

Nanoscale Science and Engineering (NSE)

Program Solicitation for FY 2005

Program Solicitation

NSF 04-043

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National Science Foundation

Directorate for Engineering

Directorate for Biological Sciences

Directorate for Computer and Information Science and Engineering

Directorate for Education and Human Resources

Directorate for Geosciences

Directorate for Mathematical and Physical Sciences

Directorate for Social, Behavioral, and Economic Sciences

Office of International Science and Engineering

Preliminary Proposal Due Date(s) (*required*):

November 10, 2004

Preliminary proposals are only required for Nanoscale Science and Engineering Centers (NSEC).

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

November 12, 2004

for Nanoscale Interdisciplinary Research Teams (NIRT)

November 18, 2004

for Nanoscale Exploratory Research (NER)

March 01, 2005

for Nanoscale Science and Engineering Centers (NSEC): Full proposals may ONLY be submitted by invitation from NSF.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Nanoscale Science and Engineering (NSE)
Program Solicitation for FY 2005

Synopsis of Program:

The National Science Foundation (NSF) announces a program on collaborative research and education in the area of nanoscale science and engineering. The goal of this program is to support fundamental research and catalyze synergistic science and engineering research and education in emerging areas of nanoscale science and technology, including: biosystems at the nanoscale; nanoscale structures, novel phenomena, and quantum control; nanoscale devices and system architecture; nanoscale processes in the environment; multi-scale, multi-phenomena theory, modeling and simulation at the nanoscale; manufacturing processes at the nanoscale; and studies on the societal and educational implications of scientific and technological advances on the nanoscale. This solicitation will provide support for Nanoscale Interdisciplinary Research Teams (NIRT), Nanoscale Exploratory Research (NER), and Nanoscale Science and Engineering Centers (NSEC).

A related program solicitation will focus on Nanotechnology Science and Engineering Education (NSEE) for FY 2005 which will provide support for four components: Centers for Learning and Teaching in Nanoscale Science and Engineering (NCLT), Informal Science Education in Nanoscale Science and Engineering (NISE), Instructional Materials Development in Nanoscale Science and Engineering (NIMD), and Nanotechnology in Undergraduate Education (NUE). Other research and education projects in nanoscale science and engineering will continue to be supported in the relevant Programs and Divisions.

Cognizant Program Officer(s):

- Gerald B. Selzer, Program Director, Directorate for Biological Sciences, Division of Biological Infrastructure, 615 N, telephone: (703) 292-8470, fax: (703) 292-9063, email: gselzer@nsf.gov
- S. Kamal Abdali, Division Director, Directorate for Computer & Information Science & Engineering, Division of Computing and Communication Foundations, 1115 N, telephone: (703) 292-8910, fax: (703) 292-9059, email: kabdali@nsf.gov
- Sankar Basu, Program Director, Directorate for Computer & Information Science & Engineering, Division of Computing and Communication Foundations, 1145 S, telephone: (703) 292-8910, fax: (703) 292-9059, email: sbasu@nsf.gov
- Joyce B. Evans, Senior Program Director, Directorate for Education & Human Resources, 875 S, telephone: (703) 292-5098, fax: (703) 292-9044, email: jevans@nsf.gov
- Duncan E. McBride, Section Head, Directorate for Education & Human Resources, Division of Undergraduate Education, 835 N, telephone: (703) 292-4630, fax: (703) 292-9015, email: dmcbride@nsf.gov
- Jian Cao, Program Director, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 531, telephone: (703) 292-7088, fax: (703) 292-9056, email: jcao@nsf.gov
- Rajinder Khosla, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: rkhosla@nsf.gov
- Tapan K. Mukherjee, Program Director, Directorate for Engineering, Division of Engineering Education & Centers, 585 N, telephone: (703) 292-8381, fax: (703) 292-9051, email: tmukherj@nsf.gov
- Ken P. Chong, Program Director, Directorate for Engineering, Division of Civil & Mechanical Systems, 545 S, telephone: (703) 292-8360, fax: (703) 292-9053, email: kchong@nsf.gov
- Geoffrey A. Prentice, Program Director, Directorate for Engineering, Division of Chemical & Transport Systems, 525 N, telephone: (703) 292-8371, fax: (703) 292-9054, email: gprentic@nsf.gov
- Leon Esterowitz, Program Director, Directorate for Engineering, Division of Bioengineering & Environmental Systems, 565 S, telephone: (703) 292-7942, fax: (703) 292-9098, email: lesterow@nsf.gov
- Enriqueta C. Barrera, Program Director, Directorate for Geosciences, Division of Earth Sciences, 785 S, telephone: (703) 292-8551, fax: (703) 292-9025, email: ebarrera@nsf.gov
- Bruce Doddridge, Program Director, Directorate for Geosciences, Division of Atmospheric Sciences, 775 S, telephone: (703) 292-8522, fax: (703) 292-9022, email: bdoddrid@nsf.gov
- Barbara Ransom, Program Director, Directorate for Geosciences, Division of Ocean Sciences, 725 N, telephone:

