National Science Foundation

# Report in Response to America COMPETES Act: SEC. 7022



This Report is written in response to the America COMPETES Act request that the NSF Director report on the NSF broader impact merit review criterion. This Report includes background on the NSF implementation of the broader impact criterion and responds to each of the five specific requests made in the COMPETES Act Sec 7022.

# Table of Contents

# BACKGROUND

In March 1997, the National Science Board (NSB) instituted two merit review criteria: Intellectual Merit and Broader Impacts. The intellectual merit criterion was revised by the National Science Board in FY 2008.

***What is the intellectual merit of the proposed activity?***

*How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?*

***What are the broader impacts of the proposed activity?***

*How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?*

All proposals submitted to NSF are reviewed using these two criteria.

Since 1997, the NSF *Grant Proposal Guide* (GPG) has provided increased guidance related to broader impacts in the preparation and review of proposals. In particular, effective in January 2002 the GPG included the requirement that Principal Investigators must address both merit review criteria in separate statements within the one page Project Summary. The GPG further required that a description of the broader impact activities be included in the Project Description and described as an integral part of the narrative. In order to further clarify the expectations of the broader impact criterion, examples to illustrate the types of broader impact activities have been added to the GPG.

Effective October 1, 2002, NSF has returned without review proposals that do not separately address both merit review criteria within the Project Summary. As shown in the chart below, the number of proposals that were returned without review for failing to address both review criteria has been decreasing.

**Proposals Returned Without Review for Failing to Address both Merit Review Criteria**

| **Fiscal Year** | **2003** | **2004** | **2005** | **2006** | **2007** |
|---|---|---|---|---|---|
| Number of Proposals | 276 | 236 | 176 | 134 | 117 |

The NSF Regional Outreach Conferences and NSF Days have sessions to help prospective proposal submitters to understand the importance and expectations in addressing the broader impact criterion. In addition to these NSF-wide outreach activities, addressing the broader impacts criterion continues to be a priority in outreach sessions held by directorates, divisions, and program officers.

## BACKGROUND

The Committee of Visitors (COVs) program reviews include evaluations of merit review and program management relative to broader impacts, as well as the impact of these activities. The COV process is explained further in item 3 below. The Advisory Committee for the Government Performance Results Act Performance Assessment (GPRA/AC) reviews COV reports in preparing its annual assessment of NSF investments in research and education.

# I: CRITERIA USED TO EVALUATE BROADER IMPACT IN RESEARCH PROPOSALS

**COMPETES Act Request: Identify the criteria that each division and directorate of the Foundation uses to evaluate the broader impacts aspects of research proposals.**

## A. NSB Broader Impact Criterion

All NSF proposals are evaluated through use of two National Science Board approved merit review criteria: Intellectual Merit and Broader Impacts. Consequently, all divisions and directorates at NSF evaluate the broader impacts of research proposals based on the NSB Broader Impacts review criterion:

***What are the broader impacts of the proposed activity?***

*How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?*

Responding to one or more of the areas identified in the Broader Impact Criterion, proposers develop activities that are evaluated by external reviewers and NSF staff during the proposal review process.

## B. Additional Broader Impact Criteria

NSF Programs may require additional criteria to highlight the specific objectives of certain programs and activities. Additional criteria vary by program, rather than by division or directorate, with the additional criteria stated in the relevant program solicitation or announcement.

In April 2008, a survey of the 243 active NSF programs was conducted. Of these programs, 84 NSF programs provided broader impact criteria in addition to the NSF-wide broader impact criterion. The additional broader impact criteria in these programs are included in the Appendix. The following examples illustrate the type of criteria in these solicitations.

**Examples of Additional Broader Impact Criteria in Program Solicitations**

- **Directorate for Biological Sciences**

  Example of BIO Program:

  *Center for Research at the Interface of the Mathematical and Biological Sciences (NSF 07-597)*

  Additional Broader Impact Review Criteria:

  - Effect of the Center on the infrastructure of the mathematical and biological sciences: The potential of the proposed Center and its activities to increase the level of collaborative research and to contribute to fundamental knowledge.
  - Ability of the Center to respond to national needs, especially in the area of the modeling of the dynamics of infectious animal diseases.

**Directorate for Computer & Information Science & Engineering**

Example of CISE Program:

*Chemistry Research Instrumentation and Facilities: Departmental Multi-User Instrumentation (NSF 07-552)*

Additional Broader Impact Criteria:

- Is there a plan to use the new or enhanced instrumentation in teaching, training and learning? How will the instrumentation impact the educational programs of the user communities?
- How will acquisition or upgrade of the requested instrumentation support the departmental plan for broadening participation? Will participation by underrepresented groups be enhanced by the instrumentation?

❖ **Directorate for Engineering Sciences**

Example of ENG Program:

*Engineering Research Centers (NSF 07-521)*

Additional Broader Impact Criteria:

- Education
  - Education strategy defines an education program that will develop graduates who are adaptive, creative innovators with the capacity to advance fundamental knowledge and exploit it to create innovations;
  - Structured to develop graduates who have the knowledge, skills, and experience needed to be successful in a globally connected, innovation-driven world;
  - Effective plans proposed to integrate ERC's cross-discplinary and systems research into courseware and curricula;
  - Strategic plan specifies desired characteristics, proposes how education program will impart these to students, and how it will measure and assess progress and impacts through longitudinal data;
  - Pre-college outreach programs will develop an effective long-term partnership with a few pre-college institutions (middle and high schools) to bring knowledge of engineering to pre-college classroom, engage a broadly diverse group of students in the ERC's programs to motivate them to study engineering, and provide a Young Scholars research program for promising high schools students;
  - Effective programs and assessment tools for college and pre-college programs based on best practices.
- Industrial/Practitioner Partnership to Advance Innovation
  - Convincing rationale for the selection of industrial or user partners and means to engage these partners in planning, research, education, and innovation;
  - Clear strategy for how small firms will be key players and help speed innovation;
  - Strong partnership with organizations and programs dedicated to speeding innovation;
  - Representative group of firms/organizations invoving practitioners (state infrastructure agencies for example) committed to membership;

- Active engagement of industry/practitioner organizations through an Industrial/Practitioner Advisory Board;
- Proposed terms of the industrial membership agreement will structure a center-wide program of industrial/practitioner collaboration to support overall ERC goals;
- Intellectual property policy will facilitate collaboration with industry through shared rights for joint work and speed technology transfer.

❖ **Directorate for Geological Sciences**

Example of GEO Program**:**

*Annual Solicitation for Research in Support of the National Space Weather Program (NSF 07-520)*

Additional Broader Impact Criteria:

In addition to the general NSF review criteria, proposals will be evaluated according to their relevance to the National Space Weather Program. Proposals should benefit and advance the NSWP, and contribute to the goal of mitigating the adverse effects of space weather by providing timely, accurate, and reliable space environment observations, specifications and forecasts. Special consideration will be given to research which holds the promise for improving operational space weather capabilities within five years. Proposals that include CCMC-related activities will be evaluated on their appropriateness for the CCMC, the level of effort required to implement and test the models, and the likelihood for eventual transition to Space Weather operations.

❖ **Directorate for Mathematical and Physical Sciences**

Example of MPS Program:

*Chemistry Research Instrumentation and Facilities: Departmental Multi-User Instrumentation (NSF 07-552)*

Additional Broader Impact Criteria:

- Is there a plan to use the new or enhanced instrumentation in teaching, training and learning? How will the instrumentation impact the educational programs of the user communities?
- How will acquisition or upgrade of the requested instrumentation support the departmental plan for broadening participation? Will participation by underrepresented groups be enhanced by the instrumentation?

❖ **Directorate for Social and Behavioral Sciences**

Example of SBE Program:

*Developmental and Learning Sciences (NSF 07-508)*

Additional Broader Impact Criteria:

Will any proposed new instruments, shared experimental facilities, and/or databases be of significant value to a broad community of users? Will the educational programs make a special contribution to the achievement of a diverse, highly competent, and globally-engaged workforce and of an educated citizenry?

# II: TYPES OF ACTIVITIES PROPOSED TO MEET BROADER IMPACTS CRITERIA

**COMPETES Act Request: Provide a breakdown of the types of activities by division that awardees have proposed to carry out to meet the broader impacts criterion.**

As indicated above, the types of activities depend more on the project and program objectives than on the particular NSF division in which the program is managed. The list below provides the primary types of activities awardees conduct to meet the broader impacts criterion.

**A. Advance Discovery and Understanding While Promoting Teaching, Training and Learning**

- Educational Methods – Integrate research activities into the teaching of science, mathematics and engineering at all educational levels (e.g., K-12, undergraduate science majors, non-science majors, graduate students and postdoctoral fellows). Develop research-based educational materials or contribute to databases useful in teaching (e.g., K-16 digital library). Partner with US and international researchers and educators to develop effective means of incorporating research into learning and education. Develop, adopt, adapt or disseminate effective models and pedagogic approaches to science, mathematics and engineering teaching.
- Inclusion – Engage students (e.g., K-12, undergraduate science majors, non-science majors, and /or graduate students and postdoctoral fellows) in the proposed research and education activities. Conduct campus visits and presentations at a wide range of institutions, including those that serve underrepresented groups. Sponsor conferences, workshops and laboratory/field activities, and demonstrate the use of information technology and connectivity. Provide international research experience opportunities for students.
- Professional Development – Participate in the recruitment, training, and/or professional development of K-12 science and math teachers. Encourage student participation at meetings and activities of professional societies. Establish special mentoring programs and support networks for high school students, undergraduates, graduate students, postdoctoral fellows, and technicians conducting research. Involve graduate and post-doctoral researchers in undergraduate teaching activities.

**C. Broaden Participation of Underrepresented Groups**

- Collaboration – Establish research and education collaborations with students, postdoctoral fellows, and/or faculty who are members of underrepresented groups or who serve at institutions serving underrepresented groups, including community colleges, colleges for women, Minority-Serving Institutions (MSIs), predominantly undergraduate institutions, colleges and universities serving people with disabilities, institutions of higher education in EPSCoR states, and museums. Form bilateral exchanges and/or feeder programs/relationships with institutions (both graduate and undergraduate) that serve underrepresented groups.
- Inclusion – Recruit and mentor individuals and groups from underrepresented groups as participants in the proposed research and education activities. Develop "hands-on" research activities and curriculum modules designed to broaden interest in science and engineering by diverse populations across various educational levels (e.g., K-12, undergraduate science majors, non-science majors, and underrepresented groups). Conduct campus visits and presentations at institutions that serve underrepresented groups. Sponsor conferences, workshops and laboratory/field activities at institutions that serve underrepresented groups, and strategically utilize information technology and

- connectivity in ways that benefit these groups. Participate in campus mentoring and intern activities focused on underrepresented students.

- Access to Profession – Develop mentoring relationships with early-career scientists and engineers from underrepresented groups and institutions. Ensure inclusion of those who are from underrepresented groups. Participate in conferences, workshops and field activities that aim to engage students from underrepresented groups in your field.
- Purposeful Engagement – Take specific actions to establish contact and implement strategies for engagement with Minority Serving Institutions (MSIs) and other types of institutions serving largely underrepresented groups.

**C. Enhance Infrastructure for Research and Education**

- Collaborations and Multi-Institutional Users – Identify and establish collaborations across disciplines and institutions, among diverse U.S. academic institutions, industry and government and with international partners. Maintain, operate and modernize shared research and education infrastructure at a variety of institutions, including minority-serving institutions, institutions serving people with disabilities, science and technology centers, engineering research centers, and field stations, museums, or research collections. Upgrade the computation and computing infrastructure, including advanced computing resources and new types of information tools (e.g., simulators, large databases, networks and associated systems, and digital libraries). Develop activities that ensure that multi-user facilities are sites of research and professional development (mentoring) for large numbers of diverse science and engineering students. Provide access to unique international capabilities or expertise.
- Development and Distribution – Stimulate and support the development and dissemination of next-generation tools and experimental platforms, instrumentation, multi-user facilities, and other shared research and education platforms across diverse academic institutions and in science, technology, engineering and mathematics (STEM) communities.
- Access and Functionality –Increase access and functionality of existing or new instrumentation, tools, or other infrastructure.

**D. Disseminate to Enhance Scientific and Technological Understanding**

- Informal Science – Partner with museums, nature centers, science centers, National Parks, and similar institutions to develop exhibits in science, math, and engineering.
- Policymakers and Public Understanding of Science – Involve the public or industry, where possible, in research and education activities. Give science and engineering presentations to the broader community (e.g., at museums and libraries, on radio shows, on websites and in other such venues). Present research and education results in formats useful to policy-makers, members of Congress, State governments, industry, and broad audiences.
- Broad Dissemination of Outcomes – Provide for access to data and appropriate metadata in a timely manner through a variety of mechanism including databases, digital libraries, websites or other venues such as CD-ROMs. Participate in multi- and interdisciplinary conferences, workshops, and research activities. Publish outcomes in diverse media formats (e.g., non-technical literature, websites, CD-ROMs, press kits) to reach broad and global audiences. Promote open access to publications and datasets from publicly funded research. Develop websites that communicate science to the general public. Make

software and appropriate documentation available in a timely manner through mechanisms such as website and open source organizations.

**E. Benefit Society**

- Public Understanding – Demonstrate the linkage between discovery and global, regional or societal benefit by providing specific examples and explanations regarding the potential application of research and education results. Analyze, interpret, and synthesize and disseminate research and education results in formats that are understandable and useful for non-scientists, including representatives from state and local governmental agencies. Communicate science and engineering issues and their ethical and societal impacts in forms widely understandable by the lay population.
- Utilization of Outcomes – Partner with academic scientists and staff at other Federal agencies and national labs, and with the private sector on both technological and scientific projects to integrate research into broader programs and activities of national interest. Provide information for policy formulation by Federal, State or local agencies. Provide new knowledge useful to help individuals and organizations make wiser decisions. Engage with industry and the broader technical community to speed the transformation of research and education outcomes into societal benefits. Increase transfer from research and technology development to marketplace.

# III: EVALUATIONS PERFORMED BY NSF REGARDING BROADER IMPACTS

**COMPETES Act Request: Provide any evaluations performed by the Foundation to assess the degree to which the broader impacts aspects of research proposals were carried out and how effective they have been at meeting the goals described in the research proposals.**

The evaluation of broader impacts of projects is conducted primarily through the following mechanisms:

**NSF Review of Annual and Final Project Reports**
NSF projects are required to submit annual and final reports. These reports include project progress in implementing broader impact activities. NSF Program Officers are responsible for reviewing annual and final reports in order to evaluate the effectiveness the projects.

**Site Visits**
NSF conducts site visits of centers and other large projects. These typically include an external team as well as NSF staff. An important part of these site visits is an evaluation of the project's progress in conducting activities related to broader impacts.

**Committees of Visitors**
Each NSF program undergoes an evaluation by an external Committee of Visitors (COV), whose membership includes external experts in science, engineering, and education. These COVs are conducted every three years.

The COVs are charged to identify:
- noteworthy achievements based on NSF awards;
- ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals;
- expectations for future performance based on the current set of awards.

COVs review the effectiveness of NSF programs, including the outcomes of activities stemming from the broader impact criterion. COVs are also asked to determine whether the broader impact criterion was appropriately addressed by external reviewers and panels, as well as NSF Program Officers in their review analyses of proposals. The COV reports are approved and discussed in the respective Advisory Committee Meeting (for example, the COV report for a program managed by the Directorate for Engineering will be reviewed by the Engineering Advisory Committee).

The COV report may also include recommendations to NSF. Subsequently, NSF prepares a response to identify actions the agency will undertake to address the COV recommendations. The next COV reviews and comments on the previous COV report, the NSF response, and the actions NSF has taken.

The COV reports with the NSF responses are available on the external NSF website at *http://www.nsf.gov/od/oia/activities/cov/index.jsp*

**NSF Program Evaluations**
In addition to COVs and evaluation of individual research projects as described above, evaluations are also conducted for some NSF research programs. These evaluations address the impact of the overall NSF program in addressing its goals, including broader impact goals.

For example, an evaluation of the CAREER has recently been conducted and an evaluation of the Science and Technology Research Centers is currently underway.

**Highlights**
As part of its annual performance and accountability reporting, NSF identifies Highlights, which are examples of discoveries resulting from NSF investments. These Highlights include many of the broader impact results from these projects. NSF is working to increase the emphasis on broader impacts in the Highlights.

**Pilot Evaluation**
The NSF Division of Chemistry is conducting an external impact evaluation of the activities conducted under the broader impact criterion in awards managed by the division. This evaluation will inform NSF on a possible additional evaluation mechanism to assess the effectiveness of projects to achieve their broader impact goals.

# IV: NATIONAL GOALS THAT BROADER IMPACTS CRITERION PROMOTE

**COMPETES Act Request: Describe what national goals, such as improving undergraduate science, technology, engineering, and mathematics education, improving kindergarten through grade 12 science and mathematics education, promoting university-industry collaboration, and broadening participation of underrepresented groups, the broader impacts criterion is best suited to promote.**

To illustrate the national goals that broader impacts are best suited to promote, four examples are given below for each of the following national goals:

- Increased Economic Competitiveness
- Increased Academic and Industry Partnerships
- Development of a Globally Competitive Science and Engineering Workforce
- Increased Participation of Women and Underrepresented Minorities in Science and Engineering
- Improved K-12 Science and Mathematics Education and Teacher Development
- Improved Undergraduate Science and Engineering Education
- Increased Public Scientific Literacy
- Increased National Security

It is important to note that in addition to the activities under Broader Impacts, NSF has programs that have been designed to address these national goals. For example, ***Grant Opportunities for Academic Liaison with Industry*** and ***Partnerships for Innovation*** are two of the NSF programs that focus on developing partnerships between academia and industry.

