with K-12 institutions to expose teachers to engineering and deliver engineering concepts and experiences to their classrooms to stimulate student interest in engineering careers. The interface of the research and the educational culture of the ERC enriches the participating universities through the transfer of ERC-generated knowledge into engineering curricula.

Surrounding this research and education culture is the ERC's innovation ecosystem, which is important for translating center advancements into actual adoption or use for U.S. competitive advantage. The innovation ecosystem of Gen-3 ERCs is achieved through a symbiotic relationship between the center researchers, industrial and practitioner members, and partner organizations devoted to stimulating entrepreneurship and innovation.

The ERC research and education culture, together with its innovation ecosystem, are developed by a team of faculty, students of all levels, and staff who share the ERC's vision. They come from different disciplines and perspectives on research, education, and technological innovation, and they include the rich perspectives offered by diversity in gender, race, ethnicity, and other demographics.

In essence, this solicitation requires that effort be devoted to creating, developing, and enhancing capacities in ERCs to support the spectrum from transformational fundamental research to technological innovation and create pathways to success in engineering careers for diverse cadres of students from middle school to graduation with degrees in engineering.

Proposals are solicited in two tracks: (1) Open Topic ERCs, where the PI's are free to structure the engineered systems vision and research program without restrictions on the research content and (2) Nanosystems ERCs (NERCs), where the PIs are free to structure the engineered systems vision but the research program must include a substantial body of nanoscale fundamental research.

For information on individual ERCs and their achievements, go to [ERC-assoc.org](http://ERC-assoc.org).

## Cognizant Program Officer(s):

*Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.*

- Lynn Preston, telephone: (703) 292-5358, email: [lpreston@nsf.gov](mailto:lpreston@nsf.gov)
- Deborah J. Jackson, telephone: (703) 292-7499, email: [djackson@nsf.gov](mailto:djackson@nsf.gov)
- Carole Read, telephone: (703) 292-2418, email: [cread@nsf.gov](mailto:cread@nsf.gov)
- Keith Roper, telephone: (703) 292-8769, email: [kroper@nsf.gov](mailto:kroper@nsf.gov)

## Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.041 --- Engineering

## Award Information

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**Anticipated Type of Award:** Cooperative Agreement

**Estimated Number of Awards:** 4

Up to 4 of any combination of Open Topic ERCs and/or NERCs, depending on quality of the proposals and availability of funds, with a start date targeted for Summer 2014.

**Anticipated Funding Amount:** \$13,000,000

\$13,000,000 to support the first year for up to four newly funded centers, depending on availability of funds in FY14.

It is anticipated that the awards would be made in the summer of 2014. The initial award would be for five years, with year one start-up budgets each of up to \$3,250,000. Subsequently, there would be year two budgets of up to \$3,500,000, year three budgets of up to \$3,750,000 and years four and five budgets of up to \$4,000,000 each, pending satisfactory annual performance and availability of funding. Pending performance and the outcome of two renewal reviews in the third and sixth year, support for years six through eight is projected to be up to \$4,000,000 in each of those years; and support for year nine and ten would be phased down at a reduced level of 33% of the prior year's support to prepare the ERC for self sufficiency from ERC program support at the end of 10 years.

## Eligibility Information

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## Who May Submit Proposals:

Proposals may only be submitted by the following:

- **Organization Limit:**

Proposals may only be submitted by the following:

Only U.S. universities with undergraduate, masters, and doctoral engineering programs with the breadth and depth appropriate to support the center's vision may submit proposals as the lead university. The lead university submits the proposal, and the award is made to the lead university. Support is provided to the partnering universities and any affiliated faculty from non-partner institutions through subawards.

A University that, by October 1, 2014, has two funded ERCs from the Classes of 2006 through 2010 and the NERC Class of 2012 may not submit a proposal in the lead role. However, the university can participate as a partner in an ERC led by another eligible institution serving in the lead role.

### Other Organizational Requirements:

**Invited full proposals must meet all of the following organizational requirements or they will be returned without review:**

- A proposed ERC must be multi-institutional, with a lead university and no more than four additional domestic university partners;
- To qualify as a partner institution, there must be a minimum of three faculty participating in the ERC along with at least a total of three students;
- The lead or one of the domestic partner universities **must** be a university that serves large numbers of students from groups that are predominantly underrepresented in engineering in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, or persons with disabilities who are U.S. citizens or Permanent Residents of the U.S.) who are studying in STEM fields;
- Commitment to include, **in the full proposal** or in the future, collaborations with foreign faculty to enable U.S. students to have an opportunity to carry out research in their laboratories;
- Commitments from domestic lead and partner universities for cost sharing, as instructed below;
- Firm and/or practitioner fee-paying members of the center are required. These intended memberships must be documented in letters of commitment as part of **the full proposal** (See "Supplementary Documents");
- Innovation partners, such as university and/or state and local government organizations devoted to promoting innovation and entrepreneurship, are required. These partners are not required to be fee-paying members of the center. However, they are to document their commitments in letters to be submitted with **the full proposal** (See "Supplementary Documents");
- Pre-college education partners are required. Letters documenting these intended commitments are required as **part of the full proposal** (See "Supplementary Documents").

The following organizational features are **not required** but may be proposed:

- The ERC **may** include as affiliated organizations, institutions participating in research and/or education programs, such as: (1) Federal Laboratories (although NSF funds may not support the participation of staff of these laboratories in the Center); and/or (2) universities or colleges that are contributing affiliated faculty in groups of less than three;
- To increase the impact of the ERC on the technical workforce, the ERC **may** partner with community colleges and or technical colleges.

### Other organizational guidance:

- If the Lead PI (Center Director) departs the university or decides to transfer to another university during the review process or after an award is made, the proposal/award remains with the lead submitting university;
- The lead university cannot change after submission of the Letter of Intent;
- The partner universities may change after the invitation to submit a full proposal. However, NSF must be notified of any changes within one month of the date of the invitation.
- A lead university can receive only one award through this solicitation. There is no limit on the number of ERC partnerships a partner university can join.

## Who May Serve as PI:

The Lead PI (Center Director) must be a tenured faculty member in an engineering department/school of engineering at the lead university. The Director's doctoral degree must be in engineering or an associated field of science; if the latter, she/he must have substantial career experience in engineering as evidenced by a primary appointment in an engineering department/school of engineering at the lead university.

### Limit on Number of Proposals per Organization:

None Specified for Preliminary Proposals.

Full Proposals may be submitted only by invitation and only by the lead university designated in the preliminary proposal.

### Limit on Number of Proposals per PI or Co-PI: 1

A PI may be identified as Center Director on only one proposal and may not propose in any other role in any other ERC proposal.

A Co-PI on one proposal can also participate in other proposals.

## Proposal Preparation and Submission Instructions

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### A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **Preliminary Proposals:** Submission of Preliminary Proposals is required. Please see the full text of this solicitation for further information.
- **Full Proposals:**
  - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=gpg](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg).
  - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)).

## B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is required. Please see the full text of this solicitation for further information.
- **Indirect Cost (F&A) Limitations:** Not Applicable
- **Other Budgetary Limitations:** Other budgetary limitations apply. Please see the full text of this solicitation for further information.

## C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):  
May 30, 2013
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. proposer's local time):  
July 30, 2013
- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):  
February 12, 2014

## Proposal Review Information Criteria

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**Merit Review Criteria:** National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

## Award Administration Information

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**Award Conditions:** Standard NSF award conditions apply.

**Reporting Requirements:** Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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## I. INTRODUCTION

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The Generation-3 (Gen-3) Engineering Research Centers (ERC) program builds on the achievements of two previous generations of centers funded between 1985 and 2006. At the request of the White House and the National Academy of Engineering, the ERC program was established in 1984 to: (1) develop a new interdisciplinary culture in engineering research and education in partnership with industry to strengthen the competitiveness of the U.S. and (2) educate new generations of engineers who would be capable of integrating fundamental knowledge across disciplines to advance systems-level technology.

The first two generations of ERCs functioned through sustained partnerships with industry and practitioners. In fact, about 85% of these centers are self-sustaining after ERC Program support has expired. These partnerships brought knowledge of industrial and professional practices to academe and streamlined the translation of the ERC research into useful products, processes, and services. These partnerships have educated thousands of ERC engineering graduates who have proven to be highly effective in advancing technology in industry.

In 2007 a new model for Gen-3 ERCs was developed to further strengthen the capacity of U.S. industry and the engineering workforce in an increasingly competitive global economy. In 2011 this model was extended to Nanosystems ERCs (NERCs). The Gen-3 model rests on the systems driven ERC research culture that integrates research and education as well as academic and industrial perspectives. In addition, the Gen-3 model enhances this platform through increased emphasis on translational research. Objectives of Gen-3 centers are to accelerate the use of ERC-generated technology; add educational experiences in entrepreneurial training, innovation, and creativity; build long-term pre-college partnerships to attract more students to engineering; and encourage foreign collaborations to give ERC students the opportunity to experience a foreign laboratory research culture.

## II. PROGRAM DESCRIPTION

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### A. Goal and Key Features of Generation Three (Gen-3) ERCs

The goal of the Gen-3 Engineering Research Centers Program is to create a culture in academia that (1) links scientific discovery to technological innovation and (2) produces engineering graduates who will be highly effective in industrial practice and creative innovators in a global economy. This culture evolves through a platform of transformational research and education programs in partnership with industry and other practitioners. The ERCs awarded through this solicitation will function with the Gen-3 goals and the following key features:

- Guiding strategic vision that joins fundamental, enabling technology, and transformational engineered systems research to innovation;
- Guiding strategic vision for developing an innovative, globally competitive, and diverse engineering workforce;
- Strategic plans that motivate and guide the research, education and diversity programs to achieve these visions;
- Cross-disciplinary research program designed to support systems motivated fundamental and applied research and enabling and systems technology, demonstrated in academic-scale proof-of-concept test beds;
- University undergraduate and graduate education programs strategically designed to produce graduates who are creative, adaptive, and innovative with knowledge about industrial practice, technology advancement, entrepreneurship, and innovation;
- Long-term pre-college partnerships to bring engineering concepts and experiences to the K-12 classroom and increase enrollment in college-level engineering degree programs;
- Innovation ecosystem to bring industrial/practitioner perspectives to the ERC and accelerate the use of ERC-generated technology in industry and practice.

**These ERCs require the following infrastructure to succeed:**

- Multi-university configuration, with complementary expertise and skills, comprised of an eligible lead U.S. university and no more than four domestic partner universities, one of which serves large numbers of students who are from underrepresented groups and majoring in STEM fields;
- Capable and diverse leadership, faculty, and student teams committed to the vision;
- A culture of inclusion that promotes success for faculty, students, and other participants from all backgrounds;
- Leadership, financial, and management systems to develop, operate, and sustain the ERC during its NSF-funded life and beyond;
- Effective cross-institution collaboration among faculty and students through shared resources (e.g., shared data, experimentation, simulations, and test beds) and shared programs of education, enabled by cyberinfrastructure;
- Collaborative partnerships with foreign faculty;
- A partnership with industry/practitioners governed by a center-wide membership agreement and a center-wide intellectual property policy to accelerate technology transfer and innovation;
- Effective academic policies that sustain and reward the cross-disciplinary, global culture of the ERC, its goals for technological innovation, and the role of its faculty and students in mentoring and pre-college outreach as well as in providing a safe research environment;
- Financial and in-kind cost sharing support from the domestic lead and partner universities plus membership fees from industry/practitioner organizations members to augment NSF support.

### B. Guidance Regarding Gen-3 Key Features

A Gen-3 Engineering Research Center is a significant undertaking that requires persistent commitment over the 10 years of NSF support. This effort includes striving toward a well-defined engineered-systems vision; forming a strong leadership team and collaborative partnerships; developing and executing a comprehensive strategic research program; crafting an effective education and research training program; establishing an industry- and practitioner-friendly innovation ecosystem; managing a supportive infrastructure; and nurturing an inclusive culture.

Since the Gen-3 ERCs have not operated long enough to develop a time-tested set of best practices for the features that are unique to these Centers, NSF expects each proposing team to develop new modes to effectively realize the Gen-3 key features. Best practices for Gen-2 ERCs are a useful starting point regarding the core features shared by both Gen-2 and Gen-3 ERCs. They can be found in the "Best Practices Manual" at [http://erc-assoc.org/best\\_practices/best-practices-manual](http://erc-assoc.org/best_practices/best-practices-manual). Faculty, staff, and students from ongoing funded Gen-2 and Gen-3 ERCs developed this manual, and they update it periodically. For the features of the

ongoing Gen-3 ERCs and the new FY 2012 Class of NERCs, see the list of centers at <http://www.erc-assoc.org/centers> and follow the links to each individual ERC's page, which includes a link to the ERC's website.

## 1. Systems Vision.

**1.a. General Vision Guidance:** A ten-year vision must drive advances in an emerging and potentially revolutionary or a transformational engineered system(s) that may significantly change current practices, establish entirely new industries, or transform public sector services or the infrastructure. The systems vision will provide an opportunity for increased national economic competitiveness or contribute to the solution of a major societal problem that has a national, and perhaps an additional international, impact. The vision also must be positioned at the cusp of emerging discoveries in science and engineering and must be expansive in scope to include innovation goals. If relevant to the technology proposed, there must be awareness of and compliance with the International Traffic in Arms Regulations (ITAR) and Export Administration Regulations. Refer to Section V.A (4.b) "Vision and Rationale for the ERC" for more details.

### What is an engineered system?

An engineered system is a combination of components/elements that work in synergy to collectively perform a useful function. The engineered system could, for example, wholly or in part constitute a new technology for a new product line. It could lead to new manufacturing processes. It can transform public sector services or infrastructure systems. Part of the complexity of engineered systems research derives from integrating factors that represent their use in products or services - factoring in their impacts on manufacturing efficiency, service delivery efficiency, the environment, society, or the human body, as appropriate to the system chosen. While fundamental, high risk/high reward research on one or more of the enabling components/elements may be required to realize the functionality of the system, focus on the individual components/elements without their integration into an engineered system is not appropriate for an ERC.

**1.b. Vision Topic Area:** Up to four awards will be funded in the following proposal submission areas, and there is no preference for the number of awards in either area.

**NOTE:** The same proposal cannot be submitted in both the Open Topic ERC and NERC tracks. In addition, a proposal with the same (or similar) vision as one submitted to one track cannot be submitted to the other track, even if the research program is changed to increase or decrease the emphasis on nanoscience and nanoengineering research.