(703) 292-8581, fax: (703) 292-9085, email: bransom@nsf.gov

- Charles D. Pibel, Program Officer, Directorate for Mathematical & Physical Sciences, Division of Chemistry, 1055 S, telephone: (703) 292-4971, email: cpibel@nsf.gov
- C. Denise Caldwell, Program Director, Directorate for Mathematical & Physical Sciences, Division of Physics, 1015 N, telephone: (703) 292-7371, fax: (703) 292-9078, email: dcaldwel@nsf.gov
- LaVerne D. Hess, Program Director (EM), Directorate for Mathematical & Physical Sciences, Division of Materials Research, 1065 N, telephone: (703) 292-4937, email: lhess@nsf.gov
- Maija M. Kukla, Program Director, Directorate for Mathematical & Physical Sciences, Division of Materials Research, 1065 N, telephone: (703) 292-4940, fax: (703) 292-9035, email: mkukla@nsf.gov
- Hans G. Kaper, Program Director, Directorate for Mathematical & Physical Sciences, Division of Mathematical Sciences, 1025 N, telephone: (703) 292-4879, fax: (703) 292-9032, email: hkaper@nsf.gov
- Rachelle D. Hollander, Program Director/Cluster Coordinator, Directorate for Social, Behavioral & Economic Sciences, 905 N, telephone: (703) 292-7272, fax: (703) 292-9083, email: rholland@nsf.gov
- Sheila Slaughter, Program Director, Directorate for Social, Behavioral & Economic Sciences, Division of Social and Economic Sciences, 995 N, telephone: (703) 292-7318, fax: (703) 292-9068, email: sslaught@nsf.gov
- Larry H. Weber, Senior Program Manager, Office of International Science and Engineering, 935 N, telephone: (703) 292-8704, fax: (703) 292-9175, email: lweber@nsf.gov
- Cassandra M. Dudka, Program Manager, Office of International Science and Engineering, 935 N, telephone: (703) 292-8703, fax: (703) 292-9177, email: cdudka@nsf.gov

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

- 47.074 --- Biological Sciences
- 47.070 --- Computer and Information Science and Engineering
- 47.076 --- Education and Human Resources
- 47.041 --- Engineering
- 47.050 --- Geosciences
- 47.049 --- Mathematical and Physical Sciences
- 47.078 --- Office of Polar Programs
- 47.075 --- Social, Behavioral and Economic Sciences

Eligibility Information

- **Organization Limit:**

See the full text of this solicitation for further information.

- **PI Eligibility Limit:**

The Nanoscale Science and Engineering Centers (NSEC) component requires that Principal Investigators be at the faculty level or equivalent.

- **Limit on Number of Proposals:**

See the full text of this solicitation for further information.

Award Information

- **Anticipated Type of Award:** Standard or Continuing Grant or Cooperative Agreement
- **Estimated Number of Awards:** 100 to 130 - The estimated program budget, number of awards and average award size/duration are subject to the availability of funds.
- **Anticipated Funding Amount:** \$81,550,000 pending the availability of funds.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Preliminary Proposals:** Submission of Preliminary Proposals is required. Please see the full text of this solicitation for further information.
- **Full Proposal Preparation Instructions:** This solicitation contains information that deviates from the standard Grant Proposal Guide (GPG) proposal preparation guidelines. Please see the full text of this solicitation for further information.

B. Budgetary Information

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

C. Due Dates

- **Preliminary Proposals (*required*) :**
November 10, 2004
Preliminary proposals are only required for Nanoscale Science and Engineering Centers (NSEC).
- **Full Proposal Deadline Date(s)** (due by 5 p.m. proposer's local time):
November 12, 2004
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November 18, 2004
for Nanoscale Exploratory Research (NER)
March 01, 2005
for Nanoscale Science and Engineering Centers (NSEC): Full proposals may ONLY be submitted by invitation from NSF.

Proposal Review Information

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

Award Administration Information

- **Award Conditions:** Standard NSF award conditions apply.
- **Reporting Requirements:** Standard NSF reporting requirements apply.

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I. INTRODUCTION

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

Nanotechnology is the creation and utilization of functional materials, devices, and systems with novel properties and functions that are achieved through the control of matter, atom-by-atom, molecule by molecule or at the macromolecular level. A revolution has begun in science, engineering and technology, based on the ability to organize, characterize, and manipulate matter systematically at the nanoscale. Far-reaching outcomes for the 21st century are envisioned in both scientific knowledge and a wide range of technologies in most industries, healthcare, conservation of materials and energy, biology, environment and education. Nanoscale Science and Engineering (NSE) underpin innovations in critical areas ranging from manufacturing to medicine. Opportunities have opened as new tools enable fundamental discoveries and technological advances. Outstanding benefits have resulted from initial applications. A special challenge and opportunity is restructuring teaching at all levels to include NSE concepts and nurturing the scientific and technical workforce of the 21st century.

Formidable challenges remain, however, in the areas of fundamental understanding, device design, system design and architecture, manufacturing, and system integration and deployment before the potential of nanotechnology becomes a reality. Successful development and application of nanoscience and technology will require careful consideration and analysis of associated social and ethical phenomena. Key research areas have been identified in advanced materials, nanobiotechnology, nanoelectronics, advanced healthcare, environmental improvement, efficient energy conversion and storage, space exploration, economical transportation, nanobiosensors, societal dimensions of nanotechnology, and improving nanotechnology education.