**Increased Economic Competitiveness**

- With support from the NSF's Experimental Program to Stimulate Competitive Research, the SUNRISE research group of the University of North Dakota has developed an oilseed-based bio-jet fuel for aviation turbines and diesel engines that withstands cold temperatures and is more stable than traditional bio-diesel fuels. A **broader impact** of this research is in its potential for increasing the economic competitiveness of the United States in the development of technology to reduce the oil extraction cost specifically for bio-jet fuel application making it more cost effective than other fuels. SUNRISE also incorporates the research into chemistry and chemical engineering courses at the university, and educates the state's agricultural and financial communities and political leaders about bio-fuels and their potential economic impact in addressing global demand for alternative sources of energy.

- As one of its **broader impacts**, the NSF- funded Collaborative Research Center for Experimental Research in Computer Systems (CERCS) at the Georgia Institute of Technology has enabled member U.S. companies to be more competitive in information technology. As part of the joint work with Hewlett-Packard (HP) laboratories in Palo Alto, CERCS faculty conduct research that is affecting product development efforts at HP. Center researchers have been collaborating with the HP's server systems group to transition methods and mechanisms used for online system management to HP's product line. This open partnership demonstrates the viability and usefulness of online power management for datacenter applications and infrastructures. Contributing to this research are joint partnerships with companies that include Intel for the development of a better understanding of platform behaviors and IBM for work on creating virtualized multi-core systems using online methods for power management.

- Worldwide, an ongoing search is underway to discover means to conserve energy and to find alternate energy sources. Biomass is one of the most promising forms of alternate energy. The mass production of fuels and chemicals from biomass is currently not feasible, due to the fact that the enzymes used for various process steps, such as fermentation, are very expensive. However, NSF-supported researchers at Michigan State University have discovered a number of inorganic catalytic process steps that are more economical. The project has a **broader impact** on the economic competitiveness of the Nation since inorganic catalytic pathways enable more feasible options in the conversation of biomass to alternative energy. For example, inorganic catalysts can aid in the conversion of starchy materials (like corn) and cellulosic biomass (such as wood chips) to biofuels (such as diesel oil) and commodity chemicals (such as propylene glycol). This research has the potential to transform the biomass conversion industry. Production methods based on enzyme reactions that are expensive to implement will become more viable once inorganic catalysts are used.

- Amid controversy regarding the growing relocation of information technology (IT) jobs to foreign locales, there have been questions regarding the real significance of these losses. NSF-funded researchers at the University of Texas-Austin analyzed a sample of 1.4 million full-time workers who lived in the 100 largest metropolitan areas in the United States in 2000. Applying econometric models, the researchers determined that all workers in metropolitan areas with a large concentration of IT workers tend to have higher wages than those in cities with lower concentrations. In addition, they concluded that the presence of IT workers has a positive effect on the productivity of other workers. The high concentration of highly-skilled IT workers provides the impetus for firms across many economic sectors to adapt cutting edge technologies to create new products and services or to improve production and marketing processes. The study also found that middle-skilled and low-skilled IT workers guarantee that existing IT systems are maintained efficiently. The **broader impact** of this project on determining the value of highly-skilled IT jobs for economic competitiveness is the finding that the IT sector contributes disproportionately to the country's economic productivity (and to employee wage rates), Moreover, the project explored the application of spatial econometric techniques to measuring the economic contribution of IT jobs over large geographic regions. In addition to producing high-quality research with broad public utility, the principal investigator serves as an effective role model for women and Hispanic students.

**Increased Academic and Industry Partnerships**

- Researchers with the NSF-supported Bernard M. Gordon Center for Subsurface Sensing and Imaging Systems at Northeastern University, in conjunction with industrial partners at Bubble Technologies Industries (BTI) and Raytheon, have developed a tool that can detect nuclear material in sealed cargo containers, trucks, and cars. Consequently, the **broader impact** of this project is, in addition to its security implication for the Nation, in the creation of academic/industry partnerships that have been integral to this technology development. Center researchers led the development of ASHERD - the Arrayed Spectrometric High-Efficiency Radiation Detector. ASHERD was tested at a Nevada test site and deemed highly successful by the Department of Homeland Security. DHS provided additional funding for its development. The first round of detection units produced by Raytheon and BTI was installed in the New York Container Terminal in Staten Island in February 2007.

- With a discovery that links a ubiquitous market with an obscure process, a researcher at the University of Maryland-College Park can produce the purest form of plastics, allowing for more elasticity, clarity, durability, rigidity, and adhesiveness than currently available products. This discovery has the potential to revolutionize the existing practices of plastic manufacturing as well as address the global problem of plastic pollution by producing a form of plastic that is 100% recyclable. In addition to the anticipated impact on economic competitiveness, a **broader impact** of this NSF - supported work is the development of the industry/academic partnerships that are required for the further development, production, and marketing of this discovery.

- NSF- funded researchers at the University of Tennessee have teamed with an industry partner to accomplish the first known successful transformation of a fern plant into a natural detection device. Presently, the research team is working toward successfully transforming a fern species so that the modified fern plants can be used to detect and monitor arsenic in soil and water. This work is expected to result in a cost-effective, real-time system to monitor water and soil quality. The creation of an industry/academic partnership has been the critical element in conducting the research and the **broader impact** of this project.

- One of the **broader impacts** of the research funded at the University of California-Berkely (in collaboration with several other universities) is the wide-ranging set of partnerships being developed with several leading giants in the information technology/cybersecurity sector of the economy. One focus of the research is identity theft on the Internet. Privacy of users is under direct attack in electronic systems, from criminals who attempt to gain personal information to irresponsible vendors who monitor usage on individual machines. One particular pernicious attack is phishing, in which attackers build sites that masquerade as legitimate web sites. The project has several lines of research. The primary thrusts of these research projects are (1) to understand how users perceive their vulnerability to identity theft attacks and how well they understand the privacy threats associated with installed software; (2) to develop mechanisms for detecting potential and actual loss of personal data from computers; (3) to build and demonstrate active systems that prevent identity theft; and (4) to understand the policy implications and legal implications for each of the proposed technology-based mechanisms for detecting identity theft.

**Development of Globally Competitive Science and Engineering Workforce**

- Researchers at the NSF-funded Center for Nano-Chemical-Electrical-Mechanical Manufacturing Systems (Nano-CEMMS) at the University of Illinois-Urbana Champaign are working to develop the science, processes and systems for manufacturing at the nanoscale level. The research at the center seeks to develop a reliable, robust, and cost effective manufacturing system for creation of three-dimensional, nanoscale devices and systems from multiple materials. A **broader impact** of the center activities focuses on developing a diverse U.S. workforce of educators, scientists, engineers, and practitioners to advance nanomanufacturing technology in the U.S. and globally. Nano-CEMMS is providing a wide range of human resource development activities designed to increase both the diversity of students involved with the center and educational opportunities for increasing interest in science and engineering at the K-12 and undergraduate levels. In addition, both undergraduate and graduate students participate in the Center's work

through research assistantships and independent study projects thus increasing the pool of professionals with knowledge and skills in manufacturing at the nanoscale level.

- Coastal margins are among the most densely populated and developed regions in the United States. They sustain highly productive ecosystems and resources, are sensitive to many scales of variability, and play a key role in global elemental cycles. Natural events and human activities place stresses upon coastal margins, rendering the development of sustainable coastal resources and ecosystems difficult and contentious, with many policy decisions historically based on insufficient scientific understanding of the causes and consequences of natural and anthropogenic impacts. The mission of the NSF Science and Technology Center for Coastal Margin Observation and Prediction (CMOP) at the Oregon Health and Science University is to study coastal margins. CMOP is enabling researchers to focus on novel technological and scientific opportunities to solve major science questions on the impact of climate on coastal margins, the role of coastal margins on global elemental cycles, and the seaward extent of human impacts. A **broader impact** of this center in workforce development is achieved through its priority on providing undergraduate internships, developing graduate courses, and developing a range of K-12 educational activities.

- American ginseng is one of the most economically important medicinal plants harvested from the wild in the United States. Recently there has been a growing awareness of crop depletion. What is causing the disappearance of wild ginseng in the Appalachians? Is human harvesting the biggest influence on its recent decline or is something else nibbling its way through the mountainside? An NSF-supported researcher at West Virginia University discovered that browsing by deer is the main factor in the decline of wild ginseng populations. White-tailed deer do not disperse ginseng seeds after consumption, thereby limiting the ability of these plant populations to reproduce. The research has suggested some possibilities for reversing ginseng population decline, such as more effective deer population control and delaying the harvesting season. Using population viability analysis, the study also provided a prognosis for long-term survival of the wild ginseng. By placing a high priority on engaging graduate and undergraduate students in the research, a **broader impact** of this project is its contribution in developing a globally competitive scientific workforce that is engaged in solutions to problems through the integration of social science and ecologically-based analyses.

- One of the **broader impacts** of a funded project at Iowa State University is the development of graduate students for a globally competitive scientific workforce in areas that draw on statistical analyses of complex problems. The statistics research is conducted in collaboration with Los Alamos National Laboratories (testing and reliability studies of complex systems), the Center for Transportation Research and Education (modeling crashes incorporating driver and roadway characteristics), National Center for Atmospheric Research (statistical modeling of atmospheric phenomena), Ames Laboratory (measurements of the orientation of crystals in metals), and Google (Data Mining). Graduate students benefit from their participation in research that better prepares them to address complex problems of national importance whether in academic research, in government, or in the private sector.

**Increased Participation of Women and Underrepresented Minorities in Science and Engineering**

- In collaboration with Salish Kootenai College (a 4-year Tribal College), researchers at the University of Montana in environmental biology are having a **broader impact** by providing culturally significant research opportunities to Native American students in Montana. During the summer, students work full time with their mentors in field and laboratory research. They also meet weekly to work on issues such as communications skills and preparation for graduate school. NSF-supported research projects include, for example, effects of forest fire retardant on native and invasive plants; identification of temperature barriers and their effect on seasonal migration of bull trout; patterns of parasite transmission among Yellowstone bison; detection of chemical cues by honeybees; and air quality in Rocky Mountain forest ecosystems.

- Providing access to cutting-edge research instrumentation is one of the main goals of NSF-funded facilities projects. The J. Bennett Johnston, Sr. Center for Advanced Microstructures and Devices (CAMD) at Louisiana State University is an NSF-supported synchrotron facility. Synchrotron facilities are accelerator-based light sources of exceptionally intense, tightly focused beams of X-rays, ultraviolet and infrared radiation that make possible both basic and applied research in fields from physics to biology to technology that are not possible with more conventional equipment. As one of its **broader impacts** to increase participation of underrepresented groups in science, use of the facility for research has been provided to students from Southern University and A & M College, a Historically Black College and University and a primarily undergraduate institution. Undergraduate students who participated in this research project were given a unique opportunity to work in a rapidly growing field of scientific study. These students were fully engaged in the synthesis, characterization, and evaluation of a complex oxide used in solid oxide fuel cells. The students also developed knowledge of oxide fuel cells and became skilled in the operation, manipulation, and interpretation of analytical instruments, such as, a X-ray diffractometer, scanning electron microscope, and various spectrometers.

- The NSF-funded Center for Integrated Space Weather Modeling (CISM) at Boston University is having a **broader impact** on increasing the participation in science of minority students through its collaborations with minority serving institutions. Examples of this effort are the annual Space Weather Weekends. The first of these events was held at Alabama A&M University (AAMU) in Huntsville, with students participating from AAMU, Norfolk State, Grambling University, Howard University, North Carolina A&T, University of Houston-Downtown, and University of Texas at Brownsville. Over the course of the weekend students learned about the sun, magnetosphere, and ionosphere, and how space weather has an effect on human activity. The students also develop knowledge of space weather through hands-on experiences with models being used for research by CISM. In addition, CISM faculty discussed with students graduate school opportunities in space physics and other fields as well. The students indicated that the weekend opened their eyes to an exciting field of science that they had not known about, and several expressed an interest in applying to graduate schools located at institutions that are involved in CISM.

- Researchers at the University of Hawaii-Hilo who are working on conservation projects participate in the Pacific Internship Programs for Exploring Science. With additional

funding from NSF, undergraduate students are provided an exciting and challenging summer research experience in conservation biology that helps prepare them for future careers in science. A **broader impact** of this effort is the success the project is having in engaging students who are traditionally under-represented in science based on ethnicity, geographic successful in blending rigorous science experiences with respect for the natural world and values of the Hawaiian Islands' native culture.

**Improved K-12 Science and Mathematics Education and Teacher Education**

- As one of its **broader impact** activities, the NSF Pittsburgh Supercomputing Center (PSC) has developed CMIST (Computational Modules in Science Teaching), a highly innovative and potentially transformative approach to presenting critical concepts in computational science in secondary school classrooms. CMIST modules are produced with realistic modeling and simulation software, such as developed and used in research at PSC. The result is materials that are not only scientifically accurate but also dynamic and visually appealing. The materials are distributed as ready-to-use DVDs that include animations and lesson plans aligned to national and state standards, and worksheets.

- At Emory University, researchers are funded by NSF to study the physics of complex fluids. The researchers are interested in how a material's microscopic structure relates to its macroscopic behavior, such as determining how easy it is for a material to spread, flow, or compress – especially in confined spaces. A **broader impact** of this project is the development of activities involving "squishy materials" to interest school children in science and to increase the level of understanding of science of undergraduate students. The laboratory has hosted groups from kindergarten through 8$^{th}$ grade. Children have the opportunity to study properties of these materials through age-appropriate hands-on activities. The laboratory also has a popular website that contains extensive information on using complex fluids to teach freshman students (no matter which major they are pursuing) about current physics research while providing researchers particle tracking software and associated tutorials.

- Researchers at the University of Nevada—Las Vegas are developing advanced engineering geophysical imaging methods that will allow them to see beneath the ground surface. With funding from NSF, the researchers are having a **broader impact** on K-12 science education. For example, an earth and environmental teacher with the Clark County School District in Las Vegas worked with the researchers to learn about engineering geophysical methods and to use electrical resistivity, electromagnetic and seismic equipment. She collected and downloaded data, analyzed the data and created subsurface maps and reports. With this firsthand knowledge of the importance of the basic physics and geological concepts that she has taught her students, the teacher created lesson plans and activities that set a foundation from which to develop her students' understanding of the physics behind the equipment that is used by geotechnical engineers. The teacher went on to develop a teacher workshop for Clark County middle and high school Earth and Physical Science teachers.

- An NSF- supported researcher at the University of Delaware is studying how a particular bacterium, *Chlorobium tepidum*, uses reduced sulfur compounds that are toxic to humans as a source of energy for photosynthesis. These metabolic processes have profound implications on global sulfur cycling and climate change. Through a unique integration of research and education, the project is having a **broader impact** on K-12 science

education and students' understanding of the interaction of humans with the environment. K-12 students grow populations of phototrophic sulfur bacteria, like *C. tepidum*, which undergraduates isolate and characterize, providing data back to classrooms via a web site. Students analyze and interpret the data. Handouts describing basic biological, chemical and geological interactions are provided to K-12 teachers who will provide truly interdisciplinary, hands-on learning to students.

- A researcher at the University of Massachusetts-Amherst is studying the response of fault systems to shifts in the tectonic regime. This NSF-supported research has implications for the evolution and present-day activity of fault systems in southern California. One of the **broader impacts** of this research activity is on improving K-12 education. For example, the researcher led a field trip to Utah for 20 students from five schools for the deaf and their earth system science teachers. The objective of the trip was to provide a field experience for students and teachers who had been working with sandbox tectonic models in the classroom. In the field, the students had the opportunity to observe, sketch, and measure active and ancient faults in a variety of rock types and transfer knowledge obtained with classroom models to examples in nature. There were both deaf and hearing people in the group and, despite using different means of communication, this was not an obstacle to accomplishing the goals of the field trip. In fact, participants found that sketching in field notebooks was a very useful tool used by everyone in the group.

**Improved Undergraduate Science and Engineering Education**

- Large research instrumentation platforms that support cutting edge research are a challenge to obtain. Through the NSF Major Research Instrumentation program, a team of researchers from Texas Tech University has obtained the Hitachi S-4300, a high resolution analytical scanning electron microscope (SEM) which enables users to see high resolution detailed images. In this project, one research lab team has been working on mammalian cells to investigate surface antibody density and distribution. Additionally, research on the absorption of nanoparticles, improvement of cotton quality, contact lenses, efficient jet fuels, and bacterial dispersion, are a few of the many multidisciplinary projects that have benefited from the acquisition of the SEM. One of the **broader impacts** of this award is the development of undergraduate courses integrating SEM research techniques for students who desire to have more in-depth training on the functions and analytical tools of the SEM. As an extension of the work with the undergraduate curriculum, a lead researcher has been participating in many outreach activities, which encourage students of underrepresented groups to become aware of and involved in scientific research.

- NSF made an award to University of North Carolina at Ashville to study rapid variability in distant cosmic radio sources. The outcome is anticipated to provide new leads on the nature of dark matter and the structure of our Galaxy. The location of the research facility in the Pisgah National Forest of western North Carolina is deep in the heart of Appalachia, a traditionally under-represented area for advanced scientific research. The project is having a **broader impact** through student and community outreach. For example, the project hosts high school students and teachers each summer for a residential science program, giving the participants a better understanding of science, and spurring some of the students to consider and embark on careers in the sciences. In addition, the researchers have hosted high school students from the local area, helping them build simple radio receivers for monitoring radio noise from the sun.

- Researchers at CUNY City College are studying “nurse cells," which have important roles in deciding which developing infection-fighting cells, called T cells, live or die. The infection-fighting cells, known as thymocytes or T cells, live in the thymus, an organ in the upper portion of the chest. Loss of the thymus results in severe immunodeficiency and increased susceptibility to infection. From previous studies it was thought that the primary role of thymic nurse cells was to aid in the removal of non-working thymocytes. In contrast to previous studies, this project has proven that nurse cells have an even more important role in the thymus. One of the **broader impacts** of the NSF-funded project is the involvement of undergraduates in the lab to participate in experiments based on their prior experience. The more experienced students conduct experiments for research resulting in publications. Other less experienced students are invited to use this laboratory time as an opportunity to learn about scientific research.