**Open Topic ERCs:** An open topic ERC must be motivated by a vision for a transformational engineered system that could not be achieved without a significant level of fundamental knowledge that feeds into devices, components/elements, and/or processes supporting the system(s). There is no preference for engineered systems topics. However, the topic must not overlap significantly with an existing ERC or graduated ERC.

**Note:** While the engineering education is recognized as a complex system, transformations in this domain are currently being explored through other funding frameworks.

**Nanosystem ERCs:** A Gen-3 Nanosystem Engineering Research Center (NERC) must be focused on a transformational engineered system(s) that could not be achieved without a significant level of fundamental knowledge of nanoscale phenomena that feeds into devices and components needed to realize the targeted engineered system(s). NERCs will be supported in emerging areas of nanoscale science that are ready to feed into proof-of-concept engineered system test beds within the 10-year life span of support.

The NERCs will be a part of the National Nanotechnology Initiative (NNI); information about the NNI is available on the NSF web site: <http://www.nsf.gov/nano>. The NNI is a government-wide activity designed to ensure that investments in this area are made in a coordinated and timely manner and to accelerate the pace of revolutionary nanotechnology discoveries. A long-term view for nanotechnology research and education needs is documented in the 2010 NSF/WTEC report, "Nanotechnology Research Directions for Societal Needs in 2020," which is available on the same NSF website.

**For NERC proposals only,** the vision must require a significant body of new fundamental nanoscale research and also should build effectively on relevant findings from extant nanoscale research. Open topic ERCs also may require new nanoscale research and rest on some extant nanoscale research; however, that research is not a significant and overriding component of the research program.

**1.c. Value Added of the Proposed Vision:** The vision of the proposed center must be uniquely transformative. Thus, it must represent a clear departure and improvement over the state-of-the-art and not just an incremental improvement. It must not be duplicative of other funded centers or programs. Specifically, if:

- The state-of-the-art analysis reveals that a significant fraction of the ten-year time frame would be spent on basic/fundamental research before enabling and systems technology research and proof-of-concept test beds could be undertaken, then the vision is not appropriate for this program;
- The state-of-the-art analysis reveals that the proposed vision will add only incremental value and not transformational value, the vision should be redefined or the proposal should not be submitted;
- The proposed engineered system is relevant to the research mission of another Federal Agency or another NSF centers program, then the vision section of the proposal must include a justification of the value added by the proposed center over the project/centers already funded by that agency or called for in solicitations from those agencies already released at the time of submission of the full proposal;
- The proposing team is derived largely from the team involved in a graduated NSF or other agency-funded center or one that would have graduated from NSF or other agency support by the time the center would be funded, then the vision must be significantly different to warrant an additional NSF investment and the value added of the vision must be justified;
- The vision overlaps the visions of current or graduated Nanoscale Science and Engineering Centers (NSEC), NERCs, ERCs or other centers supported by NSF or other Federal agencies or state governments. Then the vision chosen must be significantly different to warrant an additional NSF investment. In those cases, the difference must be specifically addressed.

**Descriptions of Ongoing ERCs and other NSF Funded Centers:** Access to the web sites for ongoing ERCs can be found at <http://www.erc-assoc.org/centers>. Descriptions of other NSF-funded centers where engineering research plays a significant role, such as Industry/University Cooperative Research Centers (IUCRC), NSECs, Science and Technology Centers (STC), Science of Learning Centers (SLC), and Materials Research Science and Engineering Centers (MRSEC), can be found by searching the NSF website at <http://www.nsf.gov/>. Nano-related centers supported by NSF and other federal agencies can be found at <http://www.nano.gov/centers-networks>.

## 2. ERC Configuration.

The core configuration of an ERC is a lead university plus up to four domestic partner universities. These institutions must be selected based on the value they add to the overall mission of the center. In addition to this core, a center must collaborate with



foreign faculty researchers throughout the duration of the center, as appropriate, to add a global perspective to the research and/or education agenda. Finally, partnerships with industry/practitioners, partnerships with state and local government and/or academic organizations devoted to entrepreneurship and innovation, and K-12 entities are required. Optional partners include affiliated individual researchers at other institutions.

**2.a. Domestic Partner Universities:** The number of domestic partner universities is limited to the lead university plus one to four additional domestic partner universities as defined in the "Eligibility, Organization Limit" section above. This does not imply that to be competitive, the proposal must include five partners; however, a configuration of one lead and no partner universities is not acceptable. To qualify as a partner institution, there must be a minimum of three faculties participating in the ERC along with at least a total of three students.

The lead or one of the domestic partners must be a university that serves large numbers of underrepresented minority students who are majoring in STEM fields AND are from collective groups underrepresented in engineering in the U.S. (i.e. African Americans, Pacific Islanders, Native Americans, Hispanic Americans, and persons with disabilities who are U.S. citizens or Permanent Residents). For example, a university may qualify as an ERC underrepresented minority-serving partner if there is a significant combined percentage of African American and Hispanic students engaged in Engineering studies, but the percentage is less than required by the Department of Education's official classifications of universities with significant populations of underrepresented minority groups. The proposal will have to justify the selection with data (See Sec. V.A. (4.f.1)). Consequently, this approach expands the set of universities eligible to be an ERC partner university. The Department of Education's official classifications of universities with significant populations of underrepresented groups can be found at: <http://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html>.

The lead and each of the partner universities must be committed to an integrated configuration to fulfill the research, university and pre-college education, innovation, and diversity goals of the ERC.

**2.b. Affiliated Domestic Institutions (Not Required):** While not a required feature, the inclusion of faculty/staff from non-partner affiliated institutions may provide needed expertise on a temporary basis in the first year and as the center evolves. These institutions may be universities, colleges, and/or federal laboratories. The number of faculty/staff in this category should be kept to a level to reduce management complexity of the center, while achieving overall objectives. The contributions of these affiliated faculty or federal laboratory personnel may be in research, education, and/or innovation. These individuals are not required to have a long-term commitment to the ERC. These institutions are not considered partners and are not required to cost share. NSF funds cannot be used to support staff from federal laboratories who participate in an ERC.

**2.c. Foreign Collaborations (Required):** One of the goals of the ERC Program is to provide an opportunity for domestic students and faculty to collaborate in a globally connected university research and education environment. Thus, the ERC will establish, over time, a set of collaborations between ERC faculty and faculty in foreign universities that include student involvement in research. These collaborations also may be with researchers in foreign institutes who engage in a pre-competitive research, as opposed to foreign institutes supported to advance new product development.

These partnerships may be formally established between the ERC and a foreign university through a Memorandum of Understanding (MOU), for example, or they may be less formal ERC faculty-to-foreign faculty collaborations. In either case, the Gen-3 ERC must ensure that the foreign collaboration adds value to the research and also offers the ERC students the opportunity to work in a foreign laboratory for a mutually specified period of time. It is essential that the student spend sufficient time in the foreign laboratory to have a meaningful international research experience that is relevant to the student's research in the ERC. In both cases, there should be mutually protective Intellectual Property (IP) policies.

These collaborations are not expected to be in place in the proposal; rather they are expected to evolve over time as the research program evolves.

**2.d. Other Required Partnerships:** The ERC also will include pre-college educational institutions to bring engineering concepts to the classroom and stimulate student interest enrolling in college-level engineering degree programs and in engineering careers. In addition, there may be partnerships with community and/or technical colleges to strengthen the technical workforce and stimulate interest in careers in engineering.

The ERC also will develop membership partnerships with firms and other practitioner organizations, as well as with university and / or state and local government organizations devoted to innovation and entrepreneurship. See Sections II.6. and II.7. for more information on these partnerships.

### 3. Research Program.

Because of the ERC construct, the research program is driven by the goals, outcomes, and challenges to meeting the engineered systems vision of the center. Hence, the vision drives the fundamental research that must be done. The ERC research program merges the fundamental research culture of academe with the systems culture of industry, and the proposing team and their universities must understand and embrace this mindset and facilitate it. Deliverables include both long-term contributions to fundamental knowledge and technology and nearer-term results to meet industry's impending needs. The research program is cross-disciplinary, encouraging teaming between faculty and students of different laboratories and disciplines.

**3.a. Research Strategic Plan:** An ERC must have a strategic research plan motivated by the engineered systems vision and positioned to advance the state of the art in research, technology and innovation. The objectives of the strategic plan are to define: (1) the characteristics/ requirements of the system and how it is expected to function; (2) the barriers in the way of realizing the vision through analysis of the state-of-the-art and practice; (3) a critical path of fundamental, enabling, and systems technology research as well as proof-of-concept test beds to explore and test the technology and translational research; (4) the human and physical capital resources needed; (5) the equipment and facilities needed; and (6) metrics for measuring progress toward final completion of individual projects.

The strategic planning process begins with a thorough analysis of the state of the art and gaps in the field the ERC will address. The purpose is to appropriately position the ERC within the context of the state of the art. For NERCs, the process would include the determination of the barriers that must be addressed through a significant body of fundamental nanoscale research, plus issues that arise from scale up to longer length regimes as needed to achieve the enabling and systems level test beds.

See the strategic plan section of the proposal format section (V.A.4c) for the required components of that analysis and the resulting plan. The planning process involves the development of a framework for delivery of the research milestones within and across the research thrusts and into the test beds.

The ERC's strategic plan is dynamic over time and will evolve with the progress of the Center and the field. Since the focus will be on emerging, highly speculative technological opportunities, the ultimate implementation at the systems level may be uncertain at this time. Nevertheless, initial systems goals and requirements, specific knowledge gaps, technology goals and deliverables, and preliminary technical/societal/regulatory barriers to achieving these goals should be identified, understanding that they will evolve in

depth and sophistication over time.

The strategic plan includes the ERC's human capital. The ERC team will include faculty, students, and staff who come from different disciplines and perspectives on research, education, technological innovation, and administration and who also bring the rich perspectives offered by diversity in gender, race, ethnicity, and other demographics. The student team will include graduate and undergraduate students engaged in research during the academic year at a ratio of two graduate students to one undergraduate student.

Finally, the strategic plan includes a plan for the equipment and facilities that will support the research program as well as a timeline and metrics to ensure successful progress of the individual projects.

**3.b. Research Program:** ERC research programs are organized into a set of "thrusters" and test beds that together comprise a coordinated approach to achieving the center's major engineered systems goals. Projects are designed to address the barriers to achieve the goals of each thrust. Thus, the research thrusts should be tailored to warrant NSF support while being strategically relevant to meeting the center vision. Synergies within and across thrusts are necessary to achieve the goals of the ERC, and test beds play a critical role in integrating the research and exploring the realities of enabling and systems-level technology. NERC research plans will include a substantial body of new nanoscale research needed to address the barriers in the way of advancing the chosen enabling and systems technology. It would also include applications of known nanoscale research findings.

It should be understood that ERC test beds are expected to go beyond the typical bench or laboratory scale, but they are not expected to approach the product and process realization stages found in industry. Rather their role in an ERC is for proof-of-concept to explore the technology and streamline technology transfer. Often, these test beds generate new research directions when barriers are more difficult to surmount than anticipated. As the technology progresses from the proof-of-concept phase, industry would be expected to support the scale-up.

Care should be taken to assure that each research thrust is designed to form cross-disciplinary collaborations between the best faculty and students from the different partner institutions to support the thrust's role in addressing the center's vision. The research program must not devolve into a collection of projects or thrusts at geographically separate institutions with little integration.

In determining the team to carry out the research program, the proposing Center Director and Thrust leaders will have to manage some of the faculty who may advocate their own research interests whether they are relevant to the strategic plan. Some will understand the opportunities offered by the ERC construct to increase the complexity and connectivity of their research and contribute to shared goals and others will not. The latter should not be included on the team.

**Note:** NSF funds may not be used to support clinical trials. If the research involves vertebrate animals, an Institutional Animal Care and Use Committee (IACUC) approval for vertebrate animal research must be included in the proposal. If the research includes human subjects, an Institutional Review Board (IRB) approval must be included in the invited full proposal as well.

#### **4. Engineering Workforce Development (Education) Program.**

The primary objective of the comprehensive ERC Engineering Workforce Development (EWD) program is to address the second goal of the ERC program; that is, to produce graduates who will be creative U.S. innovators in a globally competitive economy. To that end, the EWD program includes not only university-level education strategies but also strategies that attract pre-college and non-traditional students to engineering careers.

The EWD program will include assessment to monitor progress and impacts over time and to improve the program as needed. (Note: Because of this type of process, an Institutional Review Board approval for research involving human subjects must be included in the proposal).

**4.a. University Education Program:** The ERC will have a strategically designed university education program focused on instilling in its undergraduate and graduate students the capacity for effective industrial practice, creativity, and innovation. The primary goal is to deliver graduates to industry who are technically prepared, able to integrate knowledge across disciplines to advance technology, knowledgeable of industrial practice, experienced in advancing technology, adept at working in highly functional teams, and effective communicators. An additional goal for Gen-3 ERCs is to deliver graduates who also are creative, innovative, and entrepreneurial and are experienced working in non-U.S. research cultures.

Given this guidance, the proposing team should determine the key characteristics and skill sets its undergraduate and graduate students will possess upon graduation. Then the Center should strategically design a set of programs, research training, and other experiences for their students to acquire these desired characteristics/skill sets. The ERC's foreign collaborations will serve as the basis for the overseas laboratory experiences for the students.

In addition, the university education program impacts the curricula at the lead and partner universities. Based on the center research, new courses and course modules/content for insertion in existing courses are developed. Although not required, the ERC eventually may design and deliver a new degree program and/or certificate programs. If a NERC or an open topic ERC develops nanoscience and nanoengineering courses, course modules, lectures, etc. suitable for hosting on the cyber platform (<http://www.nanohub.org/>) of the Network for Computational Nanotechnology (NCN), those materials will be delivered to the NCN, where a broader community will have access to them in an open source mode for educational purposes.

The university education program will be carried out in collaboration with the ongoing education programs of the domestic partner universities. The program must be structured to involve ERC engineering and associated discipline students at the B.S., M.S. and Ph.D. levels and must be carried out in coordination with the center's Research Experiences for Undergraduates (REU) programs. The ERC is also encouraged to coordinate university education programs with appropriate outreach to local community colleges for broader impact.

**4.b. Pre-college Education Program:** The goal of the ERC pre-college education program is to stimulate student interest in engineering careers and increase the diversity of domestic students studying engineering at the college level. The program will form long-term partnerships with up to five pre-college institutions (i.e., school districts or individual schools). These institutions must agree to work with the center to (1) allow their STEM teachers to participate in structured ERC research and education programs; (2) provide engineering learning and activity experiences for their students; (3) integrate new course modules based on ERC research into their curriculum; (4) develop strategies to embrace underrepresented groups, both teachers and students, into these engineering experiences; (5) enable talented high school students to pursue research experiences in the ERC's laboratories through a Young Scholar program.