The National Nanotechnology Initiative (NNI; <http://nano.gov>) is a government-wide activity designed to ensure that investments in this area are made in a coordinated and timely manner, and to accelerate the pace of revolutionary discoveries. NSF's Nanoscale Science and Engineering (NSE) priority area, for which this is the flagship solicitation,

represents NSF's contribution to leadership in the NNI. This fiscal year 2005 competition is the fifth year of the NSE. Collaborative research among physicists, chemists, biologists, materials scientists, geoscientists, mathematicians, computer scientists, engineers, social and behavioral scientists, economists, and educators is an integral part of both NNI and NSE. This year's NNI effort places increased focus on fundamental research and education in novel instrumentation, nanomaterials and manufacturing processes at the nanoscale, nanoelectronics and challenges faced by conventional CMOS technology, nanobiosystems with relevance to healthcare, devices for biological, chemical, radiological and explosive agents detection and protection, energy conversion and storage, and influences of social networks on development and application of nanoscale science, engineering and technology. This NSE solicitation supports these emphases, where appropriate to NSF programs.

The NSF's mission is to promote the progress of science, engineering and related education in the United States. Its role in supporting research and education is particularly important in creating physical and human resources infrastructure in emerging areas such as nanoscale science and engineering. NSF also promotes partnerships, including collaboration with other agencies, industry and national laboratories, for projects of mutual interest. International collaborations are also strongly encouraged.

The current pace of revolutionary discoveries in nanoscience and technology is expected to accelerate greatly in the next decade. This will have profound implications on existing technologies and could result in the development of completely new technologies, improvements in health, the conservation of materials and energy, and a sustainable environment. Awards made in response to this solicitation will contribute to such future advancements.

This solicitation, previous program announcements, and additional information concerning related activities such as workshops and publications, including the "Nanotechnology Research Directions" (2000) prepared by the National Science and Technology Council, are available on-line at <http://www.nsf.gov/nano> and <http://nano.gov>.

II. PROGRAM DESCRIPTION

RESEARCH AND EDUCATION THEMES

This initiative focuses on eight high-risk/high-reward research and education themes, where special opportunities exist for fundamental studies in nanoscale science and engineering. The eight areas are:

- ***Biosystems at the Nanoscale.*** Research in this area supports the development of a fundamental understanding of nanobiostructures and processes, nanobiotechnology, and techniques for a broad range of applications in biomaterials, biosystem-based electronics, agriculture, energy, and health. The goal is to stimulate progress in the study of biological and biologically inspired systems in which nanostructures play an important role. This includes developing an understanding of the relationships among chemical composition, single molecule behavior, and physical shape at the nanoscale and biological function. Additional research areas include the study of organelles and subcellular complexes such as ribosomes and molecular motors; construction of nanometer-scale probes and devices for research in genomics, proteomics, cell biology, and nanostructured tissues; and synthesis of nanoscale materials based on the principles of biological self-assembly. Biosynthesis and bioprocessing offer fundamentally new ways to manufacture nanostructured products, including novel biomaterials, improved delivery of bioactive molecules, nanoscale sensory systems, biochips, and the modification of existing biomolecular machines for new functions.
- ***Nanoscale Structures, Novel Phenomena, and Quantum Control.*** Research in this area explores the novel phenomena and material structures that appear at the nanoscale. This research is critical to overcoming obstacles to miniaturization as feature sizes in devices reach the nanoscale. Research in this area also refers to fundamental physics and chemistry aspects, development of the experimental tools necessary to characterize and measure

nanostructures and phenomena, and development of techniques for synthesis and design. It also includes investigations of quantum algorithms and means for error correction in quantum information systems. Examples of possible benefits include molecular electronics, nanostructured catalysts, advanced drugs, quantum computing, DNA computing, the development of high capacity computer memory chips, production of two- and three-dimensional nanostructures "by design," nanoscale fluidics, biophotonics, control of surface processes and lubrication.

- **Nanoscale Devices and System Architecture.** New concepts and design methodologies are needed to create new nanoscale devices, synthesize nanosystems and integrate them into architectures for various operational environments. These require a profound understanding of the physical, chemical, and biological interactions among nanoscale components. In order to systemize the design of complex nanosystems, multiple layers of abstractions and various mathematical models to represent component behavior in different layers are also required. Research in this area includes development of new tools for sensing, assembling, processing, manipulating, manufacturing and integration along scales, controlling and testing nanostructures, devices, design and architecture of concepts, software specialized for nanosystems, and design automation tools for assembling systems of large numbers of heterogeneous nanocomponents. One can envision "smart" systems that sense and gather information and analyze and respond to that information, more powerful computing systems and architectures, and novel separation systems with molecular resolution.
- **Silicon Nanoelectronics and Beyond (SNB):** Research in SNB explores fundamental understanding of materials, processes, devices, design, and architecture challenges faced by the semiconductor industry at and beyond the time horizons of the International Technology Roadmap for Semiconductors (ITRS, <http://www.public.itrs.net>). Research will also explore ultimate limits to scaling of features and alternative physical principles for devices employed in sensing, storage, communication, and computation, including biological, molecular, and other emerging areas of electronics at the nanoscale. The research activity in this topic area could help develop innovative technologies, including bottom-up technologies at the atomic and molecular levels, that are integrable with CMOS technology and at the same time have potential to provide alternative and complementary solutions. Examples include: (a) nanoscale device structures exploiting unique electronic, photonic, and/or magnetic materials properties, nanotubes, biological, molecular, and quantum structures; (b) novel modeling, design, and systems architecture concepts, including models with enhanced fidelity across multiple levels of abstraction, spanning atoms, materials, devices, circuits, and systems; (c) innovative approaches for device processing, packaging, testing, and characterization at nanoscale dimensions, including lithographic techniques with self-assembly methods to support the fabrication of complex structures; (d) novel approaches to design, including principles of self organization, with tools that address and leverage uncertainties associated with nanoscale dimensions through probabilistic and statistical techniques.