- Funded through an NSF grant to the University of Kansas, an international and interdisciplinary research team is examining coupled natural and human systems on Adak Island, Aleutian Islands, Alaska. Comprehensive research on long term human-environmental interactions in the Bering Sea region is imperative if we are to understand the dynamics of Aleutian natural and human systems; effectively address the social, political, and economic issues that arise from changes in those system dynamics; and help formulate policy decisions for the region today. This project is having a **broader impact** on K-12 science education. In partnership with the Adak community and school, the Central Aleutians project has established the Adak Discovery Community for teachers, students, and their families. Through the Discovery Community program, activities bring the scientists, Native Americans, students and policy makers together in education and collaboration. As a reciprocal learning experience, teachers, students and community members are advising scientists on current Aleutian environmental and social concerns. In return scientists are informing the local community about methodologies and scientific ideas employed in the project.

**Increased Public Scientific Literacy**

- To achieve a broader impact, the NSF-funded Center for High-Rate Nanomanufacturing at Northeastern University sponsors presentations to the public. Center researchers have found that live presentations are an extremely effective way of engaging large numbers of the public in the ongoing work of the Center and informing them of nanoscience topics in general. Through these presentations, public audiences are connected to nanotechnology research taking place in the local community. In addition, to public presentations, the Center-sponsored live cable news updates on nanotechnology. Each segment had the potential of reaching up to 3.5 million homes in over 1,000 New England communities. In addition, podcasts focusing on nanotech research news reaching more than 2,000 listeners each are available via a Center-supported museum website and iTunes.

- The NSF-funded Nanobiotechnology Center (NBTC) at Cornell University has developed, in collaboration with the Main Street Science education program, the hands-on traveling museum exhibition *It's a Nano World*. This exhibit is having a broader impact by reaching a target audience of children ages 5-8 and their families about the wonders of the nano world through interactive exhibits specifically designed for this segment of the population. Entering through the gateway of *It's a Nano World*, visitors

are transported into the wonders of biology at the nanometer scale. *It's a Nano World* opened in spring 2003 at the Sciencenter in Ithaca, New York, and then began a national tour in late 2003 with a 6-month display at Innoventions at Epcot, Walt Disney World, Florida. During that period alone, approximately 800,000 visitors toured the exhibition, which drew rave reviews from visitors and Epcot staff. The exhibition has subsequently toured additional science museum locations throughout the United States, reaching over one million visitors.

- Scientists from the NSF-supported Center for Complex Materials (PCCM) at Princeton University are having a broader impact on public understanding of science. Developed in collaboration with the New Jersey Liberty Science Center, the traveling exhibit, Strange Matter, is bringing materials science to the curious minds of young children and their families. In drawing the biggest crowds ever seen at the Liberty Science Center, PCCM students and faculty have inspired tens of thousands of people to think about materials science, teaching children and their parents the secrets of polymers through hands-on-demonstrations and Q&A sessions.

- Chronic Wasting Disease (CWD) has spread across the country, threatening elk, white-tailed deer, and mule deer in many states. The disease is caused by an aberrant protein that destroys brain tissues. Until recently, wildlife biologists believed that the disease could be spread only by infected animals. Destroying infected herds is a common preventive strategy. A collaborative study conducted by researchers at Colorado State University and the University of Wyoming have shown for the first time that CWD can be transmitted to uninfected animals indirectly, from environments contaminated by excreta or decomposed carcasses. This profound result means that only destroying infected animals will not halt or even slow the spread of CWD. The project has developed a reliable, non-lethal method for detecting CWD in mule deer that significantly improves the ability to monitor prevalence of the disease. A broader impact on public understanding of science of this NSF-funded project has been informing the general public about this potent disease and its potential impact.

**Increased National Security**

- An NSF-supported research team at the University of Virginia has developed a scenario-based "game" for identifying and prioritizing security vulnerabilities related to critical infrastructure. The game is built around an interactive, multidimensional analysis method called the hierarchical holographic method developed by the same team. An example of the **broader impacts** of this project is the work of the research team with the Virginia Department of Transportation, in which the researchers have used the methods to identify security vulnerabilities around a gubernatorial inauguration. Additionally, working with the Department of Homeland Security, researchers have used the scenario-based "game" to aid decision analysis associated with the Department's color alert system. They have also analyzed risks to U.S. Army critical infrastructure in ways that can help prioritize protection of critical army assets.

- Researchers at Northwestern University are conducting NSF-supported bio-molecular research that has the potential to detect chemicals used for explosives. The technique uses microcantilevers, long used for sensing. Traditionally, optics has been used to measure microcantilever bending. Instead researchers have embedded transistors (specifically, metal-oxide-semiconductor-field-effect-transistors) into the

microcantilever. This alternative measuring technique affords more flexibility, such as the ability to perform high-resolution sensing in liquids or environments in which light scatters. They can equip a chip with several cantilever-transistor pairs designed to sense different molecules, allowing sensing of given molecules in an environment. The researchers have a patent for the technique and are investigating its use in detecting explosives to increase the **broader impact** of this project in the area of national security.

- At Oklahoma State University, previously developed technology for neutralization of terrorist explosives is being applied to the development of sensors for the detection of explosives. These sensors are atypical because they are capable of identifying both peroxide-based explosives and conventional nitro-organic explosives. A **broader impact** of this NSF-funded project is its potential for increasing national security. In addition, the project is having a broader impact by providing opportunities for research to students from traditionally underrepresented groups in science and engineering.

- Researchers from the University of Illinois at Urbana-Champaign, Dartmouth College, Cornell University, and Washington State University are collaborating to address the challenge of how to protect the nation's power grid. This team is improving the way the power grid infrastructure is built, and exploring ways to make it more secure, reliable, and safe. The **broader impacts** in national security of the NSF -funded project were increased with additional support from the Department of Energy and the Department of Homeland Security. The continuity of the power grid depends on the health of an underlying computing and communication network infrastructure that is at serious risk from both malicious cyber attacks and accidental failures. These risks may come from cyber hackers who gain access to control networks or create denial of service attacks on the networks themselves, or from accidental causes, such as natural disasters or operator errors. Recognizing the importance of educating the public in the role of science and technology in increasing national security, the project has developed interactive and open-ended "applets" for middle-school students, along with activity materials and teacher guides to facilitate the integration of research, education, and knowledge transfer by linking researchers, educators, and students. This is one approach the project is using to increase public knowledge in this important area.

# V: USE OF BROADER IMPACTS CRITERION TO IMPROVE UNDERGRADUATE EDUCATION

**COMPETES Act Request: Describe what steps the Foundation is taking and should take to use the broader impacts criterion to improve undergraduate science, technology, engineering, and mathematics education.**

The Foundation has taken several steps to use the broader impact criterion to improve undergraduate science, technology, engineering, and mathematics education. These steps include:

- **Integration of Research and Education.** By promoting the integration of research and education, NSF leverages its investment in research to have a positive impact on education at all levels—K-12, undergraduate, graduate, and postdoctoral scholar. The integration of research and education can take several forms. For example, incorporating recent research advances in undergraduate courses invigorates the curriculum. Faculty mentor students that are actively engage in their research projects. Research experiences for undergraduates are developed in the areas of research supported by NSF.

- **Increasing the Participation of Underrepresented Groups.** Being *broadly inclusive* is a Core Value for NSF as stated in the agency's **FY 2006-2011 Strategic Plan.** Broadening participation of groups in undergraduate science and engineering that are underrepresented (for example, by minority group, women, institutional types, geographical region) is an activity well suited toward the broader impact criterion. Research grants provide excellent opportunities for researchers to be inclusive for students at their own institutions and to provide opportunities for students at other institutions through research partnerships.

- **Improving Infrastructure.** Improving the infrastructure for research and education through facilities, instrumentation, networks, and partnerships has great potential for improving undergraduate education. Grants that have a focus on infrastructure building are able to not only improve the climate for research, but also through the broader impact criterion improve the climate for undergraduate education

The list of activities provided in answer to Section II above provide specific examples of ways in which the broader impact criterion is used to improved undergraduate science, technology, engineering, and mathematics education.

# Appendix: Survey of Additional Criteria Used in NSF Solicitations

As was previously discussed, NSF Programs may have criteria to highlight the specific objectives of certain programs and activities. These criteria are in addition to the two NSF-wide criteria: Intellectual Merit and Broader Impacts. The criteria listed here are drawn from various program solicitations from throughout the Foundation.

In April 2008, a survey of the 243 active NSF programs was conducted. Of these programs, 84 provided additional broader impact criteria to supplement the NSF-wide broader impact criterion. The additional criteria in these solicitations are included below and are organized by directorate, division, and program. Capitalized headings indicate a division and programs are indicated by lower case bold lettering. Programs that do not utilize solicitations are not included in this appendix. Solicited programs that do not provide additional criteria or additional criteria not relevant to broader impact are also not included. In the excerpts that follow, some of the language indicative of broader impact has been bolded.

# DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO)

## DIVISION OF BIOLOGICAL INFRASTRUCTURE

### I. Human Resources Cluster

**Minority Postdoctoral Research Fellowships and Supporting Activities**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06586*

Additional Review Criteria:

Because one of the objectives of the program is to **broaden the perspectives and experiences of the Fellows**, careful consideration should be given to the selection of the Sponsoring Scientists and host institutions. The NSF encourages Fellows to gain international experience by selecting foreign hosts for at least part of the tenure of the fellowship. An important basis for judging the suitability of the host institution is the degree to which the Sponsoring Scientist statement describes and offers a research environment and mentoring opportunity that could be difficult to achieve without fellowship support.

Applicants are evaluated on their ability, accomplishments, and potential as evidenced by the Curriculum Vitae and reference reports. The research and training plan is evaluated on its scientific merit, its feasibility, its significance in generating new knowledge, and its **impact on the career development of the applicant and its potential to increase participation of underrepresented groups**. Other important evaluative factors are the suitability and availability of the Sponsoring Scientist(s) and host institution(s), including colleagues and facilities.

The Postdoctoral Fellowship Program Officers manage the selection process and will consider the advice of reviewers in formulating a program recommendation. The NSF will select the Fellows on the basis of the panel's recommendations, staff review, program priorities, a **consideration of the effect of the selections on the infrastructure of science in the U.S., and the NSF's education and human resource goals**. Priority will be given to applicants who are graduate students at the time they apply, to those who choose foreign locations, and those moving to new institutions and research environments with which they have had no prior affiliation.

**Postdoctoral Research Fellowships in Biology**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07580*

Additional Review Criteria:

Applicants are evaluated on their ability, accomplishments, and potential as evidenced by the submitted CV and reference reports. The research and training plan is evaluated on its scientific merit, its feasibility, its significance in generating new biological knowledge, and its impact on the **career development** of the applicant. Other important evaluative factors are the suitability and availability of the sponsoring scientist(s) and host institution(s), including colleagues and facilities.

**Undergraduate Research and Mentoring in the Biological Sciences**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06591*

Additional Review Criteria:

Reviewers will be asked to interpret the two basic NSF review criteria in the context of the URM program. In addition, they will be asked to place emphasis on the following considerations:

The appropriateness, value, and level of innovation of the proposed URM program for the student participants, particularly the appropriateness of the research project(s) for undergraduate involvement and the nature and **extent of student participation** in these activities.

The quality of the research environment, including the record of the mentor(s) with undergraduate research participation, especially those i**nvolving underrepresented minority students**, the facilities, and the professional development opportunities.

The quality of the **mentoring strategies** to be used and their appropriateness and likely success for nurturing students in the pursuit of a research career.

Appropriateness of the student recruitment and selection plans, including **involving students from underrepresented groups**.

Quality of plans for student preparation and follow-through designed to promote **continuation of student interest** and involvement in research.

Effectiveness of the plans for managing the project and evaluating the outcomes, appropriateness and cost-effectiveness of the budget, and commitment of partners, if relevant.

**II. Resources Research Cluster**

**Biological Databases and Informatics (BD&I)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf05577*

Additional Review Criteria:
In addition, reviewers of proposals to BD&I will focus on the following issues:

Responsiveness to the program scope;

Potential to advance biological research;

Effectiveness of the project's organizational plan to reflect technical advances and new scientific discoveries;

Extent to which the operation is focused on the research community's needs;

Soundness and openness of the information-sharing plan and management of intellectual property rights;

Quality of the training environment for junior scientists and/or mid-career scientist wishing to retool (if applicable); and

Commitment to **promote participation of members of under-represented groups**.

Where appropriate, reviewers will also consider:

Cohesiveness and soundness of the planned coordination for a multi-investigator project;

Efficiency and cost-effectiveness of the proposed approach for infrastructure development; and

Soundness of the plan for maintenance of databases or software after the NSF award period.

**Improvements in Facilities, Communications, and Equipment at Biological Field Stations and Marine Laboratories (FSML)**
*http://www.nsf.gov/pubs/2005/nsf05550/nsf05550.htm*

Additional Review Criteria:

Consistent with the general NSF review criteria elaborated above, the evaluation of FSML proposals will center upon the following aspects of the proposed project:

Intrinsic merit of the proposed improvements or planning efforts **in enhancing research and training activities** at the proposing facility, including the quality and amount of data that can be collected and archived;

Thoroughness and appropriateness of the planning or needs assessment effort that led to the specific request;

Need for, and adequacy of the justification for, the proposed improvements in terms of the research and training missions of the proposing facility;

Significance and uniqueness of the facility's current and potential impact on the progress of biological research and education at local, regional and national levels;

Likely impact of the project on the improvement of biological research and training at the facility;

Likely impact of the proposed activity on the ability of the facility to accommodate visiting scientists and students;

Research and training productivity of the facility during the most recent five-year period;

Scope, utility and accessibility of data collected at the site, including the existence of well-defined data management and data sharing policies, and the utilization of standard communications protocols.

**Instrument Development for Biological Research**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07568*

Additional Review Criteria:
In addition, reviewers are also asked to consider the following:

Feasibility of the proposed instrument design, including the likelihood of achieving expected performance;

Appropriateness of the project to the goals of the IDBR program, including the likely impact of the proposed instrument or software on biological research;

Adequacy and justification for proposed budget and timeline;

The adequacy of the investigators' current research grants to support biological research that will utilize the instrument, and/or the developer's plans and capacity to transfer the technology to commercial development or to wider public research use;

The adequacy of the mechanical and electronics shops or of subcontractors offering equivalent services, as appropriate; and

**Potential of the project for the integration of research and education, and for the broadening of participation** of members of underrepresented groups or underserved communities.

As part of the consideration of the merit of the research, the reviewers examine the importance of any new knowledge to be gained during the development project, of the biological research for which the instrument is eventually intended. As a part of the consideration of the effect on infrastructure, the reviewers consider the likely importance of the instrument to the biological research community.

# DIRECTORATE FOR COMPUTER & INFORMATION SCIENCE & ENGINEERING (CISE)

## COMPUTING & COMMUNICATION FOUNDATIONS

**Expeditions in Computing**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07592*

Additional Review Criteria:

As an elaboration of the Intellectual Merit and Broader Impacts criteria, reviewers will be asked to consider the following guidance when evaluating both preliminary and full proposals.

Value-added of funding the activity as an Expedition: Are the identified research and education goals of sufficient import, scale, and/or complexity to justify this type of investment? Will the proposed activity contribute to realization of the Expeditions in Computing program goals and is it likely to demonstrate the characteristics described in the solicitation? Where necessary, comment on the value of the experimental systems or shared experimental facilities proposed?

Leadership and Collaboration Plan: Does the leadership team convincingly demonstrate the goals, experience, and capacity to manage a complex, multi-faceted, and innovative research, education, and knowledge transfer enterprise? What is the likely effectiveness of the proposed leadership and collaboration plan? Is there documentation of institutional and other commitments to the proposed activity? Is the requested budget appropriate for the scope and **complexity of the research, education** and knowledge transfer projects proposed? Does the proposed collaboration approach promise significant value added?

**Software for Real-World Systems**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07599*

Additional Review Criteria:

Research Innovations and Paradigm Shifts – SRS proposals must describe how the project will provide innovations and paradigm shifts in at least two of the three areas of scientific principles, engineering processes and methods, and **educational pedagogy** to address the challenges of designing, building, and analyzing software for real-world systems. The "Project Summary" and "Project Description" sections of the proposal must explicitly articulate the expected research contributions to be made in two (or three) of these areas.

Collaboration Plan – For multi-investigator projects, a "Collaboration Plan" is required and should provide detailed information about the roles of key project personnel and the plans for coordinating project tasks among multiple individuals, institutions and disciplines, as applicable. The Collaboration Plan will be reviewed for clarity of task definitions, effectiveness of task assignments, and achievability of project objectives.

**Broadening Participation in Computing (BPC)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07548*

Additional Review Criteria:
The following additional review criteria apply to all BPC proposals.

The degree to which proposers have demonstrated awareness of the issues and remedies of **underrepresentation**.

The degree to which the proposal describes a comprehensive evaluation plan.

The following criteria apply to Alliance and Alliance Extension proposals only.

The degree to which the proposal demonstrates institutional and organizational commitment that the project will be sustainable and part of a comprehensive effort to address underrepresentation.

The degree to which the proposal includes an **effective plan for dissemination**.

**CISE Computing Research Infrastructure (CRI)**
***http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06597***

Additional Review Criteria:
Additional considerations in evaluating all proposals are:

Whether the requested infrastructure will enable the proposers and/or a broader community to undertake important work that would not be possible without the infrastructure.

Whether there is strong synergy present in the proposal that would not be found in individual grants.

Potential impact on **broadening participation of underrepresented groups** in the CISE research and education enterprise.

**CISE Pathways to Revitalized Undergraduate Computing Education**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08516*

Additional Review Criteria:
Additional review criteria differ by CPATH project type as described below.