Through innovative teaching methods and inquiry based-learning enabled by the ERC, these pre-college teachers can inform pre-college students about the excitement of engineering and technological innovation in order to stimulate them to choose engineering degree programs in community colleges, colleges, and universities.

Community college and/or technical college faculty and students also may be included in center activities to strengthen the skills of



the technical workforce and stimulate some of these students to pursue B.S. degrees and beyond in engineering. However, their participation is not required.

It is expected that the ERC's faculty and students will participate in the full scope of the pre-college education program and that their mentoring efforts will be recognized and rewarded by their home institutions.

## **5. ERC Innovation Ecosystem - Industrial/Practitioner Members and Innovation.**

A Gen-3 ERC's innovation ecosystem rests on a membership-based partnership with firms and practitioner organizations across the value chain relevant to the vision of the center, a highly effective construct developed over the past 25 years in ERCs. Active engagement of member firms / practitioner organizations through the research program, student internships, and the employment of ERC graduates in industry and other practitioner organizations are the main mechanisms to accelerate transfer of ERC research to industry and other users. In addition, member-supported sponsored research projects play a key role in speeding the transfer of technology to industry and other practitioners.

The Gen-3 ERC expands the traditional ERC construct to promote the following additional features:

- Opportunities for large member firms or small member or small non-member firms to develop IP generated by the ERC, if the ERC member firms exercise their first right of refusal to license this IP; and
- Partnerships with university and/or state and local government organizations whose role is to facilitate entrepreneurship, innovation, and economic development at the local level.

The Gen-3 ERC innovation ecosystem is comprised of the ERC Industrial / Practitioner Advisory Board (IPAB), with a guiding IPAB Membership Agreement, as well as Facilitators of Entrepreneurship and Innovation plus Technology Transfer / Translational Research Partners.

### **5.a. Industrial/Practitioner Advisory Board (IPAB):**

The ERC operates with an Industrial / Practitioner Advisory Board (IPAB) involving all of its industry / practitioner members. The IPAB is the key mechanism for industrial/practitioner pre-competitive collaborative research with the center. The members provide guidance on strategic planning, research opportunities, education-related activities, and the role of innovation within the center.

Its membership is strategically designed to include key firms in the value chain relevant to the ERC's vision in order to optimize innovation and accelerate commercialization. As appropriate to the vision of the ERC, practitioner organizations, such as service delivery agencies or hospitals would be important members.

The ERC's industrial / practitioner membership program is fee-based. The industry / practitioners contribute financial and in-kind support to the Center. In addition, they are expected to:

- Provide knowledge of manufacturing, product design, or the practices involved in service delivery, as appropriate to the vision;
- Contribute to the education programs by providing guidance on the desired skill sets needed for success in industry and innovation;
- Help in establishing the culture of innovation required for the ERC's students and faculty.

**5.b. IPAB Membership Agreement:** The Gen-3 ERC's Industrial/Practitioner Advisory Board is governed by a center-wide Membership Agreement that defines the scope and function of its partnership with the center. The Membership Agreement also defines the ERC's Intellectual Property policies. Guidance on effective agreements and IP policies is available in the ERC Best Practices Manual in the innovation ecosystem chapter, which is focused on industrial collaboration and technology transfer; it can be found at [http://www.erc-assoc.org/best\\_practices/chapter-5-industrial-collaboration-and-innovation](http://www.erc-assoc.org/best_practices/chapter-5-industrial-collaboration-and-innovation).

The IPAB members are required to pay annual fees, and the fee schedule is documented in the Membership Agreement. Additional details on membership fees are as follow:

- The Membership Agreement will include a scaled fee structure for member firms/agencies/hospitals that will recognize the differing capacity according to their size;
- Industry commitment will start with cash membership fees, which may be augmented by in-kind contributions according to the size of the firm and the terms of the agreement;
- Agency/hospital (practitioner) member fees may be cash or in-kind;
- All members may contribute augmented support through sponsored research projects ;
- There may be firms that provide support for sponsored research projects but do not pay membership fees to join the center; these firms are not considered IPAB members;
- Proposals must demonstrate financial commitment by industry / practitioner members; however, there is no required formula in relation to NSF support;
- Fee-paying IPAB members have first option to license ERC-generated IP under the terms of the agreement.

**5.c. University, State and Local Government Facilitators of Entrepreneurship and Innovation:** In addition to the IPAB, the ERC innovation ecosystem includes formal partnerships with university and/or state and local government organizations devoted to facilitating entrepreneurship and innovation. These partners would explore how the center research may stimulate innovation, promote entrepreneurship, and impact local economic development and job creation. Furthermore, they would be involved with the ERC's education programs to bring awareness and knowledge of entrepreneurship and innovation to the ERC's students and faculty. These facilitators are not the member firms/practitioner partners.

**5.d. Technology Transfer and Translational Research Partnerships:** Technology transfer to the IPAB member firms/practitioner partners is the primary channel for potential commercialization of ERC research. However, there are times when ERC member firms / practitioners do not exercise the option to license promising ERC-generated IP to bring it to product/use, primarily because it is still nascent or does not align with their product/service delivery plans. The center would then explore partnerships with non-member companies that would license the IP. These companies could be larger firms with the resources to develop the IP.

The ERC may also pursue a partnership with small-business member or non-member firms that propose translational research in partnership with the ERC. Such proposals may be submitted by the small firms to the Small Business Innovation Research (SBIR) program solicitation or other funding opportunities as they arise. This guidance regarding partnerships with small businesses in translational research further clarifies the Gen-3 innovation ecosystem construct in prior ERC Gen-3 solicitations.

## **6. Infrastructure.**

In addition to a selective ERC configuration of domestic university partners / affiliates and foreign collaborators (Sec. II.B.2), the infrastructure required for a successful ERC includes a strong leadership team; advisory boards; a culture of inclusion; well-coordinated management systems; facilities, equipment, and headquarter space; and institutional commitment.

**6.a. Leadership Team:** Each ERC must have the following leadership team comprised of members who are diverse in gender, race and ethnicity (from groups underrepresented in engineering) and persons with disabilities:

**(6.a.1.) Center Director:** In compliance with the PI eligibility criteria, the Center Director will be a tenured engineering faculty member and the Lead NSF Principal Investigator (PI) who is responsible for leading the ERC and administering the award in accordance with the terms and conditions of the Cooperative Agreement issued by the NSF in the event of an award.

**(6.a.2.) Deputy Director/Executive Manager:** The Center may have a Deputy Director who is a faculty member and shares the leadership and management responsibilities of the Center with the Director. If there is no faculty member suitable for this role, the Center may propose to include an Executive Manager instead of the Deputy Director, who will be a staff member dedicated to working with the Director in executing the mission of the Center.

**(6.a.3.) Research Thrust Leaders:** The leadership team includes faculty members from across the domestic partner universities responsible for leading and managing major research thrusts and test beds of the ERC.

**(6.a.4.) Education Program Director:** A faculty member who is responsible for the development and execution of the ERC's university education program and supported by other faculty, students, and staff in the execution of the program.

**(6.a.5.) Pre-College Education Program Director:** A faculty or staff member who is experienced in pre-college education, responsible for development and execution of the pre-college education program, and supported by faculty, students, and staff.

**(6.a.6.) Industrial Collaboration and Innovation Ecosystem Director:** A staff member, not faculty, at the lead university who is responsible for developing the ERC's innovation ecosystem, marketing the ERC to industry / practitioners, gaining their financial support, developing and coordinating industrial / practitioner involvement with faculty and students, and managing the other partnerships for innovation and the translational research program.

**(6.a.7.) Diversity Director:** A staff or faculty member who leads the development, implementation, and assessment of the center's diversity strategic plan. This person will have proven success in recruitment and retention of underrepresented groups in engineering or STEM fields. This may be the sole role of this person within the ERC's Leadership Team or he/she may hold another role in the ERC as well.

**(6.a.8.) Administrative Director:** A staff member at the lead university who is responsible for operational management, financial management, data collection, publicity, and reporting, etc. for the ERC.

**(6.a.9.) Student Leadership Council (SLC):** Undergraduate and graduate students from all the partner universities responsible for coordinating their various activities in support of the ERC research, education, and technology transfer agenda. A student President and a student co-President lead the SLC.

The designation of individuals serving as the Administrative Director, the Industrial Collaboration and Innovation Director, and the leaders of the SLC may occur after notification of award.

**6.b. Advisory Boards:** Each ERC is supported by advice or guidance from external and internal boards and councils.

**(6.b.1.) Scientific Advisory Board:** The Scientific Advisory Board (SAB) is comprised of outside experts who are selected by the ERC Leadership Team and meet collectively as a board at least once a year with the center. (Note: Do not contact potential members or appoint this board during the proposal preparation and review process or list potential members in the participant table.)

**(6.b.2.) Industrial/Practitioner Advisory Board:** The Industrial/Practitioner Advisory Board (IPAB) will be comprised of representatives of member companies/agencies/hospitals who meet collectively as a board twice a year to advise the ERC's leadership team and meet with the NSF site visit team. The IPAB will have a chair who organizes the board's activities in coordination with the Industrial Collaboration and Innovation Ecosystem Director and the Center Director.

**(6.b.3.) Internal Academic Policy Board:** Administrators from the lead university, including the Dean of Engineering, who meet collectively as a board with the ERC Director to coordinate ERC plans and policies with departmental and university leaders.

**(6.b.4.) Council of Deans:** Led by the Dean of Engineering from the lead university, this Council of Deans from the lead and partner academic institutions meets collectively as a board to provide administrative support of the ERC and to help facilitate the ERC's research, education, and innovation efforts across the lead and partner campuses.

**6.c. A Culture of Inclusion:** NSF expects the ERC to rest on a culture of inclusion where faculty, students, and staff from all backgrounds have an opportunity to succeed in research, education, innovation, and administration. Thus, the leadership team, faculty, students, and staff involved in an ERC will be diverse in their experiences as well as diverse in gender, race, and ethnicity - i.e., women, African Americans, Native Americans, Pacific Islanders, Alaskan Natives, Hispanic Americans, or persons with disabilities who are U.S. citizens or permanent residents. The ERC also will be multicultural through the involvement of faculty and students from other countries by virtue of their role as faculty or students in the Center's domestic institutions. The ERC may also include veterans as faculty, students and staff as well as members of the ERC's RET teacher corps.

The goal is to have broad participation of groups underrepresented in engineering that exceeds the academic engineering-wide national averages and continues through time on an upward slope in relationship to those national averages. This diversity is expected of the participants from the lead and each of the partner academic institutions. While one of the partner institutions must serve large numbers of students majoring in STEM fields who are from groups underrepresented in engineering, that institution cannot be the only contributor to the diversity of the ERC.

Collaborating foreign faculty are expected to respect the diversity of the ERC's faculty and students and provide inclusive research and education environments. Because of the multicultural nature of the ERC, the participants have to be mindful that the language of discourse in the ERC's laboratories will be English to maintain an inclusive environment for all.

The lead and domestic partner universities are likely to have programs, some of them NSF-funded (e.g., ADVANCE, etc.), and offices that are established to impact a culture of inclusiveness at the respective campuses. These programs and offices must be leveraged by the ERC.

While proposals cannot include numerical projections, annual reports will include quantitative information on the demographics of the ERC personnel, benchmarked against engineering-wide averages. Reports also will include information on progress and impacts in developing a culture of inclusivity and success for all of the ERC's faculty and students.

The ERC will include pre-college institutions with diverse student bodies as discussed above.

**6.d. Organization and Management Systems:** The ERC Director must report to the Dean of Engineering of the lead university.

The ERC will function with sound management systems to assure effective integration of its components to meet its goals, sound financial management and reporting systems, and sound project selection and assessment systems that include input from its Scientific and Industrial/Practitioner Advisory Boards.

**6.e. Facilities, Equipment, Safety, and Headquarters:** In the proposal, the lead university must commit to provide headquarters of sufficient space and resources to support the leadership, management, and collaboration functions of the ERC. The ERC's research teams will be supported by appropriate research equipment and shared facilities, shared data, shared experimentation, shared simulations and test beds. The ERC will assure safe laboratory environments and safety training for its students here and abroad. The center will work with the administration at each university to monitor and assure safety regarding materials, equipment, and procedures.

A robust cyberinfrastructure, with appropriate software and staff, should be in place to facilitate collaboration across space and time. The NERCs will link with the resources of the Network for Computational Nanotechnology (NCN) as the main cyber platform for development and dissemination of any computational and simulation tools and educational materials developed by the NERC. Information about the NCN can be found at <http://www.ncn.purdue.edu/>. The NERC equipment plan will include efforts to leverage the experimental resources of the National Nanotechnology Infrastructure Network (NNIN) and the computational resources of the NCN. Information about the NNIN can be found at <http://www.nnin.org/>.

**6.f. Institutional Commitment:** The lead and partner universities will support the Center's research, education, and innovation culture; augment NSF's support during the award period through cost-sharing and other means; and sustain the ERC once NSF's support ceases. The ERC program also expects that there will be policies in place to reward faculty in the tenure and promotion process for cross-disciplinary research; research on education; research and other activities focused on advancing technology and innovation; and mentoring of university postdoctoral researchers (if supported), tenure-track faculty, graduate and undergraduate students, and pre-college students and teachers. In addition, the ERC Program expects that university students engaged in mentoring of other university students and in pre-college outreach will receive credit or official recognition for this activity.

The pre-college partners of the ERC will be committed to a long-term partnership with the center that will involve teachers and students in the ERC, will adopt a Young Scholars program, and will include engineering information and activities in their curricula.

#### C. FINANCIAL SCOPE AND SCALE OF THE ERC.

**1. NSF Award Size:** Start-up base support will not exceed \$3,250,000 for year one. Pending satisfactory annual performance, need, and availability of funds, the base support may increase to \$3,500,000 (year 2), \$3,750,000 (year 3), \$4,000,000 (year 4), and \$4,000,000 (year 5). Pending performance and the outcome of two renewal reviews in the third and sixth year, support for years six through eight is projected to be up to \$4,000,000 in each of those years; and support for year nine and ten would be phased down at a reduced level of 33% of the prior year's support to prepare the ERC for self sufficiency from ERC program support at the end of 10 years.

**2. Cost Sharing:** The lead and partner domestic universities will be committed to support and sustain the ERC through real and in-kind cost sharing. Evidence of this cost sharing is required in the invited full proposal. The financial support allocated by the Center Director to the lead and partner university faculty will depend upon their roles in the ERC; and, post award, that support will depend upon performance and need and likely will vary over time. This will impact cost sharing over time.