Under a Memorandum of Agreement signed in January 2004, the designated staff of the Semiconductor Research Corporation (SRC) will assist in proposal evaluation in this SNB topic area. If you submit a proposal for SNB, the proposal and subsequently generated review materials will be made available to designated SRC staff for the purpose of proposal evaluation and, possibly, additional funding opportunities. Designated SRC staff will be subject to a confidentiality agreement that protects personal and proprietary information of proposers. The submitted proposal should have an informative title that begins with "NIRT/SNB):. . . ." or "NER/SNB:", as appropriate to the mode of support.

- **Nanoscale Processes in the Environment.** Research in this area will focus on probing nanostructures and processes of relevance in the environment from the Earth's core to the upper atmosphere and beyond. Nanoparticles and other nanostructures found in the environment may originate from natural sources, be engineered for various uses, or be by-products of industrial and other processes such as combustion. Emphasis will be on understanding the distribution, composition, origin, and behavior of nanoscale structures under a wide variety of naturally occurring physical/chemical conditions, including nanoscale interactions at the interface between organic and inorganic solids, liquid and gases, and between living and non-living systems. Examples are biomineralization of nanoscale structures, molecular studies of mineral surfaces, study of transport of ultrafine colloidal particles and aerosols, and study of interplanetary dust particles. Possible benefits of nanoscale studies include better understanding of molecular processes in the environment, the development of manufacturing processes that reduce

pollution, new water purification techniques, artificial photosynthetic processes for clean energy, development of environmental biotechnology, and understanding the role of surface microbiota in regulating chemical exchanges between mineral surfaces and water or air.

- ***Multi-scale, Multi-phenomena Theory, Modeling and Simulation at the Nanoscale.*** The emergence of new behaviors and processes in nanostructures, nanodevices and nanosystems creates an urgent need for theory, modeling, large-scale computer simulation and new design tools in order to understand, control and accelerate development in new nanoscale regimes and systems. Research on theory, mathematical methods, modeling and simulation of physical, chemical and biological systems at the nanoscale will include techniques such as quantum mechanics and quantum chemistry, multi-particle simulation, molecular simulation, grain and continuum-based models, stochastic methods, and nanomechanics. Approaches that make use of more than one such technique and focus on their integration will play an important role in this effort. The interplay of coupled, time-dependent and multi-scale phenomena and processes in large atomistic and molecular systems will be encouraged. A critical issue is the ability to make connection between structures, properties and functions. Examples of possible benefits include better understanding of processes in chemistry, biology, physics, materials science and engineering, and the geosciences, and realization of functional nanostructures and architectures "by design" such as new chemicals, multifunctional materials, bioagents and electronic devices.
- ***Manufacturing Processes at the Nanoscale.*** Research in this area will focus on creating nanostructures and assembling them into nanosystems and then into larger scale structures. This research should address understanding nanoscale processes, developing novel tools for measurement and manufacturing at the nanoscale, developing novel concepts for high-rate synthesis and processing of nanostructures and nanosystems, and scale up of nanoscale synthesis and processing methods. Examples are synthesis of nanostructures for various functions, fabrication methods for devices and nanosystems, design concepts for manufacturing, simulation of the manufacturing methods at the nanoscale, and evaluation of the economic and environmental implications of manufacturing at the nanoscale. Possible benefits include improving understanding of manufacturing processes in the pre-competitive environment, generating a new group of nanoscale manufacturing methods, increasing the performance and scale up of promising techniques, and establishing the physical and human infrastructure for measurements and manufacturing capabilities.]
- ***Societal and Educational Implications of Scientific and Technological Advances on the Nanoscale.*** Innovations in science and technology both require societal support and influence social structures and processes, sometimes in unexpected ways. Examining the ethical and other social implications of these societal interactions is necessary, in order to understand their scope and influence and to anticipate and respond effectively to them. Support for nanoscience and nanotechnology is likely to enhance understanding of fundamental natural processes, from living systems to astronomy, and change the production and use of many goods and services. Studies of the varied social interactions that involve these new scientific and technological endeavors can improve our understanding of, e.g., economic implications of innovation; barriers to adoption of nanotechnology in commerce, healthcare, or environmental protection; educational and workforce needs; ethical issues in the selection of research priorities and applications and in the potential to enhance human intelligence and develop artificial intelligence; society's reaction to both newly created nanoparticles and nanoparticles that newly developed techniques permit us to recognize, detect, characterize, and relate to health and environmental issues; implications of converging interests of different fields of science and engineering towards the nanoscale; risk perception, communication, and management; and public participation and involvement in scientific and technological development and use. This theme aims at a long-term vision for addressing societal, ethical, environmental, and educational concerns