TI proposals
In the context of the Intellectual Merit and Broader Impacts review criteria, reviewers will be asked to consider specifically the following aspects of TI proposals.

Project Vision, Goals, Objectives, and Anticipated Outcomes. Assess the potential of the proposed project and the likelihood that it will contribute in significant ways to realization of the CPATH vision, and to systemic change in **undergraduate computing education**. Is the project truly innovative and does it have the potential to **serve as a national model**?

Current State. Evaluate the readiness of the participating organizations to undertake the proposed work. Do the proposers demonstrate a clear understanding of the current state of undergraduate computing education within the nation, within participating organizations, and within the domain of focus for the proposed project. If data are provided, do they support the proposing team's assessment?

Implementation Plan. Evaluate the soundness that the proposed implementation plan and its potential to result in realization of the proposed vision, goals, objectives and milestones for the project. Determine the degree to which individuals from CISE disciplines are engaged in the project, both in the leadership team and in the project as a whole.

Collaboration Plan. Evaluate the proposed collaboration plan and the commitment of the participating organizations to the project vision, goals, objectives and outcomes. Does the collaboration plan give confidence that organizational change necessary to project success will be implemented? Does it have the potential to develop new and sustain new multi-disciplinary computing units within institutions?

Project Expertise. Evaluate the expertise of the project team to carry out the project. Is there sufficient expertise on both the research and the educational aspects?

Institution and Community Support. Evaluate the institutional support for the project. Is there sufficient administrative and infrastructure support for the proposed transformations? Are there letters of support documenting this commitment?

Evaluation and Dissemination Plan. Assess the quality of the proposed evaluation and **dissemination activities.**

CB proposals
In the context of the Intellectual Merit and Broader Impacts review criteria, reviewers will be asked to comment specifically on the following aspects of CB proposals:

Project Vision, Goals, Objectives, and Anticipated Outcomes. Assess the potential of the proposed project and the likelihood that it will contribute in significant ways to realization of the CPATH vision. Is the project innovative and does it have the potential to develop and sustain new multi-disciplinary computing communities?

Implementation Plan. Evaluate the soundness of the proposed implementation plan and its potential to result in realization of the proposed vision, goals, objectives and outcomes. Assess the degree to which individuals from CISE disciplines will be engaged in the proposed activities.

Project Expertise. Evaluate the expertise of the project team to carry out the project. Is there sufficient expertise on both the research and the educational aspects? Assess the degree to which individuals from CISE disciplines will be engaged in the proposed activities.

Institution and Community Support. Evaluate the community support for the project.

Evaluation and Dissemination Plan. Assess the quality of the proposed evaluation and dissemination activities.

CDP proposals
In the context of the Intellectual Merit and Broader Impacts review criteria, reviewers will be asked to comment specifically on the following aspects of CDP proposals:

Project Vision, Goals, Objectives, and Anticipated Outcomes. Assess the potential of the proposed project and the likelihood that it will contribute in significant ways to realization of the CPATH vision, and to systemic change in **undergraduate computing education**. Is the vision of the conceptual development and planning activity for projects that are truly innovative and within the CPATH vision? Is planning needed or is there sufficient activity underway that fuller implementation is in order?

Implementation Plan. Evaluate the soundness of the proposed CDP project implementation plan and its potential to result in realization of the proposed vision, goals, objectives and

outcomes. Assess the degree to which individuals from CISE disciplines will be engaged in the proposed activities.

Project Expertise. Evaluate the expertise of the project team to carry out the project. Is there sufficient expertise on both the research and the educational aspects? Are all stakeholders integrally involved in the CDP project activities?

Institutional and Community Support. Evaluate the institutional or community support for this CDP activity.

Evaluation and Dissemination Plan. Assess the quality of the proposed evaluation and **dissemination activities**.

**CreativeIT**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07562*

Additional Review Criteria:

The project will be assessed on whether it responds to one or more of the following questions. Please indicate in the Project Summary which question(s) the research addresses, or the proposal may be returned without review.

Will this research improve our understanding of creative processes in the context of a specific problem in computer science, information technology, science or engineering?

Will the research lead to the development of new technologies to support human creativity?

Will the research lead to transformational research in computer science, information technology, science or engineering through the use of creative practitioners?

Will the research lead to **innovative teaching** in computer science, science, or engineering that rewards creativity?

**Cyber Trust (CT)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08521*

Additional Review Criteria:

For Cyber Trust Large proposals only, reviewers will be asked to provide specific comments on the following areas:

Research: Comment on the extent to which the project brings diverse scientific, engineering, and other disciplines together to address fundamental research issues crucial to achieving the Cyber Trust vision;

**Education and Outreach**: Comment on the degree to which the proposed education and outreach activities meet the objectives described in the solicitation;

Partnership and Technology Transfer: Comment on the quality and potential impact of the partnership and technology transfer activities;

Management and Evaluation Plans: Comment on the quality and likely effectiveness of the proposed Management and Evaluation Plans.

**CISE Computing Research Infrastructure (CRI)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06597*

Additional Review Criteria:
Additional considerations in evaluating all proposals are:

Whether the requested infrastructure will enable the proposers and/or a **broader community** to undertake important work that would not be possible without the infrastructure.

Whether there is strong synergy present in the proposal that would not be found in individual grants.

Potential impact on **broadening participation of underrepresented** groups in the CISE research and education enterprise.

Site visits may be used in addition to panel review to help select the large Infrastructure Acquisition/Development and Community Resource Development projects.

**Ethics Education in Science and Engineering**
***http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08530***

Additional Review Criteria:

Reviewers will be asked to apply several special criteria to all proposals in this program:

Is this an innovative effort? Is it likely to create long-term improvement in **ethics education for graduate students** in science or engineering?

Does the project include adequate grounding in the relevant research literatures? Does it use appropriate methodology of evaluations? Does it include relevant interdisciplinary collaboration?

Do potential results have promise for broad utility, and is there a feasible plan for **widespread dissemination**, adoption or adaptation?

Are there adequate supporting materials to document commitment from those individuals and institutions playing a substantive role in the project?

For education proposals, and those combining research and education, additional special criteria are:

Does the proposal include appropriate plans to test results beyond one institution?

Does the proposal include well-formulated, feasible plans for evaluation of effectiveness?

**INFORMATION & INTELLIGENT SYSTEMS (IIS)**
**Information and Intelligent Systems: Advancing Human-Centered Computing, Information Integration and Informatics, and Robust Intelligence**

No Additional Criteria

**Advanced Learning Technologies (ALT) Croscutting**
No Additional Criteria

# DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES (EHR)

## GRADUATE EDUCATION (DGE)

**Graduate Research Fellowship Program**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07576*

Unique Criteria:

Intellectual Merit

The intellectual merit criterion includes demonstrated intellectual ability and other accepted requisites for scholarly scientific study, such as the ability (1) to plan and conduct research; (2) to work as a member of a team as well as independently; and (3) to interpret and communicate research findings. Panelists will consider: the strength of the academic record, the proposed plan of research, the description of previous research experience, references, Graduate Record Examinations (GRE) General and Subject Tests scores, and the appropriateness of the choice of institution relative to the proposed plan for graduate education and research.

Broader Impacts

The broader impacts criterion includes contributions that (1) effectively **integrate research and education at all levels,** infuse learning with the excitement of discovery, and assure that the findings and methods of research are communicated in a broad context and to a large audience; (2) **encourage diversity, broaden opportunities**, and enable the participation of all citizens-women and men, underrepresented minorities, and persons with disabilities-in science and research; (3) enhance scientific and technical understanding; and (4) **benefit society**. Applicants may provide characteristics of their background, including personal, professional, and educational experiences, to indicate their potential to fulfill the broader impacts criterion.

**Integrative Graduate Education and Research Traineeship Program (IGERT)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08540* NSF-Wide

Additional Review Criteria for Traineeship Grants:

In responding to the standard NSF review criteria, reviewers will be asked to place emphasis on the following IGERT program objectives:

Integration and coherence of the interdisciplinary theme in its effectiveness as an intellectual focus for all participating scientists, engineers, and educators;

Quality of the proposed research efforts, and their comprehensive interdisciplinary theme, and their appropriateness for doctoral-level research, that serves as the foundation for traineeship activities and the extent to which the efforts are based on transformative science/technology/engineering/mathematical sciences;

Quality and innovation in the planned graduate education and training mechanisms, and in their integration with the research and in developing an appreciation for the global context of the interdisciplinary theme;

Effectiveness of **career development** opportunities, provision for developing professional and personal skills, fostering an international perspective and ability to work in diverse teams, and instruction in ethics and the responsible conduct of research;

Quality of the international collaborative activities and benefits to the U.S. participants, if funds are requested for those activities (optional)

Effectiveness of the strategy for recruitment, mentoring, retention, degree completion, and career progression of U.S. graduate students, including those from groups underrepresented in science and engineering: a partial list of examples of effective strategies might include development of new approaches in information technology or connectivity to engage members of underrepresented groups; collaborations with students and/or faculty who are members of underrepresented groups or are affiliated with minority-serving institutions (MSI); campus visits/presentations at MSI; regular publication of bulletins/newsletters to enhance cross-cultural/gender communication; and monitoring of graduate student retention. Plans for effective recruitment and assessment should be specific and detailed;

Appropriateness of the plans for assessment of project performance in meeting objectives and expanding the knowledge base in STEM (Science, Technology, Engineering, and Mathematics) graduate education and disseminating results to appropriate professional communities; (full proposals only)

Appropriateness of the administrative plan and organizational structure in assuring effective allocation of project resources and participation by project members; (full proposals only)

Commitment of the institution to facilitating and furthering the plans and goals of the IGERT project, to creating a supportive environment for integrative research and education, to creating a supportive environment for cyber-enabled communication, and to sustaining the successful elements of the project after NSF funding ceases; and

For institutions that have received one or more previous IGERTs, the impacts of the previous IGERTs on graduate education and interdisciplinary science and the intended institutional impact of the currently proposed IGERT.

Additional criteria for renewal projects:

Demonstrated excellence and significant achievements from the previous IGERT in the dimensions of interdisciplinary research/science/engineering; education and curricular development; trainee outcomes; recruitment, retention and successful progress of women, underrepresented minorities, and persons with disabilities; and institutional impacts;

Added value in each of the dimensions above;

Institutional commitment defining why a renewal is needed and explicitly how this renewal will contribute to sustainability, what will be sustained and how it will be sustained.

Additional Review Criteria for IGERT Resource Center:

NSF staff will give careful consideration to the following in making funding decisions:

Lead institution: Does the lead institution, and the team proposed if any, have the capacity and qualifications to plan, develop, improve and maintain a comprehensive national Resource Center to support the diverse array of IGERT projects and needs? Is the lead institution knowledgeable about cyber-infrastructure and its applicability to e-enabled communities as

well being knowledgeable about the needs of STEM graduate education? Does the key staff have the demonstrated expertise with IT and its application to the needs of diverse communities in interdisciplinary and complex STEM graduate education?

Project Design: Does the project design provide a creative and comprehensive plan for ongoing technical support for IGERT projects and NSF? Are goals for the various components of the project including hosting modes of communication and meetings, providing support for best-practice development and exchange, identifying resources, and **disseminating information** clearly stated, well planned and thought through and easily related to the overall project plan? Does the Resource Center model the exemplary use of cyber-enabled infrastructure throughout?

Management and Evaluation: Does the project have clearly articulated and well integrated management and oversight mechanisms? Does the project plan have well-developed, detailed and well integrated evaluation and assessment plans including timelines and milestones for all work? Are mechanisms for involving the IGERT community and NSF in metrics of effectiveness of the Center on an ongoing basis in a cost-effective manner clear, well-developed and thoroughly integrated into the project?

**Trainee involvement and support**: Are there mechanisms for helping IGERT projects to recruit and retain qualified trainees with a specific effort to ensure outreach to and inclusion of underrepresented minorities in STEM fields? Does the Resource Center clearly involve e-community options and modes of interaction of and support for trainee interactions across IGERTS and with appropriate external communities?

**NSF Graduate Teaching Fellows in K-12 Education (GK-12) Crosscutting/NSF-Wide**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07555*

Additional Review Criteria:

In light of the GK-12 program's objectives, reviewers will be asked to consider the above two merit review criteria with emphasis placed on:

Plans for incorporating fellows' research into the GK-12 project.

Integration of the disciplinary, multidisciplinary, or interdisciplinary research theme(s) with the education activities of the fellows in K-12 schools as an intellectual focus for the project.

Intellectual basis, quality and effectiveness of the planned education and training activities for fellows and GK-12 teachers to ensure professional development for both.

Expected benefits to fellows, their institutions of higher education, K-12 students and their schools, and GK-12 teachers.

Team composition and extent of collaboration between the proposing institution(s) of higher education and the participating K-12 school district(s).

Effectiveness of the plans and procedures for the recruitment, selection, and **mentoring of fellows** and GK-12 teachers, including **attention to diversity**.

Consistency of project designs with mathematics and science standards established by national organizations, states, and school districts.

Potential of the project to incorporate GK-12 like activities as permanent features in the training of STEM graduate students.

Plans for evaluation, assessment of project performance and **dissemination** of results.

**RESEARCH ON LEARNING IN FORMAL AND INFORMAL SETTINGS (DRL)**

**Advanced Technological Education**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07530*

Additional Review Criteria:

For the ATE program, questions such as the following are often relevant to evaluating proposals in terms of NSF's merit review criteria.

Intellectual Merit

Does the project have potential for improving student learning in science or engineering technician education programs?
Are the goals, objectives, and outcomes and the plans and procedures for achieving them, worthwhile, well-developed, and realistic?
Is the evaluation plan clearly tied to the project outcomes? Is the evaluation likely to provide useful information to the project and others?
Is the rationale for selecting particular activities or components for development or adaptation clearly articulated and informed by and build on the research literature and the work of others?
Does the project provide for effective assessment of student learning?
Is the evidence of institutional support clear and compelling, and have plans for long term institutionalization been addressed?

Broader Impacts

Does the project work with employers to address their current and future needs for technicians?

Has an assessment of workforce needs for technicians been conducted?

Will the project evaluation inform others through the **communication of results**?

Are the results and products of the project likely to be **useful at other institutions**?

Are other educational institutions involved in project activities?

Will the project's results be widely disseminated and will its products be distributed effectively and commercialized when appropriate?

Does the project promote **diversity** in the technical workforce?

**Communicating Research to Public Audiences NSF Wide**

*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf03509*

Additional Review Criteria:
In addition to the standard NSF criteria (see above), the following will be considered:

The clarity with which the PI has articulated the general science literacy goals as related to research;

The quality of the informal learning activity; and

The relation between the science literacy goals and the choice of the target audience, **the extent of the impact**, and the evaluation strategies.

**Discovery Research K-12 (DR-K12)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08502*

Additional criteria not listed with review criteria:

Dissemination
Outline plans for **innovative approaches to dissemination**. Include a description of anticipated contributions of the activity to teachers, schools, K-12 administrators, teacher educators, STEM education researchers, or policy makers. Projects are expected to plan for the production of materials that will be disseminated through the DR-K12 Resource Network as well as other means, and research reports written for publication in peer-reviewed sources.

**Informal Science Education (ISE)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08547*

Within Broader Impacts, reviewers will assess:

Audience. Is the primary target audience, as well as any secondary audience, clearly identified and segmented into subgroups as appropriate? Does the project demonstrate knowledge about the target audiences, their needs, and their interests? (Impact)

Public Audiences. Will the project likely achieve a **significant impact** on the target audience of informal learners? Does the project maximize reach to audiences nationally, regionally, or community-wide? Does the proposal offer effective ways to reach **nontraditional audiences and underrepresented groups**? (Impact)

---or---Professional Audiences. Will the project likely achieve a significant impact on professionals in the field of informal science learning? (Impact)

Impact Evaluation. Are there clear, appropriate measures and criteria for defining project success? Is there an appropriate summative evaluation plan for assessing impact? Is there an effective plan for **broadly sharing project outcomes** and findings? (Impact)

Strategic Impact. Is the project likely to **advance the field of informal science education** in a significant way? (Impact)

**Research and Evaluation on Education in Science and Engineering (REESE)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07595*

No Additional Criteria, however:

Knowledge Diffusion proposals
Knowledge diffusion projects are small grants for the synthesis of existing knowledge on a topic of critical importance to STEM learning, education, and/or evaluation, or for the **diffusion of research-based knowledge**. Synthesis proposals should identify areas where the knowledge base is sufficiently robust to support strong scientific claims, identify areas of

importance to education research, evaluation or practice, and propose rigorous methods for synthesizing findings and drawing conclusions from a range of relevant literatures. Proposals should identify the criteria to be used for including or excluding studies. Investigators are permitted to propose workshops and other meetings in pursuit of the diffusion of research-based knowledge or to provide training on topics of advanced research or evaluation methods, analysis, modeling, or measurement. Maximum award size for knowledge diffusion proposals is $250,000 for duration of up to two years.

Provides Link to examples of BI: *http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf.*

**UNDERGRADUATE EDUCATION (DUE)**

**Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06559*

Additional Review Criteria:

Additional review criteria apply. Each proposal will be evaluated on the degree of interaction between computation and the mathematical sciences in the research experiences provided to undergraduates, the degree of student participation and immersion in the proposed activities, the extent of commitment to **mentoring by senior faculty**, and the quality and efficacy of its management and evaluation plans.

**Course, Curriculum, and Laboratory Improvement (CCLI)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08546*

Additional Review Criteria:

In reviewing CCLI proposals, the standard criteria will be expanded to include the following additional review criteria as appropriate to the phase and main component of the proposed work:

Intellectual Merit: Will the project produce exemplary material, processes, or models that enhance student learning? Will it yield important assessment or research findings related to **student learning**, as appropriate to the goals of the project? Does the project build on the existing STEM education knowledge base? Are appropriate expected measurable outcomes explicitly stated and are they integrated into an evaluation plan? Is the evaluation effort likely to produce useful information?