**3. Total Support:** Post-award, ERCs establish a Center-level account into which is deposited the ERC program base support and any other support provided by other sources (e.g., IPAB membership fees) directly to the Center to carry out its goals. In addition, the ERC may include support provided to a PI's department for projects that are to be carried out under the ERC's Strategic Plan. This support is classified as associated project support in post-award financial reporting.

### III. AWARD INFORMATION

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**Anticipated Type of Award:** Cooperative Agreement

**Estimated Number of Awards:** 4

Up to 4 of any combination of Open Topic ERCs and/or NERCs, depending on quality of the proposals and availability of funds, with a start date targeted for Summer 2014.

**Anticipated Funding Amount:** \$13,000,000

\$13,000,000 to support the first year for up to four newly funded centers, depending on availability of funds in FY14.

It is anticipated that the awards would be made in the summer of 2014. The initial award would be for five years, with year one start-up budgets each of up to \$3,250,000. Subsequently, there would be year two budgets of up to \$3,500,000, year three budgets of up to \$3,750,000 and years four and five budgets of up to \$4,000,000 each, pending satisfactory annual performance and availability of funding. Pending performance and the outcome of two renewal reviews in the third and sixth year, support for years six through eight is projected to be up to \$4,000,000 in each of those years; and support for year nine and ten would be phased down at a reduced level of 33% of the prior year's support to prepare the ERC for self sufficiency from ERC program support at the end of 10 years.

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

### IV. ELIGIBILITY INFORMATION

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**Who May Submit Proposals:**

Proposals may only be submitted by the following:

**Organization Limit:**

Proposals may only be submitted by the following:

Only U.S. universities with undergraduate, masters, and doctoral engineering programs with the breadth and depth appropriate to support the center's vision may submit proposals as the lead university. The lead university submits the proposal, and the award is made to the lead university. Support is provided to the partnering universities and any affiliated faculty from non-partner institutions through subawards.

A University that, by October 1, 2014, has two funded ERCs from the Classes of 2006 through 2010 and the NERC Class of 2012 may not submit a proposal in the lead role. However, the university can participate as a partner in an ERC led by another eligible institution serving in the lead role.

#### Other Organizational Requirements:

**Invited full proposals must meet all of the following organizational requirements or they will be returned without review:**

- A proposed ERC must be multi-institutional, with a lead university and no more than four additional domestic university partners;
- To qualify as a partner institution, there must be a minimum of three faculty participating in the ERC along with at least a total of three students;
- The lead or one of the domestic partner universities **must** be a university that serves large numbers of students from groups that are predominantly underrepresented in engineering in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, or persons with disabilities who are U.S. citizens or Permanent Residents of the U.S.) who are studying in STEM fields;
- Commitment to include, **in the full proposal** or in the future, collaborations with foreign faculty to enable U.S. students to have an opportunity to carry out research in their laboratories;
- Commitments from domestic lead and partner universities for cost sharing, as instructed below;
- **irm** and/or practitioner fee-paying members of the center are required. These intended memberships must be documented in letters of commitment as part of **the full proposal** (See "Supplementary Documents.");
- Innovation partners, such as university and/or state and local government organizations devoted to promoting innovation and entrepreneurship, are required. These partners are not required to be fee-paying members of the center. However, they are to document their commitments in letters to be submitted with **the full proposal** (See "Supplementary Documents");
- Pre-college education partners are required. Letters documenting these intended commitments are required as **part of the full proposal** (See "Supplementary Documents.").

The following organizational features are **not required** but may be proposed:

- The ERC **may** include as affiliated organizations, institutions participating in research and/or education programs, such as: (1) Federal Laboratories (although NSF funds may not support the participation of staff of these laboratories in the Center); and/or (2) universities or colleges that are contributing affiliated faculty in groups of less than three;
- To increase the impact of the ERC on the technical workforce, the ERC **may** partner with community colleges and or technical colleges.

#### Other organizational guidance:

- If the Lead PI (Center Director) departs the university or decides to transfer to another university during the review process or after an award is made, the proposal/award remains with the lead submitting university;
- The lead university cannot change after submission of the Letter of Intent;
- The partner universities may change after the invitation to submit a full proposal. However, NSF must be notified of any changes within one month of the date of the invitation.
- A lead university can receive only one award through this solicitation. There is no limit on the number of ERC partnerships a partner university can join.

#### Who May Serve as PI:

The Lead PI (Center Director) must be a tenured faculty member in an engineering department/school of engineering at the lead university. The Director's doctoral degree must be in engineering or an associated field of science; if the latter, she/he must have substantial career experience in engineering as evidenced by a primary appointment in an engineering department/school of engineering at the lead university.

#### Limit on Number of Proposals per Organization:

None Specified for Preliminary Proposals.

Full Proposals may be submitted only by invitation and only by the lead university designated in the preliminary proposal.

#### Limit on Number of Proposals per PI or Co-PI: 1

A PI may be identified as Center Director on only one proposal and may not propose in any other role in any other ERC proposal.

A Co-PI on one proposal can also participate in other proposals.

## V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

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### A. Proposal Preparation Instructions

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#### Letters of Intent(required):

A Letter of Intent (LOI) is required to facilitate the NSF review process. The letter should be submitted via FastLane (not Grants.gov) no later than the LOI deadline date specified in this solicitation. The LOI allows NSF to screen the proposals with respect to eligibility

requirements, to categorize the proposals according to general topical areas, and to identify conflicts-of-interest so as to prepare for the proposal review processes. The topics themselves will not be pre-screened.

Submit information for your LOI through FastLane under these categories and only under these categories (note the character limits, which include spaces, as stated below):

- **Project Title:** For a NERC LOI, the project title should begin with "NSF Nanosystems Engineering Research Center for (insert the rest of the title and the center's acronym);" or for an open topic ERC FOI, the title should begin with "NSF Engineering Research Center for (insert the rest of the title and the center's acronym)".
- **Center PI and Point of Contact for NSF Inquiries:** Center Director's name, university, department, phone number, and e-mail address
- **Anticipated Center Co-PIs (maximum of four official Co-PIs):** Because the proposal cover sheet only allows a total of five PIs (the PI and up to four Co-PIs), identify up to four Co-PIs. Include their names, universities, departments, and locations (city, state, country).
- **Anticipated Domestic Academic Partner Universities:** *This section should include **only** the domestic "academic partner universities" anticipated to partner in the ERC (not the universities that are contributing affiliated faculty, or federal laboratories, or foreign collaborators' universities).* For each academic partner university include the name and location (city, state and country). Identify the partner university that would serve as the ERC underrepresented minority-serving institution. Each university entry can have up to 76 characters (including spaces) to show all requested information. Abbreviations can be used, as needed. A search for the organization can be done in FastLane, and if found in the search, then it can be added when selected from the list.
- **Synopsis (max 2,500 characters in this section, including any spaces):** Provide brief statements of the vision and goals of the ERC, its research program including research thrust titles and goals, its workforce development plan (university and pre-college education), and the innovation ecosystem programs, all at a sufficient level of detail to understand the proposed ERC at this early stage.
- **Other Comments (max 2,500 characters including any blank spaces):** Continue Synopsis as needed in this section.
- **Organizational Attribute:** Select the appropriate organizational attribute for the lead university from the drop down list. See Sec. V.B. below and [http://classifications.carnegiefoundation.org/lookup\\_listings/institution.php](http://classifications.carnegiefoundation.org/lookup_listings/institution.php).

**Submitter Information:** This section does not require input from the LOI author. This information is automatically added to the final LOI submission by FastLane.

#### **Letter of Intent Preparation Instructions:**

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Sponsored Projects Office (SPO) Submission is not required when submitting Letters of Intent
- A Minimum of 0 and Maximum of 4 Other Senior Project Personnel are allowed
- A Minimum of 1 and Maximum of 4 Other Participating Organizations are allowed
- Carnegie Foundation Organizational Attribute (lead University) is required when submitting Letters of Intent
- Anticipated Domestic Academic Partner University (Required) is required when submitting Letters of Intent
- Anticipated Domestic Academic Partner Universities (List all others - optional) is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is not allowed

**Preliminary Proposals (required):** Preliminary proposals are required and must be submitted via the NSF FastLane system, even if full proposals will be submitted via Grants.gov.

**Preliminary Proposal Preparation Instructions:** A preliminary proposal (preproposal) is required to provide peer-review feedback to the proposing team. The purpose is to avoid additional full proposal preparation burden, if the proposed idea is not meritorious according to the goals of the ERC program.

Submission of a Preliminary Proposal is required to be eligible for invitation for a Full Proposal. Preliminary proposals that are not compliant with the guidelines may be returned without review, thus making the proposing team automatically ineligible for submitting a full proposal. It is the submitting organization's responsibility to ensure that the preliminary proposal is compliant with all applicable guidelines.

Preliminary proposals must contain the items listed below and adhere strictly to the specified page limitations. No additional information may be provided as an appendix or by links to Web pages. Figures and tables must be included within the applicable page limit.

Preliminary proposals will contain an overview of the proposed vision, strategic plan, research, education, and innovation ecosystem efforts with sufficient detail to allow assessment of the intellectual merit and broader impacts of the proposed ERC.

The center configuration at the preliminary proposal stage would include only the lead and up to four anticipated domestic partner universities. Follow the guidance in Section B.2.a Domestic Partner Universities regarding the configuration of domestic partners. No other partners will be discussed or included in the preliminary proposal. The lead university (not PI) is binding throughout the process. However, based on feedback from the preliminary proposal peer-review process, the domestic partners may change.

The participating team will be limited to the PI and up to four co-PIs who may come from any or all of the domestic partners universities. The co-PIs may change with the submission of an invited full proposal.

**Cover Sheet:** Select the program solicitation number from the pull-down list. The ERC Program solicitation will automatically appear. Check the box indicated for the preliminary proposal. Entries on the Cover Sheet are limited to the Principal Investigator (PI) and a maximum of four co-principal investigators. The sum of \$2 should be entered on the budget line to allow correct FastLane processing.

**Title of Proposed Project:** For an Open Topic proposal, the title should begin with the "Engineering Research Center for (insert the rest of the title and the center's acronym)." For a Nanosystems ERC the title should begin with "Nanosystems Engineering Research Center for (insert the rest of the title and the center's acronym)."

**Project Summary (1 page):** Project Summaries must include three titled sections: Overview statement on Vision, Intellectual Merit, and Statement on Broader Impacts. The summary should be written in the third person, informative to those working in the same or related field(s), and understandable to a scientifically or technically literate reader. Preliminary proposals that do not contain the Project Summary, including an overview and separate statements on intellectual merit and broader impacts will not be accepted by FastLane or will be returned without review. Additional instructions for preparation of the Project Summary are available in FastLane.

**Project Description:** Maximum 7 pages total, containing the following sections:



1. Proposing Team: Start the description with a table that has four columns: (1) Name of the PI or co-PIs, (2) Institution, (3) Department(s), and (4) Most Relevant Field(s) of Expertise. There will be up to five rows, one for the PI (Center Director) and one each for up to four co-PIs.

2. Ten-year Vision for a transformational engineered system and its potential impact on society. Justification of why a center is needed to achieve that vision as opposed to a number of single investigator projects or small group grants.

3. Strategic Research Plan must clearly identify the fundamental insights that will enable the proposed ERC to achieve its vision. Strategic Research Plan must include a graphical depiction using the ERC Program's **3-Plane Strategic Planning Chart**. A sample chart can be found on the ERC Association's Website <http://erc-assoc.org/content/templates-proposal-preparation-0>. The chart tailored to the proposed ERC research plan must be placed in this section and it must be on a scale and in a font size that are readable.

4. Research Plan to address the barriers to achieving the vision, including fundamentals through to proof-of-concept in enabling and systems test beds.

5. Workforce Development (Education) Plan that includes innovations in pre-college through university education and research training.

6. Innovation Ecosystem (Strategy for selection of sectors/firms, role of industry/practitioner members, role of innovation in the ERC.) Do not list potential or committed industrial or other supporters.

**References Cited:** (maximum 3 pages) See GPG for format guidelines.

**Biographical Sketches:** (2-page limit for each) should be included for the PI and up to four co-PIs, according to the GPG, Chapter II.C.2.f. Advisors, advisees, and collaborators should not be listed on this document, as this information will be submitted separately through a conflict of interest template described below.

**No budget should be submitted:** No budget and no justification will be submitted, however, please enter \$2 in the Requested Amount box on the FastLane Cover Sheet (this entry allows correct FastLane processing).

**Supplementary Document:** A letter from the Dean of Engineering of the lead institution indicating a commitment to the center should it be invited for a full proposal submission and subsequently funded. The Dean should NOT include any financial commitments. Instead, the Dean should make a statement as to how the proposed center will align with the strategic directions of the College and the university.

**PI and co-PI Conflict of Interest document:** Please use the template found at <http://erc-assoc.org/content/templates-proposal-preparation-0>. Download and use the file named "ERC Preliminary Proposal Participants with Conflicts" to use to prepare the conflict information submission. Please read the Instructions carefully and follow guidance. Using the template, compile an Excel Workbook that identifies conflicts of interest (COIs) for the PI and up to four co-PIs. Conflicts would be listed according to the guidelines provided in the GPG, Exhibit II-2.

If the proposing team is far enough along in the process to have already developed a team greater than the PI and co-PIs identified in the preliminary proposal, then on sheet 2 of the workbook, please identify the additional faculty members and other participants such that they will not be contacted to participate in the review process.

Following the Instructions provided in the template, the completed Excel Workbook should be emailed to [ercintent@nsf.gov](mailto:ercintent@nsf.gov) immediately after the proposal is submitted, but no later than the proposal deadline. Please include in the subject line the proposal number, the name of the lead institution, and the words "Participant table with conflicts."

**No other items, appendices, supplementary documents permitted:** If any supplementary documents (except the Dean's letter) and appendices are submitted, the preliminary proposal will be returned without review.

**DO NOT SEND** other documents, including Letters of Commitment from the domestic partner universities, prospective industrial members, or other future partners; Current and Pending Support Statements; Facilities Equipment and Other Resource; Budget and Budget Justification; Data Management Plan; Postdoctoral Mentoring Plan for preliminary proposals.

**Full Proposal Preparation Instructions:** Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=gpg](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg). Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov). Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: ([http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov).