These eight scientific themes are linked by the overarching goals of achieving systematic control of phenomena at the nanoscale, exploiting new phenomena and functions that do not extrapolate outside of the nanoscale domain, and applying such capabilities in areas of national interest. Proposals that incorporate elements of more than one scientific theme are welcome. Given NSF's strong focus on developing the infrastructure for nanoscale science and engineering, all proposals should address integration of research and education, including course development, student fellowships, and other aspects

according to the nature of the project.

In FY 2005, consistent with NNI emphases, NSF encourages proposals involving novel instrumentation, manufacturing processes, nanoelectronics and challenges faced by conventional CMOS technology, energy conversion and storage, and devices for chemical, biological, radiological, or explosive agents detection that involve nanoscale processes are particularly encouraged within the seven research and education themes above (see list of NSF and NNI sponsored workshops on line on <http://www.nsf.gov/nano>). Research on converging science and technology integrated from the nanoscale for revolutionary products and improving human performance also are encouraged (see “Converging Technologies for Improving Human Performance” on line at <http://www.nsf.gov/nano>).

Each of the themes should emphasize the integration of research and education, including course development, student fellowships, and other aspects according to the nature of the project.

NSF does not normally support technical assistance, pilot plant efforts, research requiring security classification, the development of products for commercial marketing or market research for a particular project or invention. Research with disease-related goals, including work on the etiology, diagnosis or treatment of physical or mental disease, abnormality or malfunction in human beings or animals, is normally not supported. Animal models of such conditions or the development or testing of drugs or other procedures for their treatment also are not eligible for support. Research in bioengineering, with diagnosis or treatment related goals, however, that apply engineering principles to problems in biology and medicine while advancing engineering knowledge is eligible for support. Bioengineering research to aid persons with disabilities is also eligible.

MODES OF SUPPORT

A. NANOSCALE INTERDISCIPLINARY RESEARCH TEAMS (NIRT)

NIRT - Goals and Structure

Research and education areas in nanoscale science and engineering are inherently interdisciplinary. This solicitation encourages team approaches to address research and education themes where a synergistic blend of expertise is needed to make significant contributions. The Nanoscale Interdisciplinary Research Teams (NIRT) activity will support small collaborative groups of three or more investigators at the faculty level or equivalent. At least three PIs and co-PIs, all with time committed in the budget, must be listed on the cover page of the proposal. The maximum number of PIs and co-PIs is five; other participants may be listed in the project summary and on the budget pages. The duration of the project should be four years.

NIRT proposals must have the following characteristics:

- An integrating research and education focus around one or a combination of the eight themes described in Section II.,
- Partnerships,
- A clearly identified team with the skills necessary to pursue the research and education theme, and
- Components aimed at the development of a skilled workforce and an informed public in nanoscience and technology.

A grantees' conference at NSF (Arlington, Virginia) at the end of the second year will enable the principal investigators of NIRTs and NSECs to review progress, exchange information, and promote collaborations. At least one investigator from each funded research team will be required to participate. Funds should be included in the NIRT proposals for attendance at this conference.

B. NANOSCALE EXPLORATORY RESEARCH (NER)

NER- Goals and Structure

The NER solicitation component is focused on research and education at the frontiers of nanoscale science and engineering, where exploratory research is a priority. NER focuses on only seven of the eight high-risk/high-reward research and education themes listed in Section II.

- Biosystems at the Nanoscale
- Nanoscale Devices and System Architecture
- Silicon Nanotechnology and Beyond
- Nanoscale Processes in the Environment
- Multi-scale, Multi-phenomena Theory, Modeling and Simulation at the Nanoscale
- Manufacturing Processes at the Nanoscale
- Societal and Educational Implications of Scientific and Technological Advances on the Nanoscale

This solicitation component emphasizes exploratory high-risk/high-reward nanoscale science and engineering research and education that would have a high potential for innovation if the research were successful. Such research and education is characterized as:

- Preliminary feasibility work on untested, novel, and far-reaching ideas in nanoscale science and engineering with focus on one or a combination of the seven research and education themes listed above and described in Section II;
- Application of new expertise or new approaches; and
- Efforts likely to catalyze rapid and innovative advances.

Novel ideas that are not already widely researched and published will be supported. These ideas may be supported by only limited preliminary data. The project description should include:

- A statement showing the significant advancement in the proposal as compared to the state of the art;
- A clear statement as to why the proposed research should be considered particularly exploratory and high risk;
- The nature and significance of its potential impact on the field; and
- A plan for a feasibility demonstration within the time and cost guidelines must be included.