Broader Impacts: Will the project contribute to the **STEM education knowledge base**? Will the project help build the STEM education community? Will the project have a broad impact on STEM education in an area of recognized need or opportunity?

**Federal Cyber Service: Scholarship for Service (SFS)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08522*

Additional Review Criteria:

Reviewers will be asked to consider the merit review criteria with respect to the SFS program components (see Section II ["PROGRAM DESCRIPTION"]). These include:

The quality and completeness of the management and administrative plan--the plan must address all elements expressed in the program solicitation;

The quality of education and research in information assurance at the institution and the extent to which **education and research are integrated**;

The quality of application-oriented experiences to **increase the student's understanding of information** assurance needs and their relationship to educational practices, governmental and industrial partnerships, and outreach;

The extent of the participation of faculty members with specific expertise in information assurance and security, as well as **professional development** for other faculty;

The extent to which discipline faculty members are integrally involved with the scholarship students and working with the students as a cohort; and

For the Scholarship Track, reviewers may also consider the provision for appropriate student support infrastructure for the successful graduation of scholarship recipients, as expressed in the program solicitation.

**Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08510*

Additional Review Criteria:

All proposals will be evaluated on the extent to which they include commitment and collaboration of both mathematical and biological scientists in the project, and the degree of **student participation** and immersion in the proposed activities.

**Nanotechnology Undergraduate Education (NUE) in Engineering**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08544*

Additional Review Criteria:

In addition to the above, the following elements will be used by reviewers and NSF staff in evaluating all NUE 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 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?
What is the extent to which creative, interdisciplinary approaches to undergraduate engineering education are 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?

**National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08554*

Additional Review Criteria:

Evaluation of NSDL proposals will also include consideration of:

Impact. Is the need for the project convincingly argued? Does the project fill a definable gap for NSDL? Is the target audience clearly identified, and what is the potential for the project to make a significant impact on that audience? Does the potential exist for the project to model a particularly creative approach to the provision of services that enhance learning with digital educational resources or to the stewardship of a usable body of digital resources?

Plan. Is there a sound implementation plan that links clear project goals and objectives to roles and responsibilities of project personnel? Does the project demonstrate an understanding of the current state of technical development of NSDL, e.g. metadata harvesting protocols, standards for interoperability, or authentication protocols? If appropriate, does the the project demonstrate an understanding of the current state of other innovative technical developments that can bring value to the NSDL network? Does the plan describe adequately how collaboration and integration with the ongoing activities of relevant grantees or other projects will be accomplished? Where applicable, what is the potential for project capabilities to remain available beyond NSF support?

Personnel. Does the project team represent an appropriate mix of expertise and experience to accomplish the project goals? What is the evidence of the commitment and involvement of senior personnel in the project and its activities? Are the roles of various other personnel clear? If there are project partners, contributors, or other collaborators, what is the nature and strength of their commitment?

Outcomes. Does the project offer access to expanded or enhanced capabilities not previously available through NSDL? Or is the project enabling a new user audience to access NSDL? Can this serve as a model for other user audiences? Does the project have a reasonable plan to scale up this access? Where applicable, is the project providing an **opportunity for a new sector of the educational community** to take part in selecting or otherwise contributing to NSDL's collections or providing a service?

Contribution. How will the project's activities complement and add value to the growing NSDL community of users and developers? Is there potential for the project to bring new perspectives and approaches to solutions related to shared issues of networked resources and services development, e.g. needs and **requirements of learners**, new technical specifications, intellectual property concerns, or plans for sustainability? What is the potential for the project to engage new participants in achieving the goals of NSDL, e.g. business or industry, or the non-profit private sector?
Evaluation. Where appropriate, has the project presented a reasonable plan to assess progress towards its goals and to evaluate the impact of the project on the intended audience? Are there innovative approaches proposed for evaluating learners' usage of networked digital resources and their efficacy in improving learning? Do these have the potential to be applied in new settings, e.g. for resources in other disciplines, or for user audiences beyond that originally targeted by the project? If applicable, does the project offer an opportunity to understand the potential applicability to NSDL of new information technologies?

**NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07524*

Additional Review Criteria:

Reviewers will be asked to consider the above two merit review criteria with emphasis placed on the S-STEM program components (see "Program Description"). Those elements include:

**Student-support infrastructure** for the successful graduation of scholarship recipients,

Management and administration plan that is effective and clearly articulated,

Evidence of faculty participation and support from the appropriate financial aid and student services personnel,

Justification of the number and amount of scholarships requested based on current student demographics, and

Educational program of high quality.

**Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf04525*

Additional Review Criteria:

The following criteria will be taken into consideration:

ADDITIONAL CRITERIA FOR INDIVIDUALS

The number and diversity of **students mentored** to high school graduation, the associate, baccalaureate, master's, or doctoral degree levels;

The success of students mentored in pursuit of degree objectives and attendant quality of academic performance;

Demonstrated achievement in assisting students to understand how the educational system works and promoting their advancement in the educational continuum in science, technology, engineering, or mathematics;

**Affording students effective academic/research experience**, sustained academic support systems, and strategies leading to successful matriculation and degree completion in science, mathematics and engineering fields;

Substantive achievements in changing the educational system to enable improved performance and advancement for underrepresented groups; and

Demonstrated innovation that is replicable.

ADDITIONAL CRITERIA FOR ORGANIZATIONS

Demonstrated institutional sustainability in structural changes or special programs that have increased student retention and/or graduation rates;

Demonstrated quality of institutional life that fosters the establishment of linkages (i.e., off-campus community connections) that facilitate learning, contacts, and career development;

Demonstrated institutional or organizational success in the advancement or promotion of the educational and career development of students in science, technology, engineering, or mathematics fields; and

Demonstrated distinctiveness in carrying out the institution's social responsibility to create a more positive learning environment by helping to provide an atmosphere that reflects valuing diversity among students, faculty, and administrators.

**Robert Noyce Teacher Scholarship Program**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08532*

Additional Review Criteria:

In considering the above criteria, reviewers will be asked to comment on the following:

Noyce Phase I Proposals:

Capacity and ability of the institution to effectively conduct the program

Number and quality of students that will be served by the program

Justification for number of students served and amount of stipend and scholarship support

Ability of the program to recruit STEM majors who would not otherwise pursue a career in teaching

Quality and feasibility of recruitment and marketing strategies

Quality of the preservice educational program

Extent to which STEM faculty and education faculty are collaborating in developing and implementing the program

Quality of the preservice student-support and new teacher-support infrastructure

Extent to which the proposed strategies reflect effective practices based on research

Degree to which the proposed programming will enable scholarship or **stipend recipients to become successful mathematics and science teachers**

Feasibility and completeness of an evaluation plan that will measure the effectiveness of the proposed strategies

Institutional support for the program and the extent to which the institution is committed to making the program a central organizational focus

Noyce Phase II S&S Proposals:

Evidence that the previously funded project was consistent with the criteria listed above

Evidence of institution and school district support for continuing the project

Demonstrated success of the previously funded project in terms of recruitment of STEM majors and/or STEM professionals into K12 teaching and preparation to become effective teachers

Evidence that the project has recruited STEM majors who would not otherwise pursue a career in teaching

Evidence that a high quality new teacher support structure is in place

Plans for advancing the work beyond the original project

Plans for conducting a longitudinal evaluation study of previous cohorts of Noyce Scholarship and/or stipend recipients as well as evaluation and monitoring of new cohorts to address teacher and student outcome

Evaluation plans that build on and strengthen the previous evaluation effort

**Plans for disseminating results of the evaluation studies**

Plans for sustainability

Noyce Phase II M&E Proposals:

Evidence that the previously funded project was consistent with the criteria listed above for

Phase I proposals

Plans for conducting a longitudinal evaluation study of previous cohorts of Noyce Scholarship and/or stipend recipients focusing on their effectiveness as teachers, their completion of the teaching requirement, and their retention in the teaching profession.

Evaluation plans that build on and strengthen the previous evaluation effort.

Plans for disseminating results of the evaluation studies.

Innovation through Institutional Integration (I3) Proposals:

In addition to the two NSF criteria for Intellectual Merit and Broader Impacts, special review criteria for I3 are:

The extent to which the proposed project address the interrelated goals for institutional integration;

The degree of innovation in the proposed project as evidenced by a depth and quality of creative, coherent, and strategic actions that extend beyond commonplace approaches to normal institutional operations.

The extent to which the proposed project addresses programming, policies, and practices commensurate with the **sustained institutional change** needed to seed and nurture appropriate, synergistic relationships among discrete NSF awards.

**Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP)**
*http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5488&org=DUE&from=home*

Additional Review Criteria:

In considering the above criteria for Type 1A, 1B, and 1C proposals, reviewers will be asked to comment on the following:

Does the projected increase in STEM graduates appear aligned with the mission of the institution(s) and the design of the project?

Is a compelling overall vision provided for the plan of the institution(s) to achieve a substantial **increase in STEM graduates**, and is the proposed effort important to the attainment of that vision?

Is strong justification provided to indicate that the proposed efforts are likely to be successful? Do the management and implementation details provide appropriate support for the proposed project?

Are the proposed efforts likely to lead to an increase in the total number of STEM graduates, as opposed to causing an increase in one or a few STEM fields while allowing for a decrease in other STEM fields?

Does the evaluation plan include appropriate preliminary indicators, benchmarks, and methods for determining the effectiveness of the proposed implementation strategies? Are clear statements provided elaborating which of the proposed activities are likely to be institutionalized by the end of the grant period, and which of the proposed activities would require further sources of support in order to be continued?

In addition to the questions that reviewers will be asked to comment on for all Type 1 proposals, reviewers will be asked to comment on the following for Type 1B proposals:

To what extent has the previous STEP award at the institution been successful?

Is the relationship between the previous STEP award and the proposed project clear, and are the rationales for choosing new directions convincing?

In addition to the questions that reviewers will be asked to comment on for all Type 1 proposals, reviewers will be asked to comment on the following for Type 1C proposals:

To what extent has the previous STEP award at the institution been successful?

Are the proposed efforts to pursue mid-course corrections or unforeseen related opportunities grounded in data that provide convincing arguments that these efforts are important ones to pursue?

In considering the above criteria for Type 2 proposals, reviewers will be asked to comment on the following:

Does the proposal identify a significant factor(s) in **facilitating associate and/or baccalaureate degree attainment**, and/or **undergraduate access to STEM careers**, and/or persistence to **STEM graduate study**, and are the proposed efforts likely to lead to significant findings?

Is the study likely to **provide practical information useful to educators** about the potential impact of the factor(s) being studied?
How likely is the dissemination plan to inform all parts of the education community of important results from the project?

**HUMAN RESOURCE DEVELOPMENT (HRD)**

**Alliances for Broadening Participation in STEM (ABP)**
*http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13646&org=HRD&from=home*

Additional Review Criteria:

For proposals to the LSAMP Program, additional review criteria will apply in 2008.

ADDITIONAL REVIEW CRITERIA FOR LSAMP AND BD PROPOSALS

In addition to the standard NSF review criteria of demonstrating intellectual merit and broader impacts of the project, reviewers will be asked to evaluate proposals in terms of linkages to other NSF programs and plans for rigorously evaluating the projects or programs over the duration of the grant period.

Reviewers will be asked to evaluate proposals using the following program specific review criteria:

Linkages: Proposals should clearly demonstrate linkages to other NSF-funded programs and the benefits to alliance students and faculty. For projects with BD funding, reviewers will be instructed to evaluate evidence of formal connections and involvement with AGEP institutions as well as the continuation of these connections through the STEM doctoral degree.

Evaluation: Proposals will be evaluated on the rigor of the evaluation plan. Reviewers will be tasked to assess the adequacy of resources to implement a rigorous evaluation over the duration of the award period as well as the usefulness of the anticipated outcomes to the body of knowledge in transforming student learning, recruitment and **retention of underrepresented minorities** in science, technology, engineering, and mathematics disciplines and into the workforce.

**Centers of Research Excellence in Science and Technology (CREST) and HBCU Research Infrastructure for Science and Engineering (RISE) (CREST)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08528*

Additional Review Criteria:

In addition to the two NSF criteria for Intellectual Merit and Broader Impacts, special review criteria for I3 are:

The extent to which the proposed project addresses the interrelated goals for institutional integration;

The degree of innovation in the proposed project as evidenced by a depth and quality of creative, coherent, and strategic actions that extend beyond commonplace approaches to normal institutional operations.

The extent to which the proposed project addresses programming, policies, and practices commensurate with the sustained institutional change needed to seed and nurture appropriate, synergistic relationships among discrete NSF awards.

# DIRECTORATE FOR ENGINEERING (ENG)

*http://www.nsf.gov/dir/index.jsp?org=ENG*

**CHEMICAL, BIOENGINEERING, ENVIRONMENTAL, AND TRANSPORT SYSTEMS (CBET)**
*http://www.nsf.gov/div/index.jsp?div=CBET*

ALL program (16) areas use standard GPG guidelines and do not have program specific solicitations

Two Specific Programs:

**Engineering Virtual Organization Grants**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07558*

Proposals must address the following topics:

EVO structure and justification: Vision and mission; organizing and governing structure; members and recruitment; end users; stakeholders; and shared community resources (e.g., experimental facilities, observatories, data collections), their associated service providers, and access / allocation methods. Identify frontier research and education goals of the EVO, including compelling research questions and the potential for broad participation. EVOs will extend beyond small collaborations and individual departments or institutions to **encompass wide-ranging, geographically dispersed activities and groups**.

A plan for obtaining and formally documenting user requirements that will inform the EVO design, e.g., through workshops, surveys, and other means. Integration of research and education must be addressed. User requirements must address community cybersecurity and identify other challenges and barriers to design, development, implementation, management and operations, evaluation and assessment, and long-term sustainability.

Project management plan for implementation of the EVO's prototype. This plan should include a description of the project team and key individuals, their recent or ongoing involvement in VOs and related CI research and development, an organizational chart, and a project schedule for the two-year project, including its prototype deployment with a limited number of the potential CI features.

Conceptual design for designing a future full-scale implementation. This design process would identify any CI research and development needed for software tools and components currently not existing to meet user requirements either commercially or in a research-and-development phase (e.g., through federally funded projects). Projects must cite any related and existing CI software tools and components with similar functionality, and make a compelling case for the need for new software development work.

Plan for **disseminating** the conceptual design to inform CI investments for other **scientific and engineering VOs**.

**Broadening Participation Research Initiation Grants in Engineering (BRIGE)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07589*

Additional Review Criteria:

For BRIGE awards, of paramount importance are both the scientific merit of the proposed research and the extent to which the proposed activities will **broaden participation of individuals from underrepresented groups** in the engineering disciplines supported by ENG.

Additionally, the proposal will be judged on the potential of the research initiation activities to produce sufficient preliminary data to serve as the basis for a competitive research proposal to ENG.

**CIVIL, MECHANICAL AND MANUFACTURING INNOVATION (CMMI)**

**Innovation Sciences and Decision Engineering**
All Programs (7) use standard GPG guidelines and do not have program specific solicitation

**Materials Transformation and Mechanics**
All Programs (7) use standard GPG guidelines and do not have program specific solicitation

**ELECTRICAL, COMMUNICATIONS AND CYBER SYSTEMS (ECCS)**

All Programs (4) use standard GPG guidelines and do not have program specific solicitation

**ENGINEERING EDUCATION AND CENTERES (EEC)**

**Engineering Research Centers (ERC)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07521*

Additional Review Criteria:

Additional review criteria for preliminary proposals and invited full proposals are as follows:

Vision and Research

Proposal effectively defines a transformational engineered system at the cusp of emerging discoveries in science and engineering and emerging opportunities for technological innovation;

Proposal defines a culture of discovery and innovation with a symbiotic **relationship between research, education, innovation, and life-long skill development** in a global economy to stimulate innovation and provide **students** and faculty with a globally-oriented research and education experience;

Research strategic plan targets critical systems goals and breakthrough fundamental knowledge and technology barriers and defines:

High quality cross-disciplinary research program that addresses these barriers through fundamental research and enabling and systems level research and proof-of-concept test beds;

Creative role for small firms to carry out translational research within the ERC to speed technology transfer and **provide students** with an innovation experience;

Research thrusts propose significant goals, target significant fundamental and technical barriers, use high quality research methodologies that will advance the state of the art, integrate knowledge from other projects and thrusts, and involve a diverse team with the skills and disciplines needed to achieve the goals.

**Education**

Education strategy defines an education program that will develop gradutates who are adaptive, creative innovators with the capacity to advance fundamental knowledge and exploit it to create innovations;

Structured to develop graduates who have the knowledge, skills, and experience needed to be successful in a globally connected, innovation-driven world;

Effective plans proposed to integrate ERC's cross-discplinary and systems research into **courseware and curricula**;

Strategic plan specifies desired characteristics, proposes how education program will impart these to students, and how it will measure and assess progress and impacts through longitudinal data;

Pre-college outreach programs will develop an effective long-term partnership with a few **pre-college institutions** (middle and high schools) to bring knowledge of engineering to pre-college classroom, engage a broadly diverse group of students in the ERC's programs to motivate them to study engineering, and provide a Young Scholars research program for promising high schools students;

Effective programs and assessment tools for college and pre-college programs based on best practices.

Industrial/Practitioner Partnership to Advance Innovation

Convincing rationale for the selection of industrial or user partners and means to engage these partners in planning, research, education, and innovation;

Clear strategy for how small firms will be key players and help speed innovation;

Strong partnership with organizations and programs dedicated to speeding innovation;

Representative group of firms/organizations invoving practitioners (state infrastructure agencies for example) committed to membership;

Active engagement of industry/practitioner organizations through an Industrial/Practitioner Advisory Board;

Proposed terms of the industrial membership agreement will structure a center-wide program of industrial/practitioner collaboration to support overall ERC goals;

Intellectual property policy will facilitate collaboration with industry through shared rights for joint work and speed technology transfer.

