

Nanotechnology Undergraduate Education (NUE) in Engineering

PROGRAM SOLICITATION

NSF 14-541

REPLACES DOCUMENT(S):
NSF 13-541



National Science Foundation

Directorate for Engineering
Engineering Education and Centers

Directorate for Social, Behavioral & Economic Sciences
Division of Social and Economic Sciences

Directorate for Education & Human Resources
Division of Undergraduate Education

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

May 27, 2014

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Nanotechnology Undergraduate Education (NUE) in Engineering

Synopsis of Program:

This solicitation aims at introducing nanoscale science, engineering, and technology through a variety of interdisciplinary approaches into undergraduate engineering education. The focus of the FY 2014 competition is on nanoscale engineering education with relevance to devices and systems and/or on the societal, ethical, economic and/or environmental issues relevant to nanotechnology.

A well-prepared, innovative science, technology, engineering and mathematics (STEM) workforce is crucial to the Nation's health and economy. Indeed, recent policy actions and reports have drawn attention to the opportunities and challenges inherent in increasing the number of highly qualified STEM graduates, including STEM teachers. Priorities include educating students to be leaders and innovators in emerging and rapidly changing STEM fields as well as educating a scientifically literate populace; both of these priorities depend on the nature and quality of the undergraduate education experience. In addressing these STEM challenges and priorities, the National Science Foundation invests in research-based and research-generating approaches to understanding STEM learning; to designing, testing, and studying curricular change; to wide dissemination and implementation of best practices; and to broadening participation of individuals and institutions in STEM fields. The goals of these investments include: increasing student retention in STEM, to prepare students well to participate in science for tomorrow, and to improve students' STEM learning outcomes.

Recognizing disciplinary differences and priorities, NSF's investment in research and development in undergraduate STEM education encompasses a range of approaches. These approaches include: experiential learning, assessment/metrics of learning and practice, scholarships, foundational education research, professional development/institutional change, formal and informal learning environments, and undergraduate disciplinary research. Both individually and integrated in a range of combinations, these approaches can lead to outcomes including: developing the STEM and STEM-related workforce, advancing science, broadening participation in STEM, educating a STEM-literate populace, improving K-12 STEM education, encouraging life-long learning, and building capacity in higher education.

Related funding opportunities are posted on the web site for the National Nanotechnology Initiative, <http://www.nsf.gov/nano> In addition, research and education projects in nanoscale science and engineering will continue to be supported in the relevant NSF programs and divisions.

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.

- Mary Poats, Program Manager, Directorate for Engineering, Division of Engineering Education and Centers (ENG/EEC), 585 N, telephone: (703) 292-5357, fax: (703) 292-9051, email: mpoats@nsf.gov
- Frederick M. Kronz, Program Director, Directorate for Social, Behavioral & Economic Sciences, Division of Social and Economic Sciences (SBE/SES), 995 N, telephone: (703) 292-7283, fax: (703) 292-9068, email: fkronz@nsf.gov
- Yvette Weatherton, Program Director, Directorate for Education and Human Resources/Division of Undergraduate Education

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

- 47.041 --- Engineering
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 10

Anticipated Funding Amount: \$1,900,000 pending availability of funds. Each award will be up to a maximum of \$200,000 for two years.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

The lead PI must hold a faculty appointment within a College/Department of Engineering or College/Department of Engineering Technology within the submitting US academic institution.

Limit on Number of Proposals per Organization: 1

Only one (1) proposal may be submitted by a US academic institution, College/Department of Engineering or College/Department of Engineering Technology as the lead institution with the following exception: A US academic institution may submit a second proposal as the lead institution, only if it is focused on the societal, ethical, economic and/or environmental issues relevant to nanotechnology.

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

An individual may serve as the Principal Investigator (PI) or co-Principal Investigator (co-PI) on no more than one proposal.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **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.
 - 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).

B. Budgetary Information

- **Cost Sharing Requirements:** Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:** Not Applicable
- **Other Budgetary Limitations:** Not Applicable

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):
May 27, 2014

Proposal Review Information Criteria

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

Award Conditions: Standard NSF award conditions apply.

Reporting Requirements: Standard NSF reporting requirements apply.