**Important Proposal Preparation Information:** FastLane will check for required sections of the proposal, in accordance with *Grant Proposal Guide* (GPG) instructions described in Chapter II.C.2. The GPG requires submission of: Project Summary; Project Description; References Cited; Biographical Sketch(es); Budget; Budget Justification; Current and Pending Support; Facilities, Equipment & Other Resources; Data Management Plan; and Postdoctoral Mentoring Plan, if applicable. If a required section is missing, **FastLane will not accept the proposal**.

Please note that the proposal preparation instructions provided in this program solicitation may deviate from the GPG instructions. If the solicitation instructions do not require a GPG-required section to be included in the proposal, insert text or upload a document in that section of the proposal that states, "Not Applicable for this Program Solicitation." Doing so will enable FastLane to accept your proposal.

**Invited Full Proposal Preparation Instructions (by invitation only):** Full proposals may be submitted only by invitation.

As a multi-university ERC, the proposal must be submitted as a single integrated proposal by the lead university, with proposed sub awards to the other partner institutions. Separate proposals from each partner will not be accepted, since separately submitted collaborative ERC proposals are not allowed.

**Required Proposal Format:**

**(1.) Cover Sheet.** Select the ERC Program solicitation number from the pull down list. For an open topic ERC, the proposal title should begin with "Engineering Research Center for (insert the rest of the title and the center's acronym)." For a NERC, the proposal title should begin with "NSF Nanosystems Engineering Research Center for (insert the rest of the title and the centers acronym)". The title should reflect the system focus of the proposed Center. For planning purposes, June 1, 2014 should be shown as the start date. The proposed Center Director must be shown as the Lead Principal Investigator.

**(2.) Project Summary (limited to one page).** The summary should be written in the third person (i.e., the use of the pronoun "it" not "we" to represent the ERC) and should make a compelling case for the ERC. The summary should be informative to persons working in the same or related fields; and, insofar as possible, understandable to a scientifically or technically literate lay reader.

In the overview section, include the Center's title, the Center Director's name, the lead university's name, and the names of the partner universities. Write a brief clear description of the ERC, stating its vision and goals, the transformational nature of the systems technology, the fundamental barriers in the way of realization, and its impact on innovation and the engineering workforce through its education program.

In separate statements, under the headings: "Intellectual Merit" and "Broader Impacts" as relevant, provide highlights of the proposed research, university and pre-college education goals, diversity strategy, industrial collaboration, technology transfer and innovation goals and strategies.

**Proposals that do not contain the Project Summary, including an overview and separate statements on Intellectual Merit and Broader Impacts will not be accepted by FastLane or will be returned without review. Additional instructions for preparation of the Project Summary are available in FastLane.**

**(3.) Table of Contents** will be generated automatically by FastLane or Grants.gov.

**(4.) Project Description.**

The project description must contain sections (4.a) to (4.f). Section **(4.a)** is the Table of Academic / Other Participants and Industrial / Practitioner Members. The remainder of the Project Description, **Secs. (4.b) to (4.f), is limited to 25 pages.** The 25--page limit includes all figures, charts, and other tables required as a part of the narrative. **If the Project Description section exceeds the page limit, the proposal will be returned without review.**

Because of the size of the team, the project description will **not** include the normally required separate section on prior NSF support, as this information will be integrated into the discussion of the state of the art in research and education. When this section in the proposal format is approached, refer the reader to the state of the art section of the proposal.

**(4.a) Table of Academic / Other Participants and Industrial / Practitioner Members. (Not included in the 25-page limit.)**

The table should be inserted at the beginning of the Project Description using the table format available on the ERC Association website at <http://erc-assoc.org/content/templates-proposal-preparation-0>. Download and use the Word file named "ERC Participants Table Template for Inclusion in Full Proposal." Provide all of the required information. The table will list: (i) lead university; (ii) domestic partner universities (iii) universities or National Laboratories contributing affiliated faculty or staff; (iv) partner pre-college institutions; (v) foreign university partners, if known; (vi) name, department, and institutional affiliation of each member of the leadership team and of each ERC participant (faculty and staff) who will receive support from the ERC budget to carry out the research, education, and other functions of the center; (vii) Innovation Ecosystem Partners (names and locations of the firms/agencies/hospitals committed to be industrial/practitioner members and names innovation partner organizations (state and local government or other organizations partnering to promote innovation)

[Note: After the proposal is submitted and the final proposal number is obtained, submit an Excel spreadsheet, with the same information as the table above plus additional conflict of interest (COI) information for funded faculty, other non-faculty members of the Leadership team and research staff according to the GPG, Exhibit II-2. This spreadsheet is available on the website above. Use the file named "ERC Participants Table Template with Conflicts of Interest.

Please submit this table to [ercintent@nsf.gov](mailto:ercintent@nsf.gov) the same day you submit the proposal. Include in the subject line the proposal number, the name of the lead institution, and the words, "Participant Table."

The following additional sections (4.b) through (4.f), **limited to 25 pages maximum**, of the Project Description should be prepared with reference to the review criteria and the guidance provided in this and the preceding sections of this solicitation. The intellectual merit and broader impacts of the ERC must be addressed and described as an integral part of the narrative.

**(4.b) Vision and Rationale for the ERC.** State the vision of the ERC and justify why it is transformational and not incremental. Describe the proposed engineered system and its challenge(s) that an ERC could address. Position the proposed ERC relative to the state of the art. Provide a rationale for value added by the creation of the ERC in terms of the potential knowledge, technology, educational, and societal impacts and their importance.

Regarding the value added over any ongoing or graduated federally or state supported centers, provide the following information as appropriate to the vision and team:

- If the proposal is relevant to the research mission of another Federal Agency, then a justification must be included addressing the value added of the proposed ERC over the major projects/centers already funded by that agency or called for in solicitations from those agencies already released at the time of submission of the proposal;
- If the proposed vision is closely aligned to the visions of current or graduated ERCs, Nanoscale Science and Engineering Centers (NSECs), or Science and Technology Centers (STCs), then a justification must be included addressing why the proposed vision is significantly different from these to warrant an additional NSF investment.
- If the proposing team is derived largely from the team involved in a graduated NSF or other agency funded center or one that would have graduated from NSF or other agency support by the time the ERC would be funded, a justification must be included addressing how the proposed vision reflects a vision significantly different to warrant an additional NSF investment.

**Compliance with International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR), if applicable:** If the proposed topical area has obvious dual use in both the military and civilian sectors, then note the following: The Gen-3 ERC solicitation requires international collaboration and offers the opportunity to establish a partnership with foreign

researchers. Furthermore, there are often foreign students engaged in an ERC. Hence, PIs need to be cognizant of appropriate Department of State regulations, specifically the International Traffic in Arms Regulations (ITAR), and Department of Commerce regulations, specifically, Export Administration Regulations (EAR). If relevant to the technology proposed, the proposal should indicate awareness and compliance with the ITAR and EAR regulations in the section where the ERC's international collaboration is discussed. An ERC awardee under this solicitation will be responsible for ensuring compliance with the appropriate regulations. Please direct your specific questions on how to comply with these regulations to your university research administration office.

#### **(4.c) Research Program Broader Impact.**

The research program is the core of the ERC from which all center activities evolve. First, the strategic research plan must be presented using the ERC 3-plane chart framework followed by the details of the research program itself.

**(4.c.1) Strategic Research Plan:** Given the ERC's engineered system vision provide an analysis of the state of the art in the following structure:

- A synopsis of the state of the art;
- Major foundational knowledge and technology achievements by the ERC team in the context of the state of the art - i.e., benchmark the proposed research;
- Gaps in knowledge and technology that the ERC will address;
- Technical barriers in the way of addressing those gaps;
- Societal, regulatory, and other barriers in the way of achieving the goals.

Given this analysis, provide the following information:

- Research and test beds needed to address the gaps in knowledge and barriers;
- Plan for organizing the research into thrusts that integrate projects to deliver on intermediate and long-term goals;
- Plan to sunset or terminate projects when they are completed and/or no longer relevant;
- Plan to integrate the research into the test beds, to monitor test bed progress, to terminate test beds as appropriate, and to formulate new test beds;
- Milestones and timing for delivery and implementation of the research and test beds;
- Plan to manage center intellectual property across the lead and partner institutions and to enable licensing of the technologies;
- Justification of disciplinary composition of the team and any foreign collaboration in light of these goals;
- Justification of the experimental support for the research program (to be supplemented by Section 9).

Provide a graphical depiction of the strategic research plan using the ERC Program's **3-Plane Strategic Planning Chart**. A sample chart can be found on the ERC Association's Website [http://www.erc-assoc.org/funding\\_opportunities](http://www.erc-assoc.org/funding_opportunities). The chart tailored to the proposed ERC research plan must be placed in this section (4.c.1), and it must be on a scale and in a font size that are readable.

The strategic research plan must include a ten-year milestone chart (displayed in a font size that is readable) indicating the critical paths through key research projects and test beds to achieve the major research goals and deliverables. There is no preferred model for this chart; however, it should be presented in a format that clearly indicates the points of integration. A linear Gantt chart without points of interface or transitions is not effective. More clarity and specificity of milestones are expected for the first five years.

Furthermore, the strategic research plan must include a plan to accelerate the movement of ERC technology, processes, and/or services to product or actual use. Summarize the potential users that would be impacted by the ERC's research and technology outcomes. As appropriate, discuss how the plan will factor in the impact of the technology on the environment, human health, etc.

If an open topic ERC or a NERC develops nanoscale research simulation tools suitable for hosting on the cyber platform (<http://www.nanohub.org/>) of the Network for Computational Nanotechnology (NCN), those tools will be delivered to the NCN, where a broader community will have access to them in an open source mode for research and educational purposes. If applicable to the proposed ERC, include these plans in the proposal.

**(4.c.2) Research Program Detail:** Details of the research program are to be presented in terms of the thrusts, example projects, and the enabling and systems-level test beds.

**For each research thrust narrative** provide the following information at a minimum. **A readable table should be placed upfront** that lists the thrust leader and other faculty/research participants by name, their departments, and institutions. Also, list any international partners who may be involved in the early stages of the thrust efforts. Discuss the goals and objectives of the thrust vis-à-vis the goals of the ERC and the strategic research plan. Benchmark the research proposed for the thrust with respect to the state of the art (including the contributions of the proposed ERC faculty and others) and discuss the role of the thrust's research relative to the ERC's three-plane chart. Provide information on projected thrust-level fundamental knowledge and technology deliverables and on the barriers the thrust will address in the context of the ERC's strategic plan. Discuss the cross-disciplinary mix of expertise needed to achieve the goals of the thrust.

In the **project-level descriptions** for each thrust describe the research to be conducted and how it contributes to the goals of the thrust. Provide a few examples of the fundamental barriers the research will address and the methods to be taken at the project level to address them. The project-level research and the barriers to be addressed are to be presented in the context of known results and theory to demonstrate that the desired results constitute breakthroughs and are attainable in ten years. Also, discuss how the projects support the proposed enabling and systems level test beds.

There must be sufficient depth in the research descriptions for reviewers to judge the quality of the effort proposed. Communicating this quality of effort can be achieved by a few in-depth explications of exemplar projects, but it cannot be achieved by superficial descriptions of all projects. Discuss the integration of projects within the respective thrust and the interdependencies among the thrusts.

Finally, the proposed **enabling- and systems-level test beds** may be discussed either within the thrusts or as separate thrusts, as appropriate, to best describe proof-of-concept demonstrations. Discuss what is involved in and the personnel needed for constructing and implementing each proposed test bed. The research program budget should include support for technical staff at the appropriate time to work with students and faculty to build these test beds.

**(4.c.3) Foreign collaborations:** As foreign collaborations are not required to be in place by the time of the submission of the proposal, the proposal will include the ERC's strategy for developing these collaborations over time and a justification for value added in research and education. However, the proposal may include these collaborations if the partnership is in place by the time the proposal is submitted. There is no required number of these partnerships, but it must be manageable.

Note that international collaborators will seek support from their funding organizations for collaborative activities carried out at their home institutions. NSF funds may be used to support ERC faculty and ERC students in these collaborations at both the U.S. and

foreign sites of the collaboration. NSF funds may be used to support the time that international collaborators carry out research and/or educational activities at the ERC's sites in the U.S.

#### **(4.d) Engineering Workforce Development (Education Programs) Broader Impact.**

The ERC Engineering Workforce Development (EWD) Program is comprised of university-level and pre-college-level education activities that are tied to the center research and innovation ecosystem programs. As an option, the EWD Program may include activities with community colleges, as they are recognized as an alternative pathway for undergraduate students to obtain a degree in engineering. In addition, the EWD program may include veterans through their role as students in the ERC's research program or as teachers through the ERC's RET program.

**(4.d.1) University Education:** Provide the strategic goals of the center for contributing desired characteristics and skill sets of ERC graduate and undergraduate students. These students should be knowledgeable about industrial practice and capable of success in a global economy. They must exhibit creativity and innovativeness. Present a set of activities designed to impart these characteristics. In addition, discuss the potential curricular impact of the ERC research and how this impact will be achieved. Discuss how the education program will encompass all of the partner academic institutions and take advantage of available cyberinfrastructure for cross-institution educational impact.

As for research training, describe what expertise the graduate students at all the partner universities will gain through the ERC and how they will gain it, including the use of specialized instrumentation, if any. For undergraduate students, discuss the research training they will receive as well as how they will be mentored. The student research teams are to be augmented in the summer by a Research Experiences for Undergraduates (REU) program. Undergraduate students from non-ERC partner universities will be engaged in an extensive summer experience participating in the center's research programs and culture. The REU program will be supported by \$42,000 from the ERC's base budget and may be augmented from other sources. Post-award the ERC should submit a proposal to the Directorate of Engineering REU site Program.

Discuss the collaborative research environment for the students at the same campus and across the center institutions. Discuss plans to engage ERC students in research opportunities in foreign laboratories that would contribute to the impact of their work within the center and afford them the opportunity to work in a foreign research laboratory. Note: It is not expected that all ERC students will take advantage of this foreign research opportunity.

**(4.d.2) Pre-college (and Community College - optional) Education:** Provide the ERC's pre-college education program goals and strategies. Provide information on the school districts and/or individual schools committed to be partners with the ERC. Present the proposed activities including a Research Experiences for Teachers Program (RET) program, a Young Scholar Program, and other programs to involve pre-college students in the ERC activities. Discuss the roles of the ERC's faculty and students and of the pre-college institutions administrators, teachers, and students in the program.

For the RET program include some clearly articulated examples of types of research projects and engineering experiences in which the K-12 teachers (and community/technical college faculty, if appropriate) will be engaged. The RET program is to be funded by the ERC's base budget (at least \$84,000 per year). Post-award, the ERC should submit a proposal to the Directorate for Engineering RET in Engineering and Computer Science solicitation for a site award from that program to augment support to the RET program if a site award is granted.