Infrastructure

Institutional configuration is appropriate to the goals of the ERC and there is a convincing strategy for cross-institution collaboration in research and education;

If there is a foreign university partner, it is committed to the goals of the ERC and will be a strong addition to the team;

Diversity strategic plan evidences strong commitment to diversity at all levels and will result in a very diverse team with a strong impact on the diversity of the engineering workforce through:

Including partner institutions serving students underrepresented in engineering to enhance diversity;

Leadership, faculty and student teams that are diverse in gender, race, and ethnicity, and includes persons with disabilities;

University administrators from the lead and partner institutions will join in partnership with the ERC to facilitate and reward its cross-disciplinary configuration, reward cross-disciplinary research and participation in pre-college outreach, support its educational strategy, and deliver on its diversity goals;

ERC has expertise in all disciplines required to attain its goals, a capable leader and leadership team;

Organizational structure and management plan effectively organize and integrate the resources of the ERC across the partner institutions to achieve its goals and include strong advisory and project selection/evaluation systems;

Experimental, computational, and other required equipment, facilities, and laboratory space are in place or proposed to support the research of the center;

The cyberinfrastructure is effectively used to achieve collaboration and sharing of information;

Headquarters space is sufficiently large to house the leaders and staff, and support the management, communication, and cross-disciplinary collaboration functions of the ERC and cross-institution communications equipment will effectively encourage and facilitate collaboration.

**Research Experiences for Teachers (RET) in Engineering - Supplements and Sites**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07557*

Additional Review Criteria:

Must provide in-service and/or pre-service K-12 teachers or community college faculty with **discovery based learning experiences** in engineering labs/research facilities, which can be incorporated into classroom activities.

At least two teachers or community college faculty must be recruited for the program from the same K-12 school/community college in order to ensure that outcomes of the program are more effectively disseminated to the participating institutions. Participants must be currently teaching a STEM subject at their institution in order to participate in the program.

Research program must involve participants in an ongoing research project for a duration of at least six weeks. Shorter duration may be proposed with justification.

Program must have a well-defined focus, with clearly articulated research projects and activities. Research projects must have significant engineering relevance.

Program must include a sustained follow-up plan between the faculty and the participants to ensure that the **research experience is translated to classroom** practice and the program provides maximum benefit to all participants.

Program must include a detailed plan for evaluation of the project and **classroom impact**.

**Nanotechnology Undergraduate Education (NUE) in Engineering**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08544*

Additional Review Criteria:

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

What is the extent to which creative, **interdisciplinary approaches to undergraduate engineering education are 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?

**EMERGING FRONTIERS IN RESEARCH AND INNOVATION**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07579*

Additional Review Criteria:

In addition to the two NSF review criteria (intellectual merit and broader impacts), the following criteria will be used in the review of all EFRI proposals:

TRANSFORMATIVE - Does the proposed research represent an opportunity for a significant leap or paradigm shift in fundamental engineering knowledge?

**NATIONAL NEED/GRAND CHALLENGE** - Is there potential for making significant progress on a current national need or grand challenge?

The following additional criteria will be used in the review of COPN proposals:

Progress towards understanding of learning in the vertebrate brain, as discussed in the project description.

Progress towards handling spatial or temporal complexity, or replicating brain-like creativity, in technology, as discussed in the project description.

Compliance with the requirement for cross-disciplinary teams, the requirement for addressing a challenging engineering testbed and other necessary requirements in the project description.

Effectiveness of the proposed plan for management and integration.

The following additional criteria will be used in the review of RESIN proposals:

Responsiveness of the proposal to address the "Required RESIN Proposal Elements" listed in the program description.

Degree to which the vision for interdependent resilient and sustainable infrastructures is compelling, cohesive, and important for the nation.

Relevance of the engineering disciplines to the advances and interdependencies of the **infrastructures** selected for study.

Potential of the research and its **outcomes to contribute to a new multidisciplinary engineering field** (incorporating aspects of social, behavioral, and economic sciences) for interdependent resilient and sustainable infrastructures.

Effectiveness of the team's management plan.

**INDUSTRIAL INNOVATION AND PARTNERSHIPS (IIP)**

**Small Business Innovation Research Program Phase I Solicitation FY-2009 (SBIR)**
*http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf08548*

Additional Review Criteria:

The SBIR program has additional criteria which reflect the legislative emphasis of the program and complement the standard NSF review criteria listed above.

"What is the intellectual merit of the proposed activity?"

Is the proposed plan a sound approach for establishing technical and commercial feasibility?

To what extent does the proposal suggest and develop unique or ingenious concepts or applications?

How well qualified is the team (Principal Investigator, key staff, consultants, and subawardees) to conduct the proposed activity?

Is there sufficient access to resources (materials and supplies, analytical services, equipment, facilities, etc.)?

Does the proposal reflect state-of-the-art in the major research activities proposed? (Are advancements in state-of-the-art likely?)

"What are the **broader impacts** of the proposed activity?"

What may be the commercial and societal benefits of the proposed activity?

Does the proposal lead to enabling technologies (instrumentation, software, etc.) for further discoveries?

Does the outcome of the proposed activity lead to a marketable product or process?

Has the proposer evaluated the competitive advantage of this technology vs. alternate technologies that can meet the same market needs?

How well is the proposed activity positioned to attract further funding from non-SBIR sources once the project ends?

Can the product or process developed in the project advance NSF´s goals in research and **education**?

Has the proposing firm successfully commercialized SBIR or STTR-supported technology where prior awards have been made? (Or, has the firm been successful at commercializing technology that has not received SBIR or STTR support?)

# DIRECTORATE FOR GEOSCIENCES (GEO)

*http://www.nsf.gov/dir/index.jsp?org=GEO*

**DIVISION OF EARTH SCIENCES (EAR)**

**EarthScope**
*http://www.nsf.gov/pubs/2006/nsf06562/nsf06562.htm*

Additional Review Criteria:

Proposals that create synergy among the various EarthScope components and activities are encouraged. Proposals will be judged additionally on their relevance to defining community products, developing community tools, and other similar activities.

For EarthScope Education and Outreach (E&O) proposals, the following items should be included in the 15-page Project Description and will be considered in the review:

A description of **previous educational efforts of the investigators**. This might include how the investigator has: 1) influenced his or her research discipline; 2) incorporated or integrated contemporary research questions, processes, and results into **educational experiences**; 3) contributed to the literature of **teaching and learning**; 4) **mentored others** to conduct research and to educate students; or 5) demonstrated leadership among colleagues in promoting the above.

A description of the activities to be undertaken related to EarthScope research and to exploring and experimenting with ways to integrate education and research.

A plan for assessing and evaluating the effectiveness of the E&O activities.

A plan to disseminate those activities that are found to be effective.

**EAR Postdoctoral Fellowships**
*http://www.nsf.gov/pubs/2007/nsf07596/nsf07596.htm*

Additional Review Criteria:

In addition to the above criteria, the following factors will be used in the evaluation process:

Qualifications of the applicant and his/her potential for continued professional growth and leadership in the field;
Qualifications and suitability of the proposed host institution and the scientific and **educational collaborations** proposed;
Prospective benefits to the applicant, the scientific discipline, and the activities of the host institution.

**Geoscience Teacher Training (GEO-Teach)**
*http://www.nsf.gov/pubs/2006/nsf06526/nsf06526.htm*

Additional Review Criteria:
Is the proposed project likely to promote widespread implementation of effective practices in **teacher training** and **professional development** in the geosciences? Does the project have the potential to transform **geoscience education**?

Is the project design feasible? Are the times allotted for the completion of various tasks reasonable? Will the project contribute to the development of collaborative efforts to improve geoscience education? Will the project take a leadership role in the geoscience community?

Is the proposed project likely to engage leading geoscience researchers?

Will the proposed project engage middle and high school teachers? Are there teachers in leadership positions on the project team?

Is the project likely to result in **widespread dissemination** and utilization of high quality educational materials? Are the guidelines that will be used to identify high quality existing resources reasonable?

Is the proposed management plan consistent with the project's goals? Is the project cost-effective? Does the proposal include a plan for sustaining the GEO-Teach effort after the funding by this program ends?

Is there a plan to use evaluation to guide the project as it progresses?

**Dynamics of Coupled Natural and Human Systems**
*http://www.nsf.gov/pubs/2007/nsf07598/nsf07598.htm*

Additional Review Criteria:

Successful CNH proposals must be highly interdisciplinary, address the inherent complexity and highly coupled nature of natural and human systems, be well grounded in theory, and show great promise for enhancing basic theoretical understandings. Quantitative approaches, education, and global perspectives also are important. Research projects must include quantitative approaches or advanced conceptual models to study the systems chosen for investigation. Projects must also include **specific plans for education**. If appropriate, projects will be given consideration if they promote the development of long-term international partnerships.

In the evaluation of proposals submitted by teams of investigators, considerations in addition to standard NSF review criteria are:

Strength of the collaborations planned and degree of interdisciplinarity

Effectiveness of the group organization and management plan

Quality and expected **significance of the educational activities**

Strength of the dissemination plans

Extent, effectiveness, and long-term potential of collaborations with industries, national laboratories, and researchers outside the U.S., when appropriate.

Descriptions of educational activities should specify goals, methods to attain those goals, and the expertise of individuals to accomplish them. Thus, they will be evaluated based on:

Potential interest to and appropriateness for the audience targeted

Quality of planning and appropriateness of personnel

Feasibility and potential for resulting in a **disseminable product**

Integration and complementarity to the research efforts

Focus on integrated learning and discovery and the preparation of U.S. students for a broad set of careers in environmental fields.

**Opportunities for Enhancing Diversity in the Geosciences (OEDG)**
*http://www.nsf.gov/pubs/2004/nsf04590/nsf04590.htm*

Additional Review Criteria:

Is the project team capable of successfully carrying out the stated goals?

Is there evidence of institutional commitment to achieving and realizing the goals of the proposal?

Does the project have the potential to **increase the diversity of geoscience students**, or **increase understanding** of the relevance of the geosciences **among broad, diverse segments of the population**?

For Track 2 proposals, does the project team have prior experience planning and managing successful programs directed toward increasing diversity in the geosciences?

For Track 2 proposals, is there evidence that the project will become self-sustaining or be sustained by funding from sources other than NSF at the end of the funding period?

**DIVISION OF OCEAN SCIENCES**

**Ridge 2000**
*http://www.nsf.gov/pubs/2007/nsf07571/nsf07571.htm*

Additional Review Criteria:

Evaluation and Selection of Fellows

The evaluation of applicants will be based on ability as evidenced by past research work; suitability and availability of the sponsoring senior scientist and other associated colleagues; suitability of the host institution for the proposed research; likely **impact on the future scientific development of the applicant**; scientific quality of the research likely to emerge; and the potential impact of the research on the RIDGE 2000 Initiative. The criteria listed above will be used by a panel of scientists convened by NSF, with representatives from appropriate disciplines, to evaluate the proposals submitted. In addition, the applications will be reviewed by a RIDGE 2000 committee that will assess the relevance and priority of the proposed research to the RIDGE 2000 Initiative.

# OFFICE OF INTERNATIONAL SCIENCE & ENGINEERING (OISE)

*http://www.nsf.gov/div/index.jsp?div=OISE*

**East Asia and Pacific Summer Institutes for U.S. Graduate Students (EAPSI) N**
*http://www.nsf.gov/pubs/2007/nsf07584/nsf07584.htm*

**Additional Review Criteria:**
The review criteria above are for standard NSF proposals. For the EAPSI program, the reviewers are asked to consider the following additional criteria:

Qualifications of applicant, including **potential for continued growth** and the probable effect of participation in the Summer Institute on the applicant's career;

Resources and capabilities of the proposed host institution(s) and researcher(s), and/or the current stature of research in the student's field of interest in the chosen location (Australia, China, Japan, Korea, New Zealand, Singapore or Taiwan); and

Merit, complementarities, and expected mutual benefits of the proposed international collaboration.

Because EAPSI is funded and managed in partnership with organizations in the East Asia and Pacific region, final selection of participants is dependent on mutual agreement between NSF and the counterpart foreign agencies. Thus, it is possible that an applicant who has been tentatively selected based on merit review may ultimately be declined.

**International Research and Education: Planning Visits and Workshops**
*http://www.nsf.gov/pubs/2004/nsf04035/nsf04035.htm*

Additional Review Criteria:

In addition to the general NSF review criteria described above, the following criteria will be used in evaluating proposals submitted in response to this announcement:

Mutually beneficial international activity with complementary strengths in evidence.

**International experience** for students and/or junior researchers.

Novel and innovative activities.

Geographical and disciplinary balance within the OISE portfolio.

**International Research Fellowship Program (IRFP) CN**
*http://www.nsf.gov/pubs/2006/nsf06582/nsf06582.html*

**Additional Review Criteria:**
**Reviewers are asked to consider the following additional criteria:**

**Benefits to the applicant**, the research discipline, and **the United States**;

Qualifications of proposed host and host institution, and complementarity;

Qualifications of applicant, including applicant's **potential for continued growth**;

Merit of the proposed international collaboration; and

Expected mutual benefits to be derived from the proposed collaboration of the scientists and engineers in each country.

Priority will be given to those applicants who have not yet secured a tenure-track position and have no previous international research experience. IRFP aims to provide an international experience to those individuals who have never had one previously. Applicants who received their Ph.D. at a foreign institution will be given lower priority. Any potential applicants who have international experience or are already at the host site, must contact the Program Manger before submitting an application to verify suitability.

**Partnerships for International Research and Education (PIRE) N**
*http://www.nsf.gov/pubs/2006/nsf06589/nsf06589.htm*

Additional Review Criteria:

In addition to the general NSF review criteria described above, the following criteria will be used by reviewers and NSF staff in evaluating proposals submitted in response to this solicitation:

Coherence and innovation of the **international collaboration model**, including its effectiveness and replicability as an intellectual collaboration for all participating scientists, engineers, and educators;

Effectiveness of **career development opportunities** for U.S. students and researchers;

(Full proposals only) Appropriateness of the management plan and organizational structure;

(Full proposals only) Commitment of the institutions to achieving the project's goals and to sustaining the partnership; and

(Full proposals only) Appropriateness of the budget.

**Community-based Data Interoperability Networks (INTEROP) CC**
*http://www.nsf.gov/pubs/2007/nsf07565/nsf07565.htm*

**Additional Review Criteria:**

Does the proposal provide a vision and rationale that justifies the need for the Network and supports the choices of communities, data types, and interoperability mechanisms?

Does the proposal describe a plan that will enable the Network to meet its dual responsibilities for **engaging the community in developing consensus and agreement** and providing the expertise required for turning consensus into technical standards, tools and resources?

Does the proposal provide a management plan that will be effective in providing leadership and accountability for the network, close communication and interaction with the relevant community(ies) and stakeholders, and the flexibility to respond to changes in technologies and in the needs of the relevant community(ies)?

**Additional Review Criteria:**

The following additional merit review considerations apply:

How well does the proposal describe how the project will lead to progress in addressing a "big problem" in detection of the nuclear threat that involves innovation and/or high risk?

How well does the proposal describe why a project requires a long timeline, multi-disciplinary and/or multi-institutional effort?

What potential does the project have for a major advance that is relevant to detection of shielded or unshielded nuclear weapons or special nuclear material (plutonium or highly enriched uranium)?

What is the project's potential to attract **broad scientific and public interest** and support?

How effective are the project's **educational**, **dissemination**, and, especially for large awards, management plans?

**International Polar Year, 2007 CC**
*http://www.nsf.gov/pubs/2007/nsf07536/nsf07536.htm*

**Additional Review Criteria:**

Proposals will also be evaluated using additional review criteria that consider relevance to the goals of the International Polar Year 2007-2008 (IPY) (see guidance below). Proposers are encouraged to review the U.S. National Committee and ICSU-WMO planning documents available at *http://www.us-ipy.org/ and http://www.ipy.org.*

**Relevance to the goals of the International Polar Year (IPY)**
Research proposals will be evaluated to assess the degree to which the proposed activity will

Address science questions consistent with the emphasis areas described in this solicitation. Proposals that do not address at least one of the emphasis areas will be returned without review.

Contribute to **international collaborations** or partnerships and engages new investigators in polar research, where appropriate.

Address science and/or **education** in one or both polar regions, linking arctic and antarctic efforts where appropriate.

Provide open and timely access to data and products that will contribute to the legacy of IPY. provide meaningful **education and training for beginning scientists**, **teachers**, **students**, or the **broader public** within the context of the solicitation's emphasis areas.

Address outreach activities that **engage the public** in polar discovery and communicate research to school children and the general public, as well as policy makers and arctic communities.

Maximize effective use of existing logistical assets or develop new capabilities that are feasible within the IPY timeframe.

**Involve communities near field sites** and engage arctic residents in meaningful ways (arctic studies only).

Proposals focusing on IPY Education must provide clear and appropriate measures of project success. Proposals will also be evaluated according to the following characteristics.

**Polar Formal Science Education**

Teacher Professional Enhancement projects should

Provide meaningful **professional development experiences** in polar science (e.g., training, hands-on laboratory research experience, etc.);

Broadly **disseminate teacher experiences** to students and other professionals; and

Contribute to the **polar learning community** of teachers, scientists, and other education specialists that will sustain polar education in K-12 settings.

Undergraduate and Graduate Formal Education projects should include

Innovative project deliverables that demonstrate **meaningful education** and training in the polar sciences;

Goals and measurable outcomes that are defined and appropriate;

**Broad dissemination** of programmatic innovation to students and other professionals;

Development of a sustainable learning community; and an appropriate evaluation plan.

**Polar Informal Science Education projects should include**

Innovative deliverables that enhance science learning;

Project designs, including project personnel and partnerships appropriate to addressing IPY goals; and

Identification of target audiences, demonstrating knowledge of the audiences, their needs and interests.

**Coordination and Communication projects should include**

Identification of appropriate partners and approach for coordinating education projects and communications about those projects; and

Identification of target audiences and modes of communication.