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I. INTRODUCTION

One nanometer (one billionth of a meter) is a magical point on the dimensional scale. Nanostructures are at the confluence of the smallest of human-made devices and the largest molecules of living systems known today. Nanoscale science and engineering (NSE) here refers to the fundamental understanding and resulting technological advances arising from the exploitation of new physical, chemical, and biological properties of systems that are intermediate in size, between isolated atoms and molecules and bulk materials, where the transitional properties between the two limits can be controlled. During the last few years, novel structures, phenomena, and processes have been observed at the nanoscale (from a fraction of a nanometer to about 100 nm) and new experimental, theoretical, and simulation tools have been developed for investigating them. These advances provide exciting opportunities for scientific and technological developments in nanoparticles, nanostructure materials, nanodevices, and systems.

Nanotechnology is the creation and utilization of functional materials, devices, and systems with novel properties and functions that are achieved through the control and restructuring of matter at the atomic, molecular and macromolecular levels. A revolution has begun in science, engineering, and technology based on the ability to organize, characterize, and manipulate matter systematically at the nanoscale. Far-reaching outcomes for the 21st century are envisioned in both scientific knowledge and a wide range of technologies in most industries, healthcare, conservation of materials and energy, biology, environment, and education. Fundamental research in NSE underpins innovation in critical areas ranging from manufacturing to medicine.

NSE has technological, economic, environmental, social, and ethical dimensions that may change the world in which we live. Increased understanding and appreciation of the potential for nanoscale science and engineering will be needed to create an informed citizenry and a competitive workforce.

The Nanotechnology Undergraduate Education (NUE) in Engineering program aims to integrate advancements in nanoscale science, engineering, and technology into the undergraduate engineering curricula. The NUE in Engineering program provides funding for projects that will address the educational challenges of these emerging fields and generate practical ways of introducing nanotechnology into undergraduate engineering education with a focus on devices and systems and/or on social, economic, and ethical issues relevant to nanotechnology. Given the worldwide expansion of research and education in NSE, international collaborations that advance underlying NSE education goals and strengthen U.S. activities are encouraged.

II. PROGRAM DESCRIPTION

Program Goals

Advances in nanotechnology research provide new opportunities in undergraduate education. With its focus on imaging and manipulating the atom, the ultimate building block of matter, nanoscale science and engineering (NSE) provides a multitude of new interdisciplinary teaching opportunities for engaging interest and for broadening vision by students of science, engineering, and technology. NSE thus permits new strategies for enhancing science and engineering literacy, preparing the workforce for emerging technologies, and attracting a diverse group of talented students to the workforce of tomorrow. The FY 2014 solicitation is focused

on nanoscale engineering education with relevance to devices and systems, and/or on the societal, ethical, economic and/or environmental issues relevant to nanotechnology.

NUE in Engineering provides opportunities for invigorating undergraduate engineering education through creative new courses and research experiences. It blends engineering, chemistry, physics, biology, mathematics, computer science, materials science, geology, behavioral and social sciences, and design. As such, it provides new opportunities for faculty collaboration, both in teaching and in research, that cross traditional disciplinary and departmental boundaries. Some examples of nanotechnology-based topics that can be introduced into the curriculum include scanning probe methods, devices using nanotubes, bottom-up and top-down syntheses of nanoscale materials, self-assembly, nanobiotechnology, environmental aspects of nanotechnology, applications of nanotechnology to information technology, properties and fundamental phenomena in nanoscale materials, computational methods for modeling nanoscale materials, nanoscale devices, nanoscale systems, design principles at nanoscale, and the societal, ethical, economic and environmental implications of nanotechnology. See <http://www.nsf.gov/nano> for additional examples.

NUE in Engineering projects are intended to enable individuals, departments, programs, or campuses to integrate research advancements into their curricula. Integration could take the form of a new course or courses, or modification of existing courses such that a substantial portion of the course content is based on nanoscale engineering. Integration could include a module or modules in courses that focus on issues of environmental or social change and new developments in nanoscale engineering, or a new course or series of courses that include those focus areas. The projects should be evidenced-based and grounded in what is known about student learning. Proposals involving any part of the undergraduate engineering curriculum are eligible. International collaborations that advance the underlying NUE in Engineering goals and strengthen U.S. activities are encouraged.