**(4.d.3) University and Pre-college Education Program Assessment:** Present the assessment plan to monitor progress and impacts of the EWD Programs to make improvements through time and assess their long-term impacts. (Note: Because of this type of process, Institutional Review Board (IRB) approval for research involving human subjects will have to be obtained.)

**(4.d.4) Dissemination:** Both the university and pre-college programs will disseminate EWD program outcomes and curriculum/outreach products to the participating partner and outreach institutions and as materials for workforce training. If a NERC or an open topic ERC develops nanoscale education simulation tools suitable for hosting on the cyber platform (<http://www.nanohub.org/>) of the Network for Computational Nanotechnology (NCN), those tools will be delivered to the NCN, where a broader community will have access to them in an open source mode for educational purposes. If applicable to the proposed ERC, include these plans in the proposal.

#### **(4.e) Innovation Ecosystem - Industrial / Practitioner Members and Innovation Program Broader Impacts.**

Provide the ERC's innovation ecosystem goals and strategies for industrial / practitioner memberships and involvement; technology transfer to member and non-member firms; university and state and local government facilitators of entrepreneurship and innovation; and translational research, given the guidance in II.B.5.

Provide a visualization of how the proposed member firms align to the value chain relevant to the proposed center vision. That is, as the center research program evolves, note at which points in time in the ERC program development over the 10-year period of NSF funding the different types of firms would engage with the center to enable success. Some firms may be engaged for the entire 10 years, and some may be involved with focused research activities at critical points in time (e.g., test bed development).

Discuss the processes governing the role of the Industry/Practitioner Advisory Board (IPAB). Indicate that the IPAB will meet twice a year, including participation: 1) in the annual NSF site visit meeting and 2) in the ERC annual retreat. Discuss the process for the IPAB to carry out an annual (internal and external) SWOT analysis of the center's strengths (S), weaknesses (W), opportunities (O), and threats (T) to survival in preparation for the annual NSF site visit meeting. For the center annual retreat discuss how the IPAB will participate in the ERC's annual project selection/review process by providing input on project quality and industrial relevance.

Discuss the terms of the draft membership agreement, including the proposed fee structure and benefits. Proposals must include letters from all firms/practitioner organizations committed to joining the ERC as members and providing (cash and/or in-kind) support if an award is made. These letters should be uploaded into the Supplementary Documents section (10.a) of the proposal. Do not include letters from those only interested in a partnership. Indications of types of support must be described here.

Furthermore, proposals must include letter(s) from all university, state and local government organizations or programs, etc. committed to promoting entrepreneurship, nurture start-up firms, etc. to accelerate innovation in partnership with the ERC. These organizations do not pay annual membership fees to the center. Their letters are also to be uploaded into the Supplementary Documents Sec. (10.a) of the proposal.

The draft membership agreement must be included in the Supplementary Documents section (10.b) of the proposal. Indicate that the draft agreement has been reviewed by the lead and partner universities and discussed with representative industrial/practitioner firms committed to membership.

Describe the management of ERC intellectual property (IP) across the lead and partner institutions and the approaches to be taken to enable licensing of center IP and/or adopting of other center outcomes. This plan must include the management of conflicts-of-interest of ERC researchers.



Discuss the ERC's key terms of the planned IP policy for: (1) IPAB members, (2) sponsored research projects funded by IPAB members and by non-members, and (3) translational research. A chart, ERC IP Process Flow Chart, that depicts the decision points in the technology transfer, sponsored research, and translational research process can be found on the ERC Association Website at <http://erc-assoc.org/content/templates-proposal-preparation-0>. The proposal will not include a draft IP policy; rather, if an award is made, the IP policy is expected to be fully prepared within 90 days of the award.

#### (4.f) Infrastructure.

**(4.f.1) Institutional Configuration:** Justify the institutional configuration given the vision. Discuss the value added by each domestic partner university in research, education, and innovation. For the minority-serving domestic partner university, present the demographic data of the underrepresented groups enrolled in an engineering discipline. Finally, discuss the value added by partnerships with domestic affiliated faculty and any foreign collaboration that might be in place at proposal submission or planned for year one.

**(4.f.2) Team Composition:** Briefly discuss the composition and roles of the leadership team, including the Director, Deputy Director or Executive Director, Research Thrust Leaders, University Education and Pre-college Education Program Directors, Industrial Collaboration and Innovation Director, Diversity Director, Administrative Director, and Student Leadership Council.

Provide summary information in the form of a pie chart indicating the disciplinary composition of the faculty team, based on his/her departmental affiliations or degrees, as appropriate for each person.

**(4.f.3) Diversity and Culture of Inclusivity:** Provide the ERC's plan to develop a culture of inclusivity which integrates faculty, students and staff who come from different disciplines and perspectives on research, education, and technological innovation and integrates the rich perspectives offered by diversity in gender, race, ethnicity, and other demographics. The plan will include goals, non-quantitative milestones, and intended actions for success in building a culture of inclusivity and success for all. This plan will include diverse leadership, diverse faculty, and diverse graduate and undergraduate student teams, thus, producing diverse cadres of ERC graduates. Plans should articulate the roles of the deans and collaborating department chairs in preparing the plan and their commitments to working with the ERC in executing the plan.

Provide a table that shows an inventory of diversity-related programs and offices and diversity awards, at each of the partner institutions and mark with an X those that will be leveraged by the ERC. Describe how the ERC will work with those programs, offices, awardees and leverage their resources/infrastructure to create a culture of inclusion within the center. Note: Leverage only those programs and offices that make sense to meet the diversity objectives of the center.

Plans must not include quantitative targets. However, be advised that upon award, annual reports will include quantitative information on the demographics of the ERC personnel, benchmarked against engineering-wide averages. Annual reports also will include information on progress and impacts in developing a culture of inclusivity and success for all in the ERC, which may be gathered through diversity climate surveys and other means.

The proposal should include a table (format below) showing the diversity of the ERC Leadership Team, who are U.S. citizens and Permanent Residents, of the proposed ERC. These individuals, from the lead and the university-level domestic partner institutions, have been identified to participate in the ERC's research and curriculum development efforts during years one through five. Note: NSF is committed to providing equal opportunities for participation in its programs and promoting the full use of the Nation's research and engineering resources. To aid in meeting these objectives, NSF requests information on the gender, race, ethnicity and disability status of individuals named as PIs / co-PIs on proposals and awards. Submission of the information on this table is voluntary.

ERC Name	Total #*	Males	Females	African Americans	Native American, Pacific islanders	Hispanic Americans	Persons with Disabilities **
Leadership Team							
Thrust Leaders							
Faculty							
Totals							

\* It is understood that the total will equal the total of males and females who are U.S. citizens or Permanent Residents of the U.S., and the totals for racial and ethnic minorities and persons with disabilities will be larger than that total due to double counting.

\*\* A person with a disability is someone who has one or more impairments that affect substantially one or more activities of daily living, and the impairment(s) is/are not completely correctable with assistive devices.

Since it is not clear at the proposal stage which students will be involved in the ERC, please do not include students in the data. Also, do not include data for the following: foreign nationals, non-tenure-track faculty, research staff, post-doctoral students, technicians, office staff, or pre-college teachers or students.

**(4.f.4) Mentoring.** This section should provide information on how the junior faculty, students and postdoctoral researchers will be mentored for success. Also this section and the university commitment letters will indicate how the university faculty and students would be rewarded for their educational/mentoring efforts by the university administrations involved. In addition, if a postdoctoral researcher(s) is to be supported by the ERC budget, a separate Postdoctoral Mentoring Statement must be included in the Supplementary Documents Section (Sec. 10.c) of the proposal, or the proposal will be returned without review. Refer to the GPG for additional information.

**(4.f.5) Organizational Structure and Management System:** Describe the proposed organizational structure including information on how the members from participating universities and pre-college institutions will be developed into an integrated team. Include an organization chart for the ERC. Discuss the roles of the members of the ERC's Leadership Team and the roles of the Dean of Engineering at the lead institution, the Council of Deans in coordinating the partner institutions, the lead university policy boards, the Student Leadership Council, the future Scientific Advisory Board (SAB), and the Industrial / Practitioner Advisory Board (IPAB). While potential members of the IPAB will be contacted to determine their willingness to join as members and obtain their input on the proposal, **the SAB must not be formed and potential members of the SAB must not be contacted during the proposal preparation and review stages, as this compromises the review process (i.e., conflicts of interest).**

Describe how projects will be selected and evaluated and who will be responsible for the integration of projects to achieve the deliverables of the ERC. Describe how the SAB and the IPAB will be involved in the review of projects to be funded and their impacts.

Describe the process for development of a SWOT analysis by the IPAB and SLC members, how these analyses will be



communicated to the NSF site visit teams post award, and how they will impact the management system of the ERC.

**(4.f.6) Financial Support and Functional Allocation of Resources:** Discuss the plans for financial and in-kind support from all sources, except the cost sharing. Include plans for allocation of those resources to fulfill the goals of the ERC. Include a functional budget table, showing only the estimated proportional distribution of effort across the functions of the ERC in its first year without showing the support levels from any sources. The table must **not** show the sources of support, since the reviewers cannot have access to the level of academic support. A template of the table can be found at <http://erc-assoc.org/content/templates-proposal-preparation-0>.

This section of the proposal must also include a table showing the committed levels of support for the first year from IPAB member firms/agencies and any additional non-member commitments from state and/or local governments for cash and/or in-kind support. A template of the table can be found at <http://erc-assoc.org/content/templates-proposal-preparation-0>

Provide a pie chart or a table showing the planned distribution of the requested NSF funds for year one between the lead, each domestic partner university, and each university contributing affiliated faculty.

**(4.f.7) Facilities, Equipment, Safety, and Headquarters Infrastructure:** Briefly discuss the laboratories, shared facilities, and equipment for the ERC, see the required section on "Facilities, Equipment and Other Resources" in the FastLane proposal template for more detail. Discuss those facilities and equipment that will be shared by members of the ERC team. Distinguish between facilities and equipment that are already available and any that will be acquired by the Center.

Include a brief discussion of procedures in place for the ERC's laboratories/facilities to assure safe research practices, especially when the ERC involves the use of toxic or dangerous chemicals, high pressure, and other dangerous equipment, etc. Safety policies can be included in "Supplementary Documents," Sec. V.A (10.e), as appropriate.

Proposals must include a description of headquarters space, its size, and functionality. Note that the headquarters space must be located on the campus of the lead academic institution. Discuss how the facilities and equipment of the ERC and the cyberinfrastructure will be used to form a collaborative team with shared resources and information.

**(4.f.8) Institutional Commitment:** Discuss the commitment of the lead and partner institutions (universities, pre-college partners, any community/technical college partners, and innovation facilitation partners) to the research, education, diversity and innovation goals of the proposed ERC. Discuss how these institutions / organizations will assure that their policies and practices will support the Center in achieving its goals. Include a discussion of tenure and mentoring policies in light of the cross-disciplinary structure of the ERC and its mission to go beyond a traditional research culture: integrating research and education, stimulating collaboration with industry, patenting IP, and innovating technologies. Do not discuss cost sharing in this section.

(Note: This is the end of the requirements for Sec. (4) Project Description Section.)

**(5) References Cited.** Follow GPG guidance, and cite those references most relevant to the goals of the center.

**(6) Biographical Sketches** (two-page limit per person). The basic GPG guidelines for preparation of biographical material apply. Biographical sketches are required of all the faculty and key staff participants (e.g., the Center Director, Deputy Director (or Executive Director), the University Education Director, the Pre-College Education Director, Industrial Collaboration and Innovation Director (if known), the Research Thrust Leaders, the Diversity Director, the Administrative Director (if known), and faculty expected to receive support in years one through five from the ERC. For faculty, publications listed should be those most highly relevant to the proposal.

**(7) Budgetary Information.** Follow the GPG guidance for the budget and the budget justification.

**Travel Funds for ERC Leadership Team's Participation in Biennial Meetings:** Members of the ERC leadership team are required to participate in the ERC biennial meetings and cross-ERC leadership team retreats. Plans are to change the frequency of the ERC Annual meeting to every other year and to hold individual retreats of the ERC Leadership team groups in the off year. The purpose of biennial meeting is to share successes and failures across the ERCs, receive updates on the ERC Program, and provide input for future Program improvements. The purpose of the retreats is to focus on issues specific to the different leadership team groups. The biennial meetings are held in the Washington DC area for 2.5 days, and the retreats are held around the country for 1-2 days. Therefore, include travel funds in each of the annual budgets to support participation in the biennial meeting ERC for all the members of the ERC's leadership team: the Center Director, the Deputy Director (or Executive Director), the Thrust Leaders, other Co-PIs, the Education Program Director, the Pre-college Education Program Director, the Diversity Director, the Industrial Collaboration and Innovation Director, the Administrative Director, and up to four members of the Student Leadership Council. These same people would participate in one of these topic-specific retreats every other year.

Note: The budget justification section should only identify items that are not cost shared. A justification and explanation of cost shared items will be appended to the cost sharing tables that are submitted in the single-copy document section of the proposal. If additional space is required for the budget justification, put the information in the "Supplementary Documents" section of the proposal. Then, in the budget justification section, direct reviewers to the "Supplementary Documents" section of the proposal for the additional justification.

Cost sharing is mandatory and is specialized. Please see Section V.B. for additional information.

**(8) Current and Pending Support.** Include only for the Center Director, Deputy Director, and Research Thrust Leaders, and other faculty expected to receive support in the first five years from the ERC.

**(9) Facilities, Equipment and Other Resources.** Follow GPG guidance.

**(10) Supplementary Documents.** Provide supplemental documents as instructed in the GPG. The following items are to be provided as additional supplemental documents.

**(10.a.) Letters of Commitment.**

- Submit the following letters of commitment from:
  - Senior university administrators (Dean of Engineering and one other higher-level university official) for the lead university attesting to the institutional commitment to the goals of the ERC and a commitment to headquarters space in both letters. **The letters should not mention cost sharing**, as that information cannot be revealed to reviewers. The letters should indicate how tenure and promotion policies will support the ERC, commit to the ERC's diversity and mentoring plans, assure the safety of laboratories where ERC students and faculty work, and assure the development of a cross-center IP policy within 90 days, if an award is made.
  - Senior administrators (Dean of Engineering and/or a higher-level university official) for each of the partner universities attesting to the institutional commitment to the goals of the ERC. **The letters should not mention cost sharing**, as that information cannot be revealed to reviewers. The letters should indicate how tenure and

promotion policies will support the ERC, commit to the ERC's diversity and mentoring plans, assure the safety of laboratories where ERC students and faculty work, and assure the development of a cross-center IP policy within 90 days, if an award is made.