**Operational feasibility for proposals involving fieldwork**

Proposals involving fieldwork will also be evaluated for operational feasibility, which includes resource availability, environmental protection and waste management provisions, safety and health measures, and safeguards of radioactive materials. Proposers must recognize that proposals may be declined for operational reasons. For proposals involving fieldwork in the Antarctic, this operational evaluation is based largely on the Operational Requirements

Worksheets that the proposer must complete as instructed in Section V (Proposal Preparation and Submission Instructions) of the Antarctic Research solicitation (NSF 06-549).

*Safety and health requirements vary for antarctic and arctic fieldwork.* All antarctic field participants must meet specified U.S. Antarctic Program health and dental requirements. See Section V.B., (Budget preparation) of the Antarctic Research solicitation *(http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf06549* ). Candidates for wintering at the year-round stations are screened for psychological fitness.

For arctic field participants, physicals are required for deployment to Summit Field Camp in Greenland and other remote areas in Greenland.

***Additional information on the Broader Impacts review criterion:***

The polar regions present exceptional opportunities to address NSF's "Broader Impacts" review criterion. The Foundation's Advisory Committee for Polar Research has produced a document *(http://www.nsf.gov/od/opp/opp_advisory/oaccrit2.jsp* ) that may aid in proposal preparation. Other Foundation programs that may assist in achieving broader impact are the Antarctic Artists and Writers Program (*http://www.nsf.gov/od/opp/aawr.jsp*; NSF solicitation for the Antarctic Artists and Writers program, NSF 06-554, (*http://www.dev.nsf.gov/funding/pgm_summ.jsp?pims_id=12783&org=OPP* ), which deploys humanities scholars, artists, and writers to the Antarctic; and the annual program for media representatives (*http://www.nsf.gov/news/news_summ.jsp?cntn_id=100288*).

# DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

*http://www.nsf.gov/dir/index.jsp?org=MPS*

**Major Research Instrumentation Program (MRI) N**
*http://www.nsf.gov/pubs/2008/nsf08503/nsf08503.htm*

**Additional Review Criteria:**
In addition to the evaluation criteria stated above, reviewers will assess the following:

Instrument Acquisition Proposals.

The extent of shared use of the instrumentation for research and/or research training. Whether the management plan includes sufficient infrastructure and technical expertise to allow effective usage of the instrument; and provides organizational commitments for operations and maintenance.

Whether the request for operation and maintenance is justified and reasonable in magnitude. Plans for using the new or enhanced research capability in **teaching, training or learning**.

In addition, for mid-range instrument acquisition proposals: the **impact of the instrumentation at the state or national level**, and the detailed plans for funding of operation and maintenance.

Instrument Development Proposals:

Whether the plan has a realistic schedule and mechanisms to deal with potential risks. In addition, the reviewers will evaluate the availability of appropriate technical expertise to design and construct the instrument and the cost of the new technology.

Whether development of a new instrument is justified. Specifically, reviewers will consider if the proposed instrument will enable new types of measurement or information gathering and if there is a strong need for the new instrument in the larger user community.

**Management and Operation of the Virtual Astronomical Observatory**
*http://www.nsf.gov/pubs/2008/nsf08537/nsf08537.htm*

**Additional Review Criteria:**
In addition to the above merit review criteria, each proposal will be evaluated on the basis of:

The quality of the proposing organization's overall vision for the VAO;

The suitability, quality and cost effectiveness of the management plan for operating and maintaining the VAO;

The suitability, experience, and professional stature of key management individuals, both within the proposing organization and within the VAO;

The proposing organization's experience in operating scientific facilities;

The experience and stature of key scientific and technical staff;

The extent and **quality of specified educational programs**; and

The potential for appropriate partnerships with universities, non-Federal observatories, and industry.

**NSF Astronomy and Astrophysics Postdoctoral Fellowships (AAPF)**
*http://www.nsf.gov/pubs/2007/nsf07572/nsf07572.htm*

**Additional Review Criteria:**
In addition to the above criteria, the following factors will be used in the evaluation process:

Qualifications of the applicant and his/her potential for **continued professional growth** and leadership in the field;

Qualifications and suitability of the proposed host institution(s) and the scientific and **educational collaborations** proposed; and

Prospective **benefits to the applicant**, the scientific discipline, and the activities of the host institution(s).

**Partnerships in Astronomy & Astrophysics Research and Education (PAARE)**
*http://www.nsf.gov/pubs/2008/nsf08562/nsf08562.htm*

**Additional Review Criteria:**

The PAARE proposals will also be evaluated on the following:

Are the goals and mission of the partnership clearly defined and achievable, and are they building an equal partnership between the MSI and research institution?

Is there a clearly defined **mentoring scheme** for students? Does the PI understand the issues involved with recruiting, retaining and mentoring students from underrepresented groups?

Is the role of the partnering institution (or institutions), project or individual investigator clearly stated - Does the proposal demonstrate a strong partnership?

Is the planned research and education program sound and feasible?

Is there a long-term vision for the project?

Is the management plan sound?

Does the organization chart contain appropriate participants?

Is the plan for assessment of the impact, **dissemination of the results** and progress of the project reasonable?

Has the partnering institution or institutions demonstrated a commitment to supporting the proposed activities and the resources that will be provided to carry out the project?

**American Competitiveness in Chemistry-Fellowship (ACC-F)**
*http://www.nsf.gov/pubs/2008/nsf08541/nsf08541.htm*

**Additional Review Criteria:**

Partnership: How will the collaboration with the partner enrich the research of the applicant? Are there additional methods/techniques/infrastructure/materials available to the applicant through the collaboration that would not otherwise be available? Will the collaboration contribute positively to the **postgraduate educational experience** of the applicant? Will the collaboration help build lasting ties between the applicant's institution and the partner?

Broadening Participation Plan: Is the plan reasonable for the time commitment that the applicant proposes? Is the plan expected to have lasting, meaningful results? Will the activities be self-sustaining? How will the applicant determine the success of her/his broadening participation plan?

**Chemistry Research Experiences for Undergraduates (REU) NSF Wide?**
*http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503210&org=CHE*

**Additional Review Criteria:**
Reviewers will be asked to interpret the two basic NSF review criteria in the context of the REU program. In addition, they will be asked to place emphasis on the following considerations:

Appropriateness and value of the **educational experience** for the student participants, particularly the appropriateness of the research project(s) for undergraduate involvement and the nature of the students' participation in these activities.

Quality of the research environment, including the facilities, the preparedness of the research mentor(s) to guide undergraduate research, and the professional development opportunities for the students.

Appropriateness of the student recruitment and selection plans, including those for involving students from underrepresented groups and from academic institutions with limited research opportunities.

Quality of plans for student preparation and for follow-through designed to promote **continuation of student interest** and involvement in research.

For REU Sites: appropriateness and cost-effectiveness of the budget, effectiveness of the plans for managing the project and evaluating the outcomes, and commitment of partners, if relevant.

For REU Sites that request funding for the optional Ethics in Science or Engineering component: appropriateness and quality of the **proposed ethics activities**.

**Collaborative Research in Chemistry (CRC)**
*http://www.nsf.gov/pubs/2007/nsf07581/nsf07581.htm*

**Additional Review Criteria:**
In addition to the National Science Board merit review criteria, reviewers will be asked to apply the following criteria when reviewing CRC preliminary proposals and full proposals:

Importance of proposed project to areas supported by the Division of Chemistry.

Long-term scientific impact of the proposed activity.

Projects that have a high degree of risk will receive favorable consideration providing that the potential benefit is correspondingly high.

Timeliness of the planned work. Projects in emerging research areas are especially encouraged.

Appropriateness of the group members and group structure for the task.

Extent to which the group effort is focused on a cohesive well-delineated goal.

Justification of the value of the collaborative effort.

Effectiveness of the **educational and outreach plan**, including the extent to which the project **broadens participation** in the chemical sciences.

Effectiveness of the management plan.
Appropriateness of the proposed timeline and budget.

Any project requesting $750,000 or more in total costs per year may be subject to a site visit as part of the review process.

In cases of comparable merit, strong preference will be given to researchers who are not currently supported by the NSF Division of Chemistry.

**Discovery Corps Fellowships (DCF)**
*http://www.nsf.gov/pubs/2007/nsf07516/nsf07516.htm*

**Additional Review Criteria:**

Discovery Corps Postdoctoral Fellowships

To what extent will the Postdoctoral Fellowship promote the **professional development** (in both research and service) of the Fellow applicant?

What impact will the project have on the host organization(s)?

In what ways will the project address **national needs**?

Discovery Corps Senior Fellowships

To what extent will the Senior Fellowship leverage the leadership skills, research and **educational experience** and perspective of the Senior Fellow applicant?

What impact will the project have on the host organization(s)?

In what ways will the project address national needs?

**Undergraduate Research Collaboratives (URC)**
*http://www.nsf.gov/pubs/2006/nsf06521/nsf06521.htm*

**Additional Review Criteria**:

The extent to which the URC creates and tests a new model for building a research community and performing undergraduate research.

The extent to which the URC model is scalable, sustainable, able to be replicated or adapted, and integrated into the curriculum.

The quality of the research experience that URC-supported students will have, including the extent to which students will create new knowledge that is potentially publishable.

The extent to which the URC will increase the number and **diversity of students** participating in undergraduate research, including students who might not otherwise be exposed to chemical research.

The extent to which the URC builds research capacity, **infrastructure and culture** that is sustainable beyond the URC award at partnering institutions.

The extent to which the URC partnership and management promotes inclusive and **effective mentoring** and enhances the **professional development** of mentors.

The quality of the evaluation and dissemination plans.

A site visit or reverse site visit may be part of the URC review process.

**International Collaboration in Chemistry between US Investigators and their Counterparts in Germany, United Kingdom and China (ICC)**
*http://www.nsf.gov/pubs/2007/nsf07593/nsf07593.htm*

**Additional Review Criteria:**

In addition to the two NSB-approved merit review criteria, the reviewers will be asked to specifically comment on whether the researchers demonstrated a clear need for international collaboration, the synergy between the collaborating groups, the collaboration plan between the investigators, and whether the proposed project provides meaningful **international training experience** to students and junior researchers. Foreign investigators will need to address the review criteria of their partnering agency.

**MATERIALS RESEARCH (DMR)**

**Instrumentation for Materials Research (IMR)**
*http://www.nsf.gov/pubs/2007/nsf07600/nsf07600.htm*

**Additional Review Criteria:**

*Essential need for the instrument*. The utility, impact or potential impact that the instrument will have on the proposed research and/or **training/educational activities**, or on a field of research.

*Impact on Infrastructure.* How the instrument will contribute to **broader long-range** goals of the institution, fields of science, and **education**.

*The ability of the applicants to operate and maintain the instrument.* Evaluation of the qualifications of the person(s) responsible for the instrument, allocation of time on the instrument, and provisions for operation and long-term maintenance of the instrument over its expected lifetime.

*Appropriateness of development plans.* For instrument development/construction, an assessment of feasibility, costs and schedule for completion, and plans for integration and use of the instrument in the research and educational activities described subsequent to the completion of the development/construction phase.

*Relevance to research and **education.*** The proposed instrumentation acquisition/development should be relevant to the research and educational activities. Potential toward achieving **national goals of strategic importance** and impact on all sectors of materials research community should be detailed in the proposal. The expected **impact on all sectors of the materials research community** and potential for enhancing linkages between sectors should be significant.

**Materials Research Science and Engineering Centers (MRSEC)**
*http://www.nsf.gov/pubs/2007/nsf07563/nsf07563.htm*

**Additional Review Criteria:**

**In addition to the standard NSF review criteria, reviewers will be asked to use the following criteria. Preliminary proposals will be evaluated in terms of their potential to meet the criteria for full proposals. Achievements under prior NSF support will be critically assessed when re-competing proposals are evaluated.**

MRSEC proposals will be evaluated in terms of the IRG(s) and of the Center as a whole. Given competing proposals of essentially equal merit, NSF staff will be responsible for ensuring that the overall program reflects an appropriate balance among research topics and among Centers of differing size and complexity.

**Interdisciplinary Research Groups:**

Intrinsic merit of the research. Overall quality of the proposed research, and likelihood that the research will lead to fundamental advances, new discoveries, and/or technological developments.

Competence to perform the research. Capability of the investigators, technical soundness of the proposed approach, and adequacy of the resources available or proposed, including instrumentation and facilities.

Interdisciplinarity and degree of interconnection within each IRG. Benefits of a multi-investigator, interdisciplinary approach; cooperation and interdependence of the investigators.

**The Center as a Whole:**

Organizational setting and rationale for the Center. Relationship to existing and planned organizational programs and capabilities **in materials research and education**; intellectual breadth of the proposed program; potential for stimulating interdisciplinary interaction and collaboration. Potential for organizational, **national, and international impact**.

Achievements under prior NSF support, as appropriate.

-

Potential effect on the **infrastructure of science and engineering**, particularly in fostering a broadly interdisciplinary, interactive approach to materials research and education, developing effective **educational outreach programs**, fostering a climate of interaction and effective knowledge transfer between the university and its partners in industry and other sectors (see

above), effective use of seed funding, and fostering increased participation in materials research and education of **members of underrepresented groups**.

Plans and potential to develop and maintain active collaboration with industry and other organizations; to stimulate and facilitate knowledge transfer among the organizational participants and between the Center and other organizations and sectors; and to strengthen the links between university-based materials research and its application and implementation. Outreach to other organizations and sectors, including international collaboration and cooperation.

Plans to establish, operate, and maintain shared experimental facilities and to provide appropriate access to users from the home organization, other academic organizations, industry, and other sectors.

Organizational commitments and support. Likely effectiveness of the proposed management plan, including mechanisms for selection of topics and internal allocation of resources, plans for self-evaluation, and plans and potential for maintaining a flexible and innovative program. Appropriateness of the requested budget.

**International Materials Institutes (IMI)**
*http://www.nsf.gov/pubs/2008/nsf08558/nsf08558.htm*

**Additional Review Criteria:**

A critically important aspect of an IMI is its potential impact on advancing materials research on an international scale and developing an internationally competitive generation of materials researchers. In addition to the standard NSF review criteria, reviewers will be asked to use the following criteria:

The merit of the proposed international activities and the expected mutual benefit to be derived from the contributions of the scientists and engineers in each country or region.

Potential international and global impact of the IMI on advancing national and international collaborations that **integrate materials research with education** and foster **interactive approaches** to both.

Participation of U.S.-based students, postdoctoral associates and junior researchers in international materials research and **education experiences**.

Plans for contributing to the development of a worldwide materials research and education network, including **development of partnerships with states**, private foundations, industry, national laboratories, international organizations, other IMIs, universities, centers, and national facilities.

Achievements under relevant prior NSF support, where applicable.

Institutional setting and rationale for the Institute. Relationship to existing and planned institutional programs; capabilities in **materials research and education**; intellectual breadth of the research and education opportunities; potential for stimulating interdisciplinary international collaborations.

Institutional arrangements, management plan, and budget. Institutional arrangements established toward the stated goals of the IMI. Likely effectiveness of the proposed management plan, including allocation of resources, plans and potential for implementing

flexible and innovative programs, and plans for evaluating the programs of the Institute. Appropriateness of the requested budget.

**Materials World Network: Cooperative Activity in Materials Research between US Investigators and their Counterparts Abroad (MWN)**
*http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12820&org=DMR*

Additional Review Criteria:

Reviewers will also take into consideration the value added by the proposed international collaboration in materials and condensed matter research, and the extent to which the collaboration **integrates research and education** and promotes diversity. Preference will be given to proposals where the intellectual efforts in the US and abroad are balanced and where students and junior researchers participate in international research experiences.

Representatives from NSF's Division of Materials Research will manage the review of proposals on the US side, either in parallel or jointly with participating funding organizations. Coordinated support will be arranged for successful proposals by the participating organizations. Information about proposals will be shared between the participating organizations as appropriate. While each side reserves the option to fund proposals independently, strong preference will be given to proposals with support from both NSF and the counterpart organization.

**MATHEMAICAL SCIENCES (DMS)**

**Mathematical Sciences Postdoctoral Research Fellowships (MSPRF)**
*http://www.nsf.gov/pubs/2007/nsf07573/nsf07573.htm*

**Additional Review Criteria:**

**Additional Evaluation and Selection of Fellows**

The evaluation of applicants will be based on ability and potential as evidenced by past research and letters of support; suitability and availability of the sponsoring scientist and other colleagues, as well as other conditions at the proposed host institution such as adequate space, basic services, and supplies; likely impact of the scientific advisor and the host institution on the scientific development of the applicant; scientific quality of the research likely to emerge; and the potential of the **applicant's contributions to the Foundation's education** and human resource goals. Applications will be evaluated by a panel of mathematical scientists.

The selection of Fellows will be made by the National Science Foundation, and applicants may expect to be notified by letter on or about February 8th.

Although the Fellow usually receives verbatim copies of reviews (as stated elsewhere in this solicitation), no written reviews are generated during the review process for this program, so the Fellow will not receive copies of reviews for proposals submitted to this program solicitation.

**Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS)**
*http://www.nsf.gov/pubs/2006/nsf06559/nsf06559.htm*

**Additional Review Criteria:**

Additional review criteria apply. Each proposal will be evaluated on the degree of interaction between computation and the mathematical sciences in the research experiences provided to undergraduates, the degree of student participation and immersion in the proposed activities, the extent of commitment to **mentoring** by senior faculty, and the quality and efficacy of its management and evaluation plans.

**Interdisciplinary Grants in the Mathematical Sciences (IGMS)**
*http://www.nsf.gov/pubs/2004/nsf04518/nsf04518.htm*

**Additional Review Criteria**:In addition to the National Science Board merit review criteria, reviewers will be asked to apply several equally-weighted activity specific criteria when reviewing IGMS proposals. These criteria are:

Competence: The quality of independent research and accomplishment of the PI in his or her own area of expertise.