Project Characteristics

NUE in Engineering emphasizes new approaches to undergraduate engineering education through interdisciplinary collaborations. These collaborations could lead to, but are not limited to:

- A freshman course introducing the basic phenomena and processes at the nanoscale, the unifying principle of matter at the nanoscale, connections to other disciplines, and application areas of societal relevance;
- New examples of undergraduate nanoscale engineering courses that are presented through the development of laboratory and demonstration experiments, manuals and other written materials, software, and web-based resources;
- Development and dissemination of new teaching modules for nanoscale engineering of relevance to engineering education that can be used in existing undergraduate courses;
- Incorporation of undergraduate research opportunities in nanoscale engineering into the curriculum at any level; and
- Development of courses or curricular enhancements related to nanoscale engineering and technology and environmental or social change.

The NUE is the only solicitation focused on NSE as part of the National Nanotechnology Initiative (NNI).

III. AWARD INFORMATION

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 10

Anticipated Funding Amount: \$1,900,000 pending availability of funds. Each award will be up to a maximum of \$200,000 for two years.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

The lead PI must hold a faculty appointment within a College/Department of Engineering or College/Department of Engineering Technology within the submitting US academic institution.

Limit on Number of Proposals per Organization: 1

Only one (1) proposal may be submitted by a US academic institution, College/Department of Engineering or College/Department of Engineering Technology as the lead institution with the following exception: A US academic institution may submit a second proposal as the lead institution, only if it is focused on the societal, ethical, economic and/or environmental issues relevant to nanotechnology.

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

An individual may serve as the Principal Investigator (PI) or co-Principal Investigator (co-PI) on no more than one proposal.

Additional Eligibility Info:

NUE in Engineering proposals must be submitted by US universities and two- and four- year colleges (including community colleges) accredited in, and having a campus located in the US that have a College/Department of Engineering or a College/Department of Engineering Technology with undergraduate programs in disciplines usually supported by NSF. Projects may be proposed by individual investigators or by groups from a

College/Department of Engineering or a College/Department of Engineering Technology. The lead Principal Investigator must hold a faculty appointment in a College/Department of Engineering or a College/Department of Engineering Technology. Collaboration as appropriate with individual investigators or groups from other Colleges/Departments with undergraduate programs in disciplines usually supported by NSF, in a non-lead role are permitted. NUE in Engineering proposals involving more than one institution must be submitted as a single administrative package with the managing Principal Investigator (PI) from the lead institution. Synergistic collaboration among researchers and collaborations or partnerships with industry, government laboratories and foreign institutions are encouraged when appropriate. Non-US institutions may participate in project activities using their own resources.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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. 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. 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/bfa/dias/policy/docs/grantsgovguide.pdf>). 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.

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.

Additional review criteria described in Section VI. A. should be addressed when preparing a proposal.

1. COVER SHEET

The NSF organizational unit to which proposals should be directed is EEC - Nanotechnology Undergraduate Education in Engineering. The proposal title should begin with component acronym: "NUE".

2. PROJECT DESCRIPTION

The project description for NUE in Engineering proposals should contain the following components:

- a. Goals and Objectives. The goals of the project should be stated clearly and concisely in relation to the goals of the NUE component.
- b. Results of Prior NUE and Prior NSF Education-Related Support. In addition to results of prior support as required by the GPG or NSF Grants.gov Application Guide, institutions participating in prior NUE and/or related NSF-funded education awards must describe the relationship of these awards to this new proposal.
- c. Detailed Project Plan. The project plan should be the longest section of the Project Description. It should include description of the project's features, clearly delineating the plan to introduce or enhance nanotechnology in the undergraduate curriculum and its relevance to engineering education. The plan should include:
 - Background on the proposed project describing how it builds on nanoscale and pedagogical research;
 - Statement describing the expected impact of the project on the undergraduate curriculum at the participating institution(s) and, if applicable, elsewhere;
 - Number and percentage of undergraduate students who would be impacted by the project at the participating institution(s), and the extent to which under-represented groups would be served;
 - Plans for institutionalization of projects; and
 - References to required letter(s) of institutional and departmental commitments to the project noted under Supplementary Documents (see below).
- d. Experience and Capability of the Principal Investigator(s). Briefly describe the experience and capability of the PI(s). Include a brief description of the rationale for including the specific faculty members and institutional units within the project. State the role of each and cite the expertise that each will contribute to the project.
- e. Evaluation Plan. All projects must conduct their own formative and summative (third-party) evaluation, and all projects must

participate in an NSF-supported program evaluation. Describe criteria to be used in evaluating the quality and impact of the project, how the project's impact on student learning will be assessed, and the process for collecting and analyzing information at the proposer's institution or from others involved in testing of course materials developed.