C. NANOSCALE SCIENCE AND ENGINEERING CENTERS (NSEC)

NSEC - Goals and Structure

The new Nanoscale Science and Engineering Centers (NSECs) competition in FY 2005 will address major opportunities and challenges in nanoscience, engineering and technology. In FY 2005, NSEC focuses on only two of the eight research and education themes listed in Section II.

- Manufacturing Processes at the Nanoscale. The title of the center will be “NSEC: Center for Hierarchical Manufacturing (CHM)”
- Societal and Educational Implications of Scientific and Technological Advances on the Nanoscale. The title of the center will be “NSEC: Center for Nanotechnology in Society (CNS)”

The NSEC solicitation component will address opportunities that are too complex and multi-faceted for individuals or small groups of researchers to tackle on their own. Centers will bring together researchers with diverse expertise -- in partnership with other private and public sector organizations -- to address complex, interdisciplinary challenges. They will integrate research with education both internally and through a variety of partnership activities. Each NSEC, whether based at a single institution or distributed across a number of institutions, must have an overarching research and education theme, well-integrated programs, and a coherent and effective management plan. The NSECs as a whole will span the range from exploratory research -- focused on discovery -- to technology innovation, and will involve a broad spectrum of disciplines such as engineering, mathematics and computer science, the physical, biological, environmental, social and behavioral sciences, and fields in the humanities. The scope of individual NSECs and the disciplines involved in them will vary.

All NSECs in the FY 2005 competition must include the following components:

- A plan to achieve major goals in these themes that require the coherence and critical mass of a university-based center;
- A well integrated, cross-disciplinary research program distinguished by intellectual excellence and driven by a clear vision, in which the whole is greater than the sum of the parts;
- A strong emphasis on education, incorporating extensive student participation in the Center's interdisciplinary research, and including (as appropriate to the Center) activities in course and curriculum development and effective partnerships to advance pre-college education, workforce training, and/or the public understanding of science and engineering;
- Effective partnerships with industry, government laboratories and agencies, non-governmental organizations, and/or other users of research outcomes;
- Activities to foster human resource development and enhanced participation of under-represented groups in relevant fields; and
- Activities to address the societal ramifications of advances in nanoscale science and technology. For example, this may include technology forecasting and economic and social impact analysis for the technology focus area of the proposed NSEC, examination of societal implications of the research outcomes, and activities to enhance public understanding of nanoscience and technology in relation to the goals of the NSEC.

Proposals for the Center on Hierarchical Manufacturing (CHM), must address the following additional components:

- A systems-level focus that drives the research from discovery through proof-of-concept, including the design and/or development of nanosystems, structures, enabling tools technology, processes or devices, and proof-of-concept test beds that pull together disparate research efforts to test a system or complex concept and thus identify where further research efforts are required;
- Collaboration with other centers on nanomanufacturing, including two NSECs established in 2003 and grantees from other agencies. The new NSEC is expected to: a. collaborate with grantees from other agencies with similar

programs; b. share resources with those programs for mutual advantage; c. work toward a nanomanufacturing network that encourages extensive industrial collaboration; and d. participate in joint nanomanufacturing program evaluations.

- Plans for a nanostructured materials and nanomanufacturing database, and
- Plans for a clearinghouse activities that the Center will undertake including plans for involvement of a wide range of shareholder groups, and coordination and/or compilation of appropriate data for material properties, manufacturing processes, best practices, educational materials, etc.

Proposals for the Center for Nanotechnology in Society (CNS), must address the following additional aspects:

- How the Center and its partners aim at a long-term vision for addressing societal, ethical, environmental and educational concerns through research, education, outreach and dissemination. Justifications for specific research foci should take account of a broad range of interests and concerns.
- Plans for collaboration with other NSEC and NIRT grantees (and other partners, as appropriate) on topics related to responsible nanotechnology.
- Interdisciplinary fellowship programs
- How the Center and its affiliates will provide a clearinghouse for relevant research results and information about ethical and social dimensions of nanoscale science, engineering, and technology
- Plans for public engagement with Center activities and for involvement of a wide range of stakeholder groups

NSECs may also choose to include *optional activities*, as appropriate, such as (but not limited to):

- Collaboration with other U.S. and/or international centers, laboratories, and groups, which may include exchange programs for students and faculty;
- Shared experimental facilities, including fabrication and/or characterization equipment, equipped and maintained for the benefit of users within and outside the center; and
- Collaboration with and access to unique capabilities offered by existing national facilities and resources (such as the National Nanotechnology Infrastructure Network, Network for Computational Nanotechnology, synchrotron x-ray facilities, neutron sources, the National High Magnetic Field Laboratory, the General Social Survey, the Panel Study of Income Dynamics, the American National Elections Studies, other broad-based sources of survey information and survey expertise, and advanced computational facilities and resources through partnership with national laboratories and other institutions and centers).

A grantees' conference at NSF (Arlington, Virginia) at the end of the second year will enable the principal investigators of NIRTs and NSECs to review progress, exchange information, and promote collaborations. At least one investigator from each funded research team will be required to participate. Funds should be included in the NSEC proposals for attendance at this conference.