- o Partner university organization and/or state or local government agencies **committed** to partnership with the ERC to facilitate its impact on entrepreneurship, innovation, job creation, and local economic development.
- o Administrator of each of the proposed pre-college or community college partners committing to their roles in the ERC as discussed in the pre-college education guidance section above.
- o Officials of firms and agencies able to commit to membership.
- o Officials from any participating federal laboratories indicating their involvement in the ERC and their commitment to provide financial support for their staff participating in the ERC.
- o Domestic affiliated faculty if their projects are planned to be in place during years one through five. Note that no letters are required from the administrators of the universities providing affiliated faculty.
- o Foreign collaborators, if the projects are planned to be in place during years one through five.

The letters as they appear in the proposal should be addressed to:

Ms. Lynn Preston, Leader of the ERC Program

Division of Engineering Education and Centers

National Science Foundation

4201 Wilson Boulevard, Suite 585

Arlington, VA 22230

#### (10.b) Draft Membership Agreement.

Upload the draft membership agreement in "Supplemental Documents".

#### (10.c) Postdoctoral Mentoring Plan.

Provide a mentoring plan for post docs who will be supported by ERC funds. See the GPG for more guidance.

#### (10.d) Data Management Plan

Provide a Data Management Plan according to guidance in the GPG. Go to [http://nsf.gov/eng/general/ENG\\_DMP\\_Policy.pdf](http://nsf.gov/eng/general/ENG_DMP_Policy.pdf) for Engineering-specific guidance.

#### (10.e) Laboratory Safety Policy

As appropriate, per Sec. V.A (4.f.7), provide the policy that will be used to ensure standard laboratory safety practices throughout the ERC lead and partner institutions.

**All letters must be placed in the Supplementary Documents section of the FastLane proposal or the Grants.gov proposal and submitted electronically, as part of the proposal. If submitting through Grants.gov, refer to the NSF Grants.gov Application Guide. Please instruct the authors of these letters not to mail, email, or fax copies to the NSF.**

**(11) Single Copy Documents-viewable only by NSF** (also refer to the GPG Chapter II.C.1 on "Single-Copy Documents" for additional information):

**(11.a) Optional List of Suggested Reviewers or Reviewers Not to Include:** Proposers may include in the single copy documents section a list of suggested reviewers who they believe are especially well qualified to review the proposal. Proposers also may designate persons they would prefer not review the ERC proposal, indicating why. These suggestions are optional. GPG Exhibit II-2 contains information on conflicts of interest that may be useful in preparation of this list. The cognizant Program Officer handling the proposal considers the suggestions and may contact the proposer for further information. However, the decision whether or not to use the suggestions remains with the Program Officer.

**(11.b) Required Cost Sharing Tables and Justification:** Complete and submit the following tables: "Committed Cash and In-Kind Academic Support, Years 1-5" and, if applicable, a table showing the "Nature of In-Kind Support" identifying any in-kind commitments and the sources of the commitments. A template of those tables can be found at <http://www.erc-assoc.org/>, under the button marked "Funding Opportunities (second bullet)." The tables should be uploaded into the single copy documents section of the full proposal. Appended to the cost sharing tables will be a justification / explanation of the source, nature, amount, and availability of any proposed cost sharing. **Proposers are directed not to include these tables and the cost sharing justification in any other part of the proposal, as cost sharing commitments are not to be provided to reviewers.** Refer to section B. Budgetary Information and Cost Sharing in this solicitation for information on cost sharing requirements and policies.

#### (12) Post Proposal Submission to NSF: Other Required Documents -

**(12.a)** On receipt of the proposal number after submission, send an email to [ercintent@nsf.gov](mailto:ercintent@nsf.gov). The subject heading of the email should note the proposal number and the lead institution. Attach the table of participants containing conflict of interest information as instructed above.

**(12.b)** If the proposal is site visited, a 10-page proposal update that integrates changes in the proposal resulting from reviewer input, including the site visit report, will be requested to facilitate the final stages of the review process.

#### SUMMARY OF INVITED FULL PROPOSAL REQUIREMENTS

**(Note: This is not a total list of the ERC proposal requirements. Refer to the ERC Solicitation and the PAPPG for complete requirements)**

Topic	Full Proposal
Academic cost sharing (Lead and domestic partner universities)	Yes
Industrial/Practitioner member cash and in-kind support	Yes
Identification of funded faculty/staff members from the lead and university-level partner institutions	Years 1-5
Names of participating pre-college institutions	Yes

Names of pre-college teachers	No
Names of participating innovation facilitation partner(s), i.e. university, and/or state and local government organizations devoted to entrepreneurship, stimulating innovation, etc.	Yes
Names of firms/practitioner organizations committed to membership in the ERC	Yes
Letter of Intent (LOI) must be submitted through FastLane	Yes
Full Proposals can be submitted through FastLane or Grants.gov (see solicitation for instructions)	Yes
Draft membership agreement	Yes
Draft IP policy	No
Letter of commitment from the Dean of Engineering and one other higher level administrator, including a commitment to headquarters space in each letter	Yes - (but no cost sharing identified in letters)
Letters of commitment from the partner universities' Deans of Engineering and one other higher level administrator (per institution) (no letters are required from administrators from universities contributing affiliated faculty)	Yes - (but no cost sharing identified in letters)
Letter of commitment from domestic faculty from affiliated universities, if the project(s) will be supported in years one through five	Required only if there are these types of collaborations proposed
Letters of commitment from foreign faculty collaborators if the project(s) will be in place in year one.	Required only if there are these types of collaborations are identified for year one
Letters of commitment from administrators of federal laboratories contributing support for staff to carry out research and other roles in the ERC, attesting to laboratory support for that staff time	Required only if there are these types of collaborations proposed
Letters of commitment to membership from firms / agencies / hospitals committed to joining the ERC as members and providing cash and in-kind support to the ERC	Yes
Letters from firms/agencies/hospitals only interested but not committed to joining the ERC	No
Letters of commitment to partnership from pre-college partner administrators (school district or individual schools) committing to the RET, Young Scholars and student participation programs and to including engineering in pre-college education	Yes
Letters of commitment from community college administrators	Only if included in the ERC
Letters of commitment from state or local government agency or state governor providing non-member financial support to the ERC	This type of support is not required but if it is proposed, a letter of commitment is required
Letters of commitment from innovation facilitation partner(s), i.e. university, and/or state and local government organizations devoted to entrepreneurship, stimulating innovation, etc.	Yes
Pie Chart/Table of Year 1 Planned Distribution of NSF Funds	In the "Financial Support and Functional Allocation of Resources" section of the Project Description
Functional Budget Table	Included in Project Description
Year 1 Committed Industrial and Other Non-NSF, Non-Academic Support table	Included in the Project Description
Table of "Committed Cash and In-Kind Academic Support, Years 1-5" and a table "Nature of In-Kind Support." Also, append to the tables a justification/explanation of any cost shared items.	Submitted in the "Single-Copy Documents" section

## B. Budgetary Information

**Cost Sharing:** Cost Sharing is required.

**NOTE:** Cost Sharing is required for Invited Full Proposals.

Invited full proposals will include a budget for each of the five years. FastLane or Grants.gov will automatically provide a cumulative budget. Provide a separate budget for subcontracts to the domestic partner institutions and any affiliated institutions whose faculty and would be supported by the ERC's budget. The budget for year one may be no more than \$3,250,000, no more than \$3,500,000 for year two, no more than \$3,750,000 for year three, no more than \$4,000,000 for year four, and no more than \$4,000,000 for year five.

**Cost Sharing:** Cost Sharing is required but inclusion of voluntary committed cost sharing is prohibited.

### Mandatory Cost Sharing Requirements and Policies:

Pursuant to the National Science Board's (NSB's) Recommendation 5 (as stated in NSB 09-20) mandatory cost sharing for the NSF Engineering Research Centers (ERC) Program has been reinstated, since cost sharing is foundational to the strategic programmatic goals of the ERC Program.

Cost sharing is not a review criterion for ERCs; it is an eligibility criterion. Because cost sharing is not a review criterion, details on cost sharing will not be shared with reviewers.

Academic cost sharing is required of the lead university and core domestic partner university(ies) to support and sustain the ERC. Upon issuance of the award, the lead university is responsible for securing, retaining, managing, certifying and delivering to NSF the ERC's cost sharing (cash and in-kind), at the level stated in the cooperative agreement. The total level of cost sharing will be the responsibility of the lead university, but such cost sharing also can include contributions by any or all of the partner universities. The

actual amount will be calculated based on the formula that is described below; see "Cost Sharing Formula." The formula reflects both the type of institution and the level of funding proposed. Cost sharing is not required nor expected of institutions solely contributing affiliated faculty.

Institutions providing affiliated faculty, pre-college partners, and university, state and local government organizations devoted to entrepreneurship and innovation do not cost share. Refer to the sections below for guidance on how to provide details on cost sharing for NSF and to ensure that the reviewers do not see cost sharing.

Inclusion of cost sharing above the mandatory level as stated in the ERC cost sharing formula would be considered "voluntary committed cost sharing," which is specifically prohibited according to NSF's [revised cost sharing principles](#). ERC proposals that include cost sharing amounts in excess of the specified formula run the risk of being returned without review or declined.

Instructions for Disclosure and Non-Disclosure of Cost Sharing within the Proposal:

- **Cost Sharing and Letters of Commitment:** Since cost sharing is not to be seen or considered by reviewers, any letters of commitment should **not** mention any cost sharing (cash or in-kind), since the reviewers will see these letters. See Sec. V.A (10.a) for details concerning the letters of commitment.
- **Cost Sharing in the Budget Submission:** The proposed cost sharing (including the estimated value of any in-kind cost sharing), according to the formula below, must be shown on Line M of the NSF proposal budget form. (Line M is masked from reviewers.) **Cumulative cost sharing should be entered for all 5 years on Line M of the first year budget.** Do not include the cost sharing figures on Line M of the budget for years 2-5. Do not include the justification / explanation for any cost-shared items in the budget justification section of the proposal. Only the non-cost shared items should be explained in the budget justification section, identifying the source, nature, amount and availability of non-cost shared items.
- **Cost Sharing Tables and Justification:** The cost sharing commitment of the ERC must be documented in the proposal and the details presented in the tables of committed support. The lead institution is instructed to provide a table of "Committed Cash and In-Kind Academic Support, Years 1-5" (including any partner university providing cash for years 1-5). Proposers must also complete the table "Nature of In-Kind Support" identifying in-kind commitments and the sources of the commitments. A template of those tables can be found at <http://erc-assoc.org/content/templates-proposal-preparation-0>. The tables should be uploaded into the single-copy documents section of the proposal. Append to the cost sharing tables a justification / explanation of the source, nature, amount and availability of any proposed cost sharing. Proposers are directed not to include these tables and the cost sharing justification in any other part of the proposal, as cost sharing commitments are not to be provided to reviewers.

#### Cost Sharing Formula:

It is understood that the availability of financial resources may present significant challenges to commit to cost sharing in an ERC for some smaller universities and colleges and universities that do not have high research activity. Therefore, the ERC cost sharing requirements are graduated and vary by the basic classification categories of universities and colleges as defined in the "Carnegie Foundation's Classification of Institutions of Higher Education." See [http://classifications.carnegiefoundation.org/lookup\\_listings/institution.php](http://classifications.carnegiefoundation.org/lookup_listings/institution.php). The classification categories and ERC cost sharing requirements are as follows:

- RU/VH: Research Universities (very high research activity) - required cost sharing level is 20% of the allocation of the NSF budget to the lead or partner university;
- RU/H: Research Universities (high research activity) - required cost sharing level is 15% of the allocation of the NSF budget to the lead or partner university;
- DRU: Doctoral/Research Universities - cost sharing level is 10% of the allocation of the NSF budget to that partner university;
- Master's L: Master's Colleges and Universities (larger programs) - cost sharing level is 10% of the allocation of the NSF budget to that partner university/college;
- Bac/Diverse: Baccalaureate Colleges--Diverse Fields - cost sharing level is 5% of the allocation of the NSF budget to that partner college.

If the university is classified in more than one Carnegie category, it must cost share at the highest cost sharing category as described above. In addition, the Carnegie classification that is to be used is the classification in place at the LOI submission deadline, and it will remain throughout the duration of the competition and any subsequent award. The total ERC cost share will be 20% or less, depending upon the Carnegie classifications for each of the partners.

#### Cost-Sharing Sources:

The proposed cost sharing must be shown on Line M on the proposal budget. Documentation of the availability of cost sharing must be included in the proposal. Only items which would be allowable under the applicable cost principles, if charged to the project, may be included as the awardee's contribution to cost sharing. Contributions may be made from any non-Federal source, including non-Federal grants or contracts, and may be cash or in-kind (2 CFR § 215.23). It should be noted that contributions counted as cost-sharing toward projects of another Federal agency may not be counted towards meeting the specific cost-sharing requirements of the NSF award. All cost-sharing amounts are subject to audit. Failure to provide the level of cost-sharing required by the NSF solicitation and reflected in the approved award budget may result in termination of the NSF award, disallowance of award costs and/or refund of award funds to NSF.

Administrative requirements related to cost sharing may be found in 2 CFR § 215.23, "Cost Sharing or Matching." For additional information on cost principles consult: 2 CFR Part 220, Cost Principles for Educational Institutions (OMB Circular A-21); or 2 CFR Part 230, Cost Principles for Nonprofit Organizations (OMB Circular A-122), as applicable.

#### Other Budgetary Limitations:

The overall center-level budget should be prepared to assure sufficient funding from all sources to achieve the goals of the ERC. Hence, this budget would include faculty and staff to support the research, education, industrial collaboration/innovation, and management of the ERC. Budgets should include resources for reporting, site visit costs, and travel for cross-ERC collaboration and NSF meetings. The budget submitted to NSF will include an allocation plan for the NSF funding only.

## C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):  
May 30, 2013
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. proposer's local time):

July 30, 2013

- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):

February 12, 2014

LOIs and full proposals must be submitted by 5:00 p.m. proposer's local time on the relevant deadline or the proposal will be returned without review.

## D. FastLane/Grants.gov Requirements

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### For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail [fastlane@nsf.gov](mailto:fastlane@nsf.gov). The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

### For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <http://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: [support@grants.gov](mailto:support@grants.gov). The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

**Submitting the Proposal:** Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane are strongly encouraged to use FastLane to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

## VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

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Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in the GPG as [Exhibit III-1](#).