f. Dissemination of Results. Describe plans to communicate the results of the project to other professionals in the science, technology, engineering, and mathematics (STEM) and education communities, both during and after the project. Describe the information or materials to be disseminated (e.g., computer presentations, laboratory manuals, software, multimedia materials); how the material will be made available to other institutions; the means of dissemination (e.g., faculty development workshops, journal articles, conference presentations, electronic networks, media); and the procedures for determining the success of the dissemination effort. Describe procedures to be used to maintain the quality and currency of any material developed, to provide support for faculty users, and to publicize the availability of materials.

Please note that per guidance in the GPG, the Project Description must contain, as a separate section within the narrative, a discussion of the broader impacts of the proposed activities. You can decide where to include this section within the Project Description.

Publishing NUE Educational Content on [nanoHUB.org](http://nanohub.org)

NUE awardees are required to publish all educational content, assessment instruments, and learning results of their NUE programs on [nanoHUB.org](http://nanohub.org). The goal is to connect NUE programs with a large community of over 240,000 users interested in nanoscale engineering and science education worldwide. [nanoHUB.org](http://nanohub.org) offers one of the best ways to disseminate educational content to the larger community through a reliable and easy-to-use cyber-environment. To facilitate this process, [nanoHUB.org](http://nanohub.org) already offers a wide-range of services to the NUE community.

- [nanoHUB.org](http://nanohub.org) supports the upload of materials developed in a large range of formats - PowerPoint, PDF, Movies, Animations, etc. All content can be uploaded through a simple process supported by step-by-step instructions. (see <https://nanohub.org/contribute>)
- [nanoHUB.org](http://nanohub.org) also offers a unique feature to host modeling and simulation tools. These range from simple codes to sophisticated engines, all accessible through simple user interfaces. Over 14,000 students in over 780 classes have utilized such tools in systemic classroom use. The time from [nanoHUB](http://nanohub.org) publication to adoption in a classroom is less than 6 months for most of the adopted tools. Over 70% of the tools are adopted for class room use.
- PIs that upload content on [nanoHUB.org](http://nanohub.org) will immediately start receiving up-to-date usage statistics, usage locations, and in the near future usage patterns for their own insights. These insights can also be used for various NSF required reports and internal university reports on the PI's impacts.
- [nanoHUB.org](http://nanohub.org) also allows its content to be easily cross-listed on websites and other resources supported through this NUE program.
- If desired, the [nanoHUB](http://nanohub.org) educational team will work with NUE project PIs to develop pedagogically sound materials using [nanoHUB](http://nanohub.org) materials.
- [nanoHUB.org](http://nanohub.org) has an on-going program of evaluating and assessing its content, enabling NUE program PIs to leverage the insights coming from such work.
- [nanoHUB.org](http://nanohub.org) provides open access to all content materials. Software contributions to [nanoHUB](http://nanohub.org) are encouraged to adopt a standard open source software license (<http://opensource.org/>). Teaching materials, seminars, lectures and alike are encouraged to utilize a Creative Commons License (<http://creativecommons.org/>).

Hosting an NUE Program Web Page on [nanoHUB.org](http://nanohub.org)

NUE awardees are also required to host their entire program web page on [nanoHUB](http://nanohub.org). As such the whole nano program will be exposed to the large [nanoHUB](http://nanohub.org) user base. The Network for Computational Nanotechnology (NCN staff) can coordinate with the NUE program staff on the development of a page design for a custom look and feel, and help train program staff on how to independently edit page content. Due to the ease of modifying [nanoHUB](http://nanohub.org) group pages, the program staff can easily update web content without need of specialized personnel. Various typical web 2.0 capabilities are available in these customized group pages such as: tagging, searching, wikis, threaded discussions, blogs, wishlists, and calendars. Below are two examples of center websites:

- NCN: <https://nanohub.org/groups/ncn>
- NPT: <https://nanohub.org/groups/npt>

For further information, please contact [nanoHUB](mailto:contact@nanohub.org) staff at: contact@nanohub.org.