III. ELIGIBILITY INFORMATION

Organization Limit:

A. Nanoscale Interdisciplinary Research Teams (NIRT): NIRT proposals may be submitted by a single organization or a group of organizations consisting of a lead organization in partnership with one or more partner organizations. U.S.

academic institutions with significant research and degree-granting education programs in disciplines normally supported by NSF are eligible to be the lead organization. Principal investigators are encouraged to form synergistic collaborations with industry, government laboratories, and scientists and engineers at foreign organizations where appropriate, though no funds will be provided to those organizations. Collaborations between university and industry researchers using the approach of the GOALI (Grant Opportunities for Academic Liaison with Industry, NSF 98-142, <http://www.nsf.gov/goali>) are encouraged. Primary support for any foreign participants/activities must be secured through their own national sources. At least three PIs and co-PIs, all with funded time committed in the budget, must be listed on the cover page or on the budget page of the proposal. The maximum number of PIs and co-PIs is five; other participants may be listed in the project summary and on the budget pages.

Synergistic collaboration among researchers, and collaborations or partnerships with industry or government laboratories is encouraged. For foreign participants, the U.S. organization may provide funds under participant support costs for travel and per diem for visits to the U.S. organization, as consistent with applicable international agreements. No NSF funds may go directly to foreign organizations. For this solicitation, funds for salaries and research expenses of staff of national laboratories, state agencies, and non-NSF Federally Funded Research and Development Centers (FFRDC) may not be requested. However, it is appropriate for students supported by the award to work at an FFRDC or comparable site or for the award to support research expenses incurred when scientists from such entities work at university sites. Federal employees may not receive salaries or in other ways augment their agency's appropriation through grants made by this solicitation, and no funds for equipment at FFRDCs are allowed.

B. Nanoscale Exploratory Research (NER): Proposals may be submitted by U.S. academic institutions with undergraduate and/or Ph.D. programs in disciplines usually supported by NSF. Research may be proposed by individual investigators or by small groups from academic institutions. Synergistic collaboration among researchers, and collaboration or partnerships with industry or government laboratories are encouraged when appropriate. Prospective proposers are encouraged to contact one of the program officers listed in this solicitation (except for the MPS program officers) for additional guidance on suitability of NER submission if there are questions.

C. Nanoscale Science and Engineering Centers (NSEC): NSECs may be based at a single U.S. academic institution or may consist of a **lead institution** in partnership with one or more **partner institutions**. U.S. academic institutions with undergraduate and Ph.D. programs in disciplines normally supported by NSF are eligible to submit one preliminary proposal -- and one full proposal ONLY if invited by NSF -- as the lead institution. Partnerships of the lead institution with other universities/colleges are encouraged.

A single institution cannot be the **lead institution** in more than one preliminary proposal, or on more than one full proposal if invited by NSF. Institutions may be involved as a **partner institution** in any number of preliminary proposals and full proposals.

PI Eligibility Limit:

The Nanoscale Science and Engineering Centers (NSEC) component requires that Principal Investigators be at the faculty level or equivalent.

Limit on Number of Proposals:

A. Nanoscale Interdisciplinary Research Teams (NIRT): An organization -- a university, or a campus in a multi-campus university -- may submit no more than four (4) proposals in response to this solicitation on which it is the lead organization. An exception is made for an additional NIRT proposal that may be submitted in nanoscale processes in the environment or societal and educational implications of scientific and technological advances on the nanoscale. Both of those research and education themes are described in Section II. The same organization may be a collaborative partner in any number of other multi-organization group proposals in which it is not the lead. An authorized organizational representative of the lead organization will make the selection of the proposals that are submitted. Proposals submitted to other NSF programs are not eligible for consideration by this competition. NIRT proposals involving more than one organization must be submitted as a single administrative package with the managing principal investigator from the lead organization.

B. Nanoscale Exploratory Research (NER): An institution -- a university, or a campus in a multi-campus university -- may submit no more than two (2) proposals in response to this NER solicitation on which it is the lead institution. An exception is

made for an additional NER proposal that may be submitted in nanoscale processes in the environment, societal and educational implications of scientific and technological advances on the nanoscale or "nanoscale devices and system architecture." All those research and education themes are described in Section II. At least one proposal must have a P.I. or co-P.I. at the level of assistant professor or equivalent. An authorized organizational representative of the lead institution will make the selection of the proposals that are submitted. Proposals submitted to other NSF programs are not eligible for consideration by this competition. NER proposals involving more than one institution must be submitted as a single administrative package with the managing principal investigator from the lead institution.

C. Nanoscale Science and Engineering Centers (NSEC): In order to reduce the burden of proposal writing for the science and engineering community and the burden of subsequent proposal review and evaluation for reviewers and NSF staff, NSF will accept full proposals for NSECs by invitation only, based on the results of the preliminary proposal evaluation. While more than one institution may be involved as a partner institution in a preliminary proposal and full proposal, one lead institution must accept overall management responsibility for the Center in a preliminary proposal and full proposal. Full proposals may ONLY be submitted by invitation from NSF. U.S. academic institutions with undergraduate and Ph.D. programs in disciplines normally supported by NSF are eligible to submit only one (1) preliminary proposal – and only one (1) full proposal ONLY if invited by NSF – as the lead institution.