Movement: The degree of movement by the PI beyond his or her own areas of expertise. Bolder moves will be favored over minor, incremental changes or additions.

Consequence: The degree of expected impact of the grant activity on the PI's own research, as well as on the **development of students** in both disciplines involved.

**University-Industry Cooperative Research Programs in the Mathematical Sciences (UICRP)**
*http://www.nsf.gov/pubs/2005/nsf05504/nsf05504.htm*

**Additional Review Criteria**:

**University-Industry Postdoctoral Research Fellowships**

In the case of postdoctoral fellows who have been identified in the proposal, the fellow's ability, accomplishments, potential, and **long-range career goals**
or

In the case of proposals containing recruitment plans, the anticipated effectiveness of the proposed recruitment process to identify and select a highly qualified postdoctoral fellow;

The quality of the proposed research to be conducted at both the academic and industrial sites;

The qualifications of and commitment by both the faculty mentor and the industrial sponsor;

The appropriateness of the academic/industrial interaction; and

The impact of the proposed training on the **professional development** of the postdoctoral fellow.

**2. University-Industry Senior Research Fellowships**

The scientific record of the Fellow and the potential and likelihood of a significant impact;

The activity plan, including the appropriateness of the match of the Fellow and proposed activity site, and likelihood of productivity;

The effect of the fellowship on the growth and expansion of the **total career potential** of the Fellow, including future collaborations;

Tthe likely impact on the academic institution after the end of the Fellowship tenure, including expected **impact on colleagues, students, and curricula**. This will be based on the explicit institutional impact statement in the proposal that describes the expected follow-up activities of the Fellow; and

The commitment of the university and industrial partners, provision of facilities, research plan, etc.

**Industry-Based Graduate Research Assistantships and Cooperative Fellowships**

The impact of the proposed training on **the professional development** of the graduate assistant/fellow;

The quality of the proposed activity at the industrial site;

Tthe qualifications of both the supervising faculty member and the industrial mentor;

The commitment of the university and industrial partners, provision of facilities, etc.

The appropriateness of the academic/industrial interaction; and

The anticipated effectiveness of the proposed recruitment process to identify and select highly qualified graduate assistants/fellows.

**Center for Research at the Interface of the Mathematical and Biological Sciences (CIMBS)**
*http://www.nsf.gov/pubs/2007/nsf07597/nsf07597.htm*

**Additional Review Criteria:**

Effect of the Center on the **infrastructure** of the mathematical and biological sciences: The potential of the proposed Center and its activities to increase the level of collaborative research and to contribute to fundamental knowledge.

Ability of the Center to respond to **national needs**, especially in the area of the modeling of the dynamics of infectious animal diseases.

Institutional capabilities and management plan: The ability of the institution to effectively host the Center. The likely effectiveness of the management plan. Qualifications of the Center Director, if known, or the selection process for that director. Additional issues include reasonableness and appropriateness of the budget.

Following panel review, site reviews will be done for one or more finalists. The analysis by the site review teams will be critical in making the final award recommendation.

**Conferences, Workshops, and Special Meetings in the Mathematical Sciences**
*http://www.nsf.gov/pubs/2005/nsf05540/nsf05540.htm*

**Additional Review Criteria**:

In decisions about proposals submitted for this solicitation, DMS program officers will consider carefully how well proposals meet the DMS Priorities and Additional Review Criteria described in Section II. These are:

**Diversity** and breadth of participation by individuals and institutions.

Involvement of **participants from under-represented groups** and of students and junior investigators.

Connection to frontiers of mathematical sciences and between mathematical sciences and other science and engineering disciplines.

Overall impact on the US mathematical sciences community.

**Mathematical Sciences Research Institutes**
*http://www.nsf.gov/pubs/2008/nsf08565/nsf08565.htm*

**Additional Review Criteria:**

**IN ADDITION to the above criteria, the following will be used in the evaluation process:**

The overall impact of the proposed scientific activities on the mathematical sciences;

The quality of the stated missions and goals of the institute and its likely effectiveness in meeting these missions and goals;

The breadth of involvement of appropriate subfields of the mathematical sciences;

The capabilities of the institute leadership, including management and organizational ability of the proposed director(s), and the commitment of the proposed leadership team;

The design, structure and management of the operation of the institute, including the quality and effectiveness of the management plan (including plans for interaction among the institute staff), the method of selection of activities and the method of selection of participants;

The level of the institutional commitment to **promoting diversity** and the quality of the implementation plan;

The quality and appropriateness of the institute's **education and training** components, especially plans to attract, involve, and **mentor researchers early** in their career paths;

The extent, where appropriate, to which communication and interaction with other areas of science and engineering are fostered. This may include linkages and partnerships with other university research groups or industry, national laboratories, non-profit organizations, etc.;

The quality and likely effectiveness of the proposed outreach activities;

The quality of the evaluation plan;

The reasonableness and appropriateness of the budget;

The quality and likely effectiveness of plans for future institute growth and resource development;

The quality and appropriateness of the infrastructure support for the institute (including, but not limited to space, administrative staff, equipment, and access to facilities) and the suitability of location with regard to office space, laboratory space if needed, computing environment, access to library facilities, and housing.

# OFFICE OF POLAR PROGRAMS (OPP)

*http://www.nsf.gov/dir/index.jsp?org=OPP*

**Antarctic Sciences (ANT)**

**Antartic Research (AR)**
http://www.nsf.gov/pubs/2008/nsf08535/nsf08535.pdf

**Additional Review Criteria:**

**Rationale for access to Antarctica**

NSF supports fieldwork in Antarctica for research that can only be done or is best done in Antarctica. Proposals must make a compelling case that the fieldwork is needed to accomplish the goals of the proposed investigation. External reviewers will be asked to comment on the importance of fieldwork, and program officers will consider this in their recommendation.

**Operational feasibility**

Proposals involving fieldwork will also be evaluated for operational feasibility, which includes resource availability, environmental protection and waste management provisions, safety and health measures, and safeguards of radioactive materials. Proposers must recognize that proposals may be declined for operational reasons. For proposals involving fieldwork in the Antarctic, this operational evaluation is based largely on the Operational Requirements Worksheets that the proposer must complete as instructed in Section V.A. (Proposal Preparation and Submission Instructions).

All antarctic field participants must also meet specified U.S. Antarctic Program health and dental requirements. See Section V.B. (Budget Preparation).

Candidates for wintering at the year-round stations are screened for psychological fitness.

**Joint support from international partners and other federal agencies**

**International collaborative proposals**, especially when joint fieldwork is involved, as well as proposals that involve **other US federal agencies** require special efforts for coordination between the sponsoring organizations. NSF will engage potential partner organizations as required to determine project feasibility prior to making awards.

Antarctica presents exceptional opportunities for projects in all of the above areas to respond to NSF's broader-impacts proposal evaluation criterion -- "What are the broader impacts of the proposed activity" -- that asks how well the proposed activity will advance understanding while promoting teaching and learning; how well it will broaden the participation of underrepresented groups; to what extent it will enhance the research and education infrastructure (facilities, instruments, networks, partnerships, etc.); how well the results will be disseminated broadly to enhance scientific and technological understanding; and what may be the benefits to society of the proposed activity.

The Foundation's Advisory Committee for Polar Research, Working Group on Implementation of criterion 2, has produced a document, *Criterion 2 Background and List of*

*Representative Activities*, that proposers may want to consider when addressing the broader-impacts review criterion. The NSF Office of Budget, Finance, and Award Management has also prepared a document, *Merit Review Broader Impacts Criterion: Representative Activities*, describing activities that demonstrate broader impacts. [Note: The term "Criterion 2" used to be synonymous with the term "Broader Impacts Criterion." The latter term alone is currently used. The OPP Advisory Committee completed their work on the issue prior to this change in the criterion name.]

An NSF-supported web site has two topics that may help a proposal respond effectively to these NSF objectives: a list of Polar Research Community Outreach Projects and a tutorial, Educational Outreach and the Polar Research Community, intended to help polar scientists identify and leverage opportunities for integrating educational outreach into their research. Proposers are encouraged to **develop "Broader Impacts"** activities that are specific to their research. Awareness of or collaboration with two other Foundation programs also may be helpful in achieving broader impact. They are the *Antarctic Artists and Writers Program*, which deploys scholars in the humanities to help record the U.S. antarctic heritage, and the annual program for media representatives to visit and interview research teams and others in the U.S. Antarctic Program. Information concerning the media program can be found at *http://www.nsf.gov/news/news_summ.jsp?cntn_id=110142.*

**Antarctic Artists and Writers Program (AAWP)**
*http://www.nsf.gov/pubs/2008/nsf08552/nsf08552.pdf*

**Additional Review Criteria:**

The review panel and NSF will look for how the proposed project would satisfy the above criteria and those below.

**Intellectual Merit**

I.

In addition to the above:

Is the artist or writer prominent in her or his field, with a substantial record of achievement and critical recognition as indicated by prior works, reviews of prior works, appointments to academic or professional positions, honors, and awards?

In the case of an early career artist or writer, does the proposal demonstrate the likelihood of making a significant contribution to enhance programmatic goals --- advancing knowledge and understanding of the U.S. Antarctic Program?

Will the project result in works that are representative of Antarctica or of activities in Antarctica?

Is the required travel to Antarctica, as a practical matter, available only from the U.S. Antarctic Program?

Is the requested travel essential to the completion of the proposed work?

If underwater diving is to be a part of the field program, is the need for it defended in the proposal? (Read the "Underwater diving" section under “Proposal preparation and submission” in the Antarctic Research program solicitation.)

If photography is the main goal of the proposal, will the project **convey new understanding** using the medium of photography, or will it simply add, however competently, to the Antarctic photographic stock?

**2. Broader Impacts**

In addition to the above:

The proposal must provide a concrete plan showing that, as a result of being in Antarctica, a significant body of work will reach a ***significant audience***. Even an accomplished artist or writer may find it difficult to convince the Foundation on this point. Normally it is essential that she or he collaborate with producers, publishers, art galleries, or other organizations appropriate to his or her genre to assure sufficient exposure of the results of the Antarctic experience.

There is no firm definition of "significant audience" in the Antarctic Artists and Writers Program. However, having your **work experienced by large and/or diverse audiences** can be seen as significant. Some formats for showing your work could include public lectures, shows at major galleries, traveling exhibitions, major articles in general circulation magazines, and/or a book published by a major publisher.

To increase **interest, engagement, and understanding of Antarctic research**, applicants are encouraged to explore various methods of informal education, which include activities such as films, museum exhibitions, public lectures, and book readings. Project activities may be carried out in any location that reaches the intended target audience outside of formal education settings, such as in a museum (e.g., science-technology center, natural history museum, zoo, aquarium, planetarium, arboretum or botanical garden, history or art museum); community center; library; or theater.

See the web site *http://www.nsf.gov/od/opp/ipy/ipyinfo.jsp* for a periodically updated list of NSF IPY awards and/or contact the cognizant NSF program officers.

**3. Operational Feasibility**

The ability to provide operational or logistical support to a project is an important element in NSF's decision. Logistical support is expensive and there are limited resources. Proposals involving fieldwork will be evaluated for operational feasibility, which includes resource availability, environmental protection and waste management provisions, safety and health measures, and safeguards of radioactive materials. Proposers must recognize that proposals may be declined for operational reasons. The proposal must contain sufficient information for reviewers to determine if field work is justified. If the proposal is ranked highly (see section below – part VI. B., "Review and Selection Process"), then additional detailed information about field work will be solicited prior to a final decision by NSF.

**Post-Doctoral Fellowships in Polar Regions Research**
*http://www.nsf.gov/pubs/2008/nsf08501/nsf08501.pdf*

**Additional Review Criteria:**

In addition to the above criteria, the following factors will be used in the evaluation process:

Candidate's abilities and accomplishments and his/her **potential for continued professional growth** as evidenced by the Curriculum Vitae and reference reports;

Potential of the proposed research and training plan to impact the **candidate's career development**;

Suitability and commitment of the proposed sponsoring scientist(s) and host organization(s), including availability of mentors and facilities and suitability of proposed mentoring plan, to promote the research and training plan of the candidate;

Prospective benefits to the activities of the host organization(s); and

Prospective contributions from the candidate's proposed activities to the stated fellowship program goals.

**Arctic Sciences (ARC)**

**Arctic Research Opportunities (ARO)**
*http://www.nsf.gov/pubs/2006/nsf06603/nsf06603.htm*

**Additional Review Criteria:**

**International Polar Year (IPY)**

In addition to the NSF merit review criteria, proposals submitted as contributions to IPY will be evaluated on the relevance and effectiveness of the project to address goals for IPY as expressed by the U.S. National Academy of Sciences (U.S. NAS) and the International Council of Scientists (ICSU). For U.S. NAS IPY information, see *http://dels.nas.edu/us-ipy.* For ICSU IPY information, see *http:// www.ipy.org* or *http://www.ipy.org/concept/index.html*.

# DIRECTORATE FOR SOCIAL DIRECTORATE FOR SOCIAL BEHAVIORAL & ECONOMIC SCIENCES (SBE)

*http://www.nsf.gov/dir/index.jsp?org=SBE*

**BEHAVIORAL AND COGNITIVE SCIENCES (BCS)**

**Human Origins (HOMINID)**
*http://www.nsf.gov/pubs/2008/nsf08512/nsf08512.htm*

**Additional Review Criteria:**

In addition to the general criteria described above, the following criteria will be considered by peer reviewers and NSF staff in evaluating proposals submitted in response to this solicitation:

Does the data access plan specifically address the mechanisms and time frame under which data and specimens obtained through support via this competition will be made **rapidly and widely available**?

Do the researchers indicate the mechanism(s) by which they will ensure that the research is responsive to the needs of interested communities?

Infrastructure proposals only: Does the proposal address the question of project support after the expiration of the HOMINID award?

**Dynamics of Coupled Natural and Human Systems (CNH)**
*http://www.nsf.gov/pubs/2007/nsf07598/nsf07598.htm*

**Additional Review Criteria:**

Successful CNH proposals must be highly interdisciplinary, address the inherent complexity and highly coupled nature of natural and human systems, be well grounded in theory, and show great promise for enhancing basic theoretical understandings. Quantitative approaches, **education**, and **global perspectives** also are important. Research projects must include quantitative approaches or advanced conceptual models to study the systems chosen for investigation. Projects must also include specific plans for **education**. If appropriate, projects will be given consideration if they promote the development of long-term international partnerships.

In the evaluation of proposals submitted by teams of investigators, considerations in addition to standard NSF review criteria are:

Strength of the collaborations planned and degree of interdisciplinarity

Effectiveness of the group organization and management plan

Quality and **expected significance of the educational activities**

Strength of the **dissemination plans**
Extent, effectiveness, and long-term potential of **collaborations with industries, national laboratories, and researchers outside the U.S**., when appropriate.

Descriptions of educational activities should specify goals, methods to attain those goals, and the expertise of individuals to accomplish them. Thus, they will be evaluated based on:

Potential interest to and appropriateness for the audience targeted

Quality of planning and appropriateness of personnel

Feasibility and potential for resulting in a disseminable product

Integration and complementarity to the research efforts

Focus on integrated learning and discovery and the preparation of U.S. students for a **broad set of careers in environmental fields**.

**Developmental and Learning Sciences (DLS)**
*http://www.nsf.gov/pubs/2007/nsf07508/nsf07508.htm*

**Additional Review Criteria:**

The following additional review criteria apply only to proposals to the Integrative Research Activities for Developmental Science (IRADS).

In addition to the evaluation criteria stated above, NSF will consider the following additional criteria in making IRADS awards. Excellence must be demonstrated in all criteria (general merit criteria above and considerations specific to IRADS proposals below) for support to be recommended:

Value of the Collaborative and Integrative Mode to Research, Education, and Knowledge Transfer. Are the science and research challenges of sufficient import, scale, and complexity to justify a collaborative or IRADS investment? Will the partnerships achieve significant intellectual exchange? Will any proposed new instruments, shared experimental facilities, and/or databases be of significant value to a **broad community** of users? Will the educational programs make a special contribution to the achievement of a **diverse, highly competent, and globally-engaged workforce and of an educated citizenry**?

Integrative Nature of the Proposed Project**.** Are research, **educational**, and knowledge transfer activities strategically integrated such that the whole is greater than the sum of its parts? Are the partners vital participants in an integrated whole?

Leadership**.** Do the Principal Investigator (PI) and the leadership team convincingly demonstrate the vision, experience, and capacity to manage a complex, multi-faceted, and innovative research education, and knowledge transfer enterprise?

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are to be treated as confidential documents. Verbatim copies of reviews, excluding the names of reviewers, are made available to the Principal Investigator/Project Director by the Program Director. In addition, the proposer will receive an explanation of the decision to award or decline funding.

**SOCIAL AND ECONOMIC SCIENCES (SES)**

**Nanotechnology Undergraduate Education (NUE) in Engineering**
*http://www.nsf.gov/pubs/2008/nsf08544/nsf08544.htm*

**Additional Review Criteria:**

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

What is the extent to which creative, interdisciplinary approaches to undergraduate engineering education are 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?

**Ethics Education in Science and Engineering (EESE)**
*http://www.nsf.gov/pubs/2008/nsf08530/nsf08530.htm*

**Additional Review Criteria:**

Reviewers will be asked to apply several special criteria to all proposals in this program:

Is this an innovative effort? Is it likely to create long-term improvement in ethics **education for graduate students** in science or engineering?

Does the project include adequate grounding in the relevant research literatures? Does it use appropriate methodology of evaluations? Does it include relevant interdisciplinary collaboration?

Do potential results have promise for **broad utility, and is there a feasible plan for widespread dissemination**, adoption or adaptation?

Are there adequate supporting materials to document commitment from those individuals and institutions playing a substantive role in the project?

For education proposals, and those combining research and education, additional special criteria are:

Does the proposal include appropriate plans to test **results beyond one institution**?

Does the proposal include well-formulated, feasible plans for evaluation of effectiveness?