A comprehensive description of the Foundation's merit review process is available on the NSF website at: [http://nsf.gov/bfa/dias/policy/merit\\_review/](http://nsf.gov/bfa/dias/policy/merit_review/).

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in [Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years \(FY\) 2011-2016](#). These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the core strategies in support of NSF's mission is to foster integration of research and education through the programs, projects and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students, and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the variety of learning perspectives.

Another core strategy in support of NSF's mission is broadening opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

## A. Merit Review Principles and Criteria

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The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the



national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

## 1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

## 2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. ([GPG Chapter II.C.2.d.i.](#) contains additional information for use by proposers in development of the Project Description section of the proposal.) Reviewers are strongly encouraged to review the criteria, including [GPG Chapter II.C.2.d.i.](#), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
  - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
  - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

## Additional Solicitation Specific Review Criteria

### Preliminary Proposals

Reviewers are instructed that the first review "gate" through which the proposal will be judged includes the Vision, Strategic Plan, and Research Program. Only proposals that pass through this gate with high quality efforts and also pass through the workforce development and innovation ecosystem gates with high quality efforts will be considered for an invitation to submit a full proposal.

### Vision, Strategic Research Plan, and Research Program -

- Vision effectively identifies an engineered system at the cusp of emerging discoveries and emerging opportunities for technological innovation with significant potential for transformational impact;
- Research strategic plan:
  - Powerful fundamental and technology insights drive the strategic plan
  - The 3-plane strategic plan chart effectively targets critical engineered systems goals, identifying significant technical barriers; and as appropriate, targeting societal, environmental, and other non-technical barriers to

- achieving those goals;
  - Effectively structures a compelling cross-disciplinary research program to address these barriers through a significant body of fundamental (at the nanoscale for NERCs) and enabling and systems level research plus proof-of-concept test beds..
- Engineering Workforce Development (Education): Plan will attract pre-college students to engineering and result in the graduation of students who have the skill sets to succeed in technological innovation in industry in a globally competitive economy.
- Innovation Ecosystem: Strategic configuration of members and membership plan would result in a highly effective approach to industrial collaboration and innovation.
- Clearly demonstrated need for a center to accomplish its goals.

#### **Invited Full Proposals**

The additional review criteria for ERC proposals are as follows. Reviewers are instructed that the first review "gate" through which the proposal will be judged includes the Vision, Strategic Plan and Research Program. Only proposals that pass through this gate with high quality research efforts and also with high quality Engineering Workforce Development (education), innovation ecosystem programs, and a high quality infrastructure for the proposed ERC will be considered for a site visit or funding.

#### **Vision, Strategic Research Plan and Research Program -**

- Vision effectively defines an engineered system at the cusp of emerging discoveries in science and engineering and emerging opportunities for technological innovation with significant potential for transformational impact;
- Vision effectively defines a culture with a symbiotic relationship between research, education, and innovation that will produce an innovative, globally, competitive, and diverse engineering workforce;
- Strong state-of-the-art analysis that clearly justifies the value added of the ERC over current investments in the field;
- Research strategic plan:
  - Through the 3-plane strategic plan chart, effectively targets critical engineered systems goals and identifies significant technical barriers; and as appropriate, targets societal, environmental, and other non-technical barriers to achieving those goals;
  - Effectively structures a high quality and compelling cross-disciplinary research program to address these barriers through a significant body of fundamental (at the nanoscale for NERCs) and enabling and systems level research plus proof-of-concept test beds;
  - Includes a strong plan to manage systems test bed work, including managing interfaces and knowledge exchange with the enabling and fundamental research tasks and a strategy to monitor the progress of test beds including contingency plans, sun setting efforts, and formulating new test beds;
  - Effectively stages anticipated research milestones, technological outcomes, and translatable system innovations chronologically through a milestone chart;
  - Effective plans for human capital that integrate perspectives on research, education, and innovation and support a demographically diverse team;
  - Sound plan for experimental resources.
- Research thrusts and test beds effectively support the strategic plan through:
  - Planning to achieve significant research milestones;
  - Addressing key fundamental and technical barriers;
  - Developing innovative research methodologies that advance the state of the art;
  - Integrating knowledge from other projects and thrusts;
  - Effectively integrating knowledge to explore technology realities through proof-of-concept enabling and systems test beds at an academic scale;
  - Cycling knowledge and test bed results back to the strategic planning process;
  - Identifying an exceptional team with the skills and disciplines needed to achieve the goals; foreign faculty collaborators add value to the research.
- Research program provides opportunities to significantly enhance undergraduate education through significant involvement of undergraduate ERC students in research during the academic year; and, for non-ERC students, through a Research Experiences for Undergraduates (REU) program (budgeted at \$42K per year).
  - Plans in place to port nanoscale simulation tools to the Network for Computational Nanotechnology for hosting nanoHUB.org, for NERCs; and, as appropriate, for Open Topic ERCs.

#### **Engineering Workforce Development (Education) -**

##### **University Education**

- The goals of the university education strategic plan will impart skill sets to undergraduate and graduate students so that they will be:
  - Effective in advancing technological innovation in industry;
  - Adaptive and creative innovators;
  - Effective in innovation in a globally-connected, innovation-driven world
- The strategic plan clearly specifies:
  - Desired characteristics and skill sets of student researchers;
  - Approaches to impart these skill sets to students via the education program
  - Measures to assess progress and impacts through longitudinal data;
  - Mechanisms to incorporate assessment feedback to improve program content and delivery.
  - Actionable plans to mentor students, post-doctoral researchers, and junior faculty
- The education program will be integrated with the research with foreign collaborators so students have the opportunity to carry out research relevant to the ERC's goals at foreign laboratories for a time sufficiently long to provide knowledge of foreign research practices, equipment, and other competencies;
- Effective plans to integrate the ERC's cross-disciplinary and systems research into courseware and curricula and make the course materials available to all ERC partners and for workforce training;
  - For NERCs and open topic ERCs, course and curriculum materials for nanoscale education will be ported to the Network for Computational Nanotechnology for hosting on nano HUB.org.

##### **Pre-college Education**

- Pre-college education program will develop an effective long-term partnership with five pre-college institutions (school districts or individual schools) nearby the lead and/or partner universities so the mix includes middle and high schools;
- Pre-college partners and the ERC are committed to introduce engineering principles and activities into the pre-college classroom through a Research Experiences for Teachers (RET) Program (budgeted at \$84K per year); The RET Program will:
  - Provide in-service and/or pre-service K-12 STEM teachers and community college faculty (if included) with engineering research experiences in ERC research labs/facilities;

- o Result in increased knowledge of engineering for the teachers, strong engineering content modules for the classroom derived from ERC research, and effective engineering experiences for students;
  - o Include substantive plans for sustained follow-up between faculty and pre-college teachers and any community/technical college faculty to ensure research experiences are translated into classroom practice;
- The RET Program and the broader pre-college education program will engage a broadly diverse group of students in the ERC's programs to motivate them to study engineering;
- The pre-college education program will support a Young Scholars research program for promising high schools students to carry out research in the ERC's laboratories;
- If community college or technical college faculty and students are involved, the experience will add value to the educational capacity of the faculty and students;
- If the program includes community/technical college faculty and students, there will be value added to both the ERC and those faculty and students.

#### For Both the Precollege and University Programs:

- Effective assessment and tools are proposed to incorporate feedback from assessments/evaluations into the education programs to improve program content and deliver on program goals.
- Effective plans are in place to disseminate outcomes and curriculum/outreach products of the college and pre-college /community college programs to the participating partner and outreach institutions and beyond (for NERCs this would include porting the materials to a nanoHUB.org for broader dissemination).

#### Innovation Ecosystem

- Convincing strategy for developing innovation ecosystem including industrial/practitioner members; partnerships with university and / or state and local government organizations to facilitate entrepreneurship and innovation;
- Convincing rationale for the selection of industrial/practitioner members across the value chain relevant to the vision who will be engaged in planning, research, education, and innovation;
- Active engagement of industry / practitioner organizations through an Industrial / Practitioner Advisory Board;
- Draft terms of the industrial / practitioner membership agreement will structure a Center-wide program of industrial/practitioner collaboration to support overall ERC goals;
- Proposed terms for a center-wide intellectual property policy will facilitate collaboration with industry through shared rights for joint work and enable technology transfer (note draft policy is not included in the proposal);
- For intellectual property that members do not license, clear strategy for the ERC to pursue sponsored research projects with non-member large firms or with member or non-member small firms to accelerate commercialization;
- Convincing evidence that any conflicts of interest regarding faculty and start-up firms will be effectively managed; and other firms impacted by the ERC's research will be managed at the university level;
- Plans are in place to coordinate with education and outreach programs to provide ERC students exposure to concepts in intellectual property, entrepreneurship, commercialization, and professional "soft skills" needed in industry.

#### Infrastructure

- **Configuration:** Institutional configuration is appropriate to the goals of the ERC and a convincing strategy for cross-institution collaboration in research, education, and innovation; at least one partner serves large numbers of students from underrepresented groups who are majoring in STEM field to enhance diversity;
- **Leadership:** Capable Center Director with experience in managing teams; Deputy Director/Executive Director will support the director and add management value to the team, other members of the leadership team have the skill sets and experience to contribute to the ERC's goals;
- **Team:** Faculty/research staff team is high quality with the expertise in the disciplines required to attain the ERC's goals and
- **Culture of Inclusivity:** Proposal evidences a strong commitment to:
  - o Respect for the differing faculty perspectives on research and education;
  - o An inclusive culture that will result in a diverse team of leaders, faculty, students, and staff from the lead and all partner institutions;
  - o Strong partnerships with the involved deans and department chairs that evidence a commitment to a culture of inclusivity, diversity, and success for all for the ERC;
  - o Inclusion in the proposal of faculty, students and staff who are diverse in gender, race, and ethnicity (from groups underrepresented in engineering), and persons with disabilities;
  - o Leveraging of other diversity programs, university offices, and awards, at all the domestic partner universities, designed to serve underrepresented groups in STEM;
  - o Pre-college partnerships involve schools/schools districts that serve diverse populations.
- **Mentoring:** ERC committed to mentoring at all levels and partner universities are committed to rewarding ERC faculty and students mentoring activities; post-doctoral student mentoring plan shows commitment to mentoring and preparing them for career success.
- **Organizational Structure and Management Systems:** Organizational structure and management plan effectively organize and integrate the resources of the ERC across the partner institutions to achieve its goals and effectively use advisory boards, including their role in advising on project selection/evaluation systems.
- **Equipment, Facilities, Safety and Headquarters Space:**
  - o Experimental, computational, and other required equipment, facilities, and laboratory space are in place or proposed to support the research of the Center;
  - o Strong commitments at all levels to safety in the ERC's laboratories;
  - o Cyberinfrastructure is effectively used to achieve collaboration and sharing of information;
  - o Headquarters space is located on the campus of the lead university, is sufficiently large to house the leaders and staff, and supports the management, communication, and cross-disciplinary collaboration functions of the ERC.
- **Financial Commitment:** Level of committed industrial / practitioner financial and in-kind support is commensurate with typical levels of support for academic research in the fields involved in the ERC.
- **University Commitment:** University administrators from the lead and partner institutions will:
  - o Join in partnership in support of ERC's vision and goals;
  - o Assure cross-university industrial membership and IP policies that recognize shared rights for joint work;
  - o Assure cross-university involvement in the ERC's education program;
  - o Support the ERC's plans for diversity and building a culture for inclusivity and success for all;
  - o Develop policies to reward faculty for participating in cross-disciplinary research and innovation, mentoring, university and pre-college education, and delivering on the ERC's diversity goals;
- **Data Sharing:** Appropriate policies are in place for universities receiving ERC funds to share findings, data and other research products.

## B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, Site Visit Review, or Reverse Site Review.

Preliminary proposals will receive ad hoc and panel review. Approximately 30 of the submitting PIs will be invited to submit a full proposal. The invited full proposals will receive ad hoc and panel review, and a subset of these full proposals will receive site visits. All of the site visits will either be held on the campuses of the lead universities of the proposed ERCs, or as reverse site visits at or near NSF. The location of the site visits will be determined at a later date. At the conclusion of all the site visits, small teams from each of the site-visited proposed ERCs will brief a final review panel at NSF. Based on the information gained from these reviews and recommendations, NSF will select a subset of proposals for award.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will be completed and submitted by each reviewer. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

## VII. AWARD ADMINISTRATION INFORMATION

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### A. Notification of the Award

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Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

### B. Award Conditions

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An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)\*; or Research Terms and Conditions\* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

\*These documents may be accessed electronically on NSF's Website at [http://www.nsf.gov/awards/managing/award\\_conditions.jsp?org=NSF](http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF). Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov).

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the *NSF Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=aag](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag).

### C. Reporting Requirements

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For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). Within 90 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the

nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=aag](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag).

NSF requires ERCs to submit annual reports that are more extensive in scope than those required of single investigator awards. NSF provides guidelines for these reports. NSF also requires ERCs to collect and submit to NSF data on indicators of progress, outcome, impact, and financial management. NSF provides data definition guidelines and templates for the recording and submission of these data through a secure web site.

## VIII. AGENCY CONTACTS

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*Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.*

General inquiries regarding this program should be made to:

- Lynn Preston, telephone: (703) 292-5358, email: [lpreston@nsf.gov](mailto:lpreston@nsf.gov)
- Deborah J. Jackson, telephone: (703) 292-7499, email: [djackson@nsf.gov](mailto:djackson@nsf.gov)
- Carole Read, telephone: (703) 292-2418, email: [cread@nsf.gov](mailto:cread@nsf.gov)
- Keith Roper, telephone: (703) 292-8769, email: [kroper@nsf.gov](mailto:kroper@nsf.gov)

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: [fastlane@nsf.gov](mailto:fastlane@nsf.gov).

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: [support@grants.gov](mailto:support@grants.gov).

## IX. OTHER INFORMATION

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The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website at [https://public.govdelivery.com/accounts/USNSF/subscriber/new?topic\\_id=USNSF\\_179](https://public.govdelivery.com/accounts/USNSF/subscriber/new?topic_id=USNSF_179).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this new mechanism. Further information on Grants.gov may be obtained at <http://www.grants.gov>.

## ABOUT THE NATIONAL SCIENCE FOUNDATION

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The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

*Facilitation Awards for Scientists and Engineers with Disabilities* provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.



The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <http://www.nsf.gov>

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
  - Send an e-mail to: [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov)
  - or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

## PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, [NSF-50](#), "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and [NSF-51](#), "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton  
Reports Clearance Officer  
Office of the General Counsel  
National Science Foundation  
Arlington, VA 22230

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