National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL)

Investigators are also encouraged to use the National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL) as part of their dissemination efforts; see <http://nsdl.org>. To ensure that educational materials can be indexed and cataloged within the appropriate collections of NSDL, standard metadata elements and tags should be embedded in web-based products, e.g. documents, animations, simulations, and modules. A variety of review and user annotation procedures are also under development as NSDL services. Information about metadata standards is available from the Dublin Core Metadata Initiative at <http://dublincore.org>.

3. PROJECT BUDGET

The budget should include a request for funds to cover the cost of attendance of the Principal Investigator at each year's annual awardee's meeting in the Washington, D.C. area.

4. SUPPLEMENTARY DOCUMENTS

Letter(s) describing the intellectual commitment to the project of institutional and academic department(s) signed by a senior academic officer (dean or above) with authority to implement the activities listed in the proposal (if awarded) must be included as a Supplementary Document(s). The letter(s) should be referenced in the Project Description and outline the school's and department's commitment to the project and how the project may effect a lasting change at the institution. If these signed statements are not included in the Supplementary Documents section, the proposal will be returned without review.

Because this program does not require preliminary proposals, potential PIs are encouraged to contact Program Officers, Mary Poats, Fred Kronz, or Yvette Weatheron listed in this solicitation before submitting a proposal. The Program Officer will help the PI determine whether the proposed work is appropriate for NUE in Engineering.

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited.

C. Due Dates

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

May 27, 2014

D. FastLane/Grants.gov Requirements

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. 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. 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

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/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in [Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018](#). 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 strategic objectives 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 must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of 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

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

In addition to the above, the following elements will be used by reviewers and NSF staff in evaluating all NUE in Engineering proposals:

- Does the proposal focus on nanoscale engineering education with relevance to devices and systems and/or on the societal, ethical, economic and/or environmental issues relevant to nanotechnology?
- Are the goals and measurable expected outcomes defined and are they appropriate to the scope, scale, and state of the project?
- Does the proposal describe a convincing rationale and appropriate methods that are grounded in the engineering education knowledge base?
- Is there a clear work plan that is aligned with the expected outcomes?
- Is the project likely to produce high quality results that contribute to the undergraduate engineering education knowledge base?
- Is the project evidence-based and grounded in what is known about student learning?

- Is the project likely to have an impact on engineering education, student learning, and faculty practice?
- Are expected results (e.g. modules, curricula) defined and appropriate?
- Is the evaluation plan likely to produce useful, formative and summative information?
- Are the plans for project assessment and institutionalization beyond the faculty members involved in the proposal sound?
- To what extent are creative, interdisciplinary approaches to undergraduate engineering education fostered?
- What is the likelihood that the project will engage students and faculty at participating institutions (and, if applicable, elsewhere) in creative opportunities for undergraduate nanoscale engineering education?
- What is the potential impact on developing a diverse workforce and enhancing engineering and science literacy and the scale of the potential impact?

B. Review and Selection Process

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

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

A. Notification of the Award

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

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. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from 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.

C. Reporting Requirements

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.

VIII. AGENCY CONTACTS

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:

- Mary Poats, Program Manager, Directorate for Engineering, Division of Engineering Education and Centers (ENG/EEC), 585 N, telephone: (703) 292-5357, fax: (703) 292-9051, email: mpoats@nsf.gov
- Frederick M. Kronz, Program Director, Directorate for Social, Behavioral & Economic Sciences, Division of Social and Economic Sciences (SBE/SES), 995 N, telephone: (703) 292-7283, fax: (703) 292-9068, email: fkronz@nsf.gov
- Yvette Weatheron, Program Director, Directorate for Education and Human Resources/Division of Undergraduate Education (EHR/DUE), 835S, telephone: (703) 292-5323, email: yweather@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: 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.

IX. OTHER INFORMATION

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.

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

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
 - 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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