IV. AWARD INFORMATION

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

A. Nanoscale Interdisciplinary Research Teams (NIRT): A NIRT award will be in the range of \$250,000-\$500,000 per year for four years depending on the scope of the work proposed. Grants may be awarded in a variety of sizes and durations. The total request for NSF funding for each project, for all investigators and all organizations, may not exceed \$2 million. NSF expects to fund approximately 50-55 NIRT awards in FY 2005 depending on the quality of submissions and the availability of funds. Anticipated date of awards: April 2005.

B. Nanoscale Exploratory Research (NER): NER awards will be made as one-year grants. NER awards may not exceed \$160,000 and cannot be renewed. NSF plans to fund about 45-50 new NER awards in fiscal year 2005. NSF expects to invest approximately \$6.1 million in this solicitation component in FY 2005, subject to the quality of submissions and availability of funds. Anticipated date of awards: April 2005.

C. Nanoscale Science and Engineering Centers (NSEC): NSF plans to establish 2 NSECs in FY 2005. The NSEC awards are expected to be about \$4 million per year for the Center on Hierarchical Nanomanufacturing and about \$2.6 million per year for the Center for Nanotechnology in Society, (CNS), both for five years. NSECs will be eligible to compete for one five-year renewal. NSF expects to invest approximately \$7 million in the NSEC solicitation component from fiscal year 2005 funds. Awards will be made as cooperative agreements. Anticipated date of award: April 2005.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Preliminary Proposals (*required*):

Preliminary proposals are only required for the Nanoscale Science and Engineering Centers (NSEC)

Preliminary proposals must be submitted via NSF FastLane by 5:00 p.m. proposer's local time on November 10, 2004. Preliminary proposals must consist of:

(1) A **Cover Sheet** showing the name of the proposed Center Director (principal investigator) and key participants (co-

principal investigators), and the preliminary proposal title.

(2) A **Project Summary** (not to exceed one page), providing an executive summary highlighting the main activities, administration, infrastructure and partnerships of the Center. It must indicate, in separate statements, the intellectual merit of the proposed work and its broader impacts. (See Section VI.)

(3) A **Project Description** providing a narrative, **not to exceed 15 pages total**, which must:

- Provide an overview of the Center as a whole, including the vision of the Center, a concise rationale for establishing the Center, and an outline of the existing and planned capabilities of the participating institutions in relevant research and education.
- Describe the proposed research and education activities of the Center; indicating clearly which investigators and/or groups of investigators will have primary responsibility for the various aspects of the research and education program.
- Describe the activities proposed to integrate research and education, develop human resources, and cooperate with public and private sector organizations.
- If appropriate, provide a systems-level focus for the Center and/or plans to develop proof-of-concept test beds.
- If appropriate, describe activities to collaborate with shared experimental facilities and/or cooperative activities with international partners.
- Give an outline of the proposed arrangements for administration and management of the Center.
- Describe, in separate statements, the intellectual merit of the proposed work and its broader impacts. (See Section VI.)

In addition, in the Project Description:

The Center on Hierarchical Manufacturing (CHM), must address:

- A systems-level focus that drives the research from discovery through proof-of-concept, including the design and/or development of nanosystems, structures, enabling tools technology, processes or devices and proof-of-concept test beds that pull together disparate research efforts to test a system or complex concept and thus identify where further research efforts are required; and
- Collaboration with the other centers on nanomanufacturing, including two NSECs established in 2003 and one in 2004, and grantees from other agencies. The new NSECs are expected to: a. collaborate with grantees from other agencies with similar programs; b. share resources with those programs for mutual advantage; c. work toward a nanomanufacturing network that encourages extensive industrial collaboration; and d. participate in joint nanomanufacturing reviews.

The Center for Nanotechnology in Society (CNS), must address:

- A long-term vision for addressing societal, ethical, environmental and educational concerns;
- Justifications for specific research foci;
- Clearinghouse and outreach activities;
- Involvement of partners or affiliates and collaboration with other NSEC and NIRT grantees on topics related to responsible nanotechnology; and

Plans to involve a wide range of stakeholders.

(4) A References Cited section, **not to exceed two pages**.

(5) Biographical Sketches of the proposed Center Director (PI) and key participants (co-PIs), **not to exceed two pages each**.

(6) Cumulative proposal budget for the entire Center, including subawards to other institutions, as applicable, **for the five-year total only**, provided as a single budget page. To do this in FastLane, please enter the 5-year total budget in FastLane as the year 1 budget – this will also print as the cumulative budget in FastLane. In the same way, if more than one institution is involved, include a separate single five-year total budget for each non-lead institution (subawardee) if, and only if, the 5-year total for that subawardee exceeds \$3 million. Also provide a single budget justification for anticipated costs for the first year of the project, for the entire Center including all subawardee institutions (limited to 2 pages).

(7) Special Information/Supplementary Documentation, consisting **only** of:

7.a. A **list of each participating institution, and each participating investigator** (at the faculty level or equivalent), by full name, and indicate his or her institutional and departmental affiliations. Additional biographical information is **not** required in the preliminary proposal. Names should be grouped by institution, and listed alphabetically within each group.

7b. A **one-page synopsis of institutional and other commitments** to the proposed Center. (Letters of support should not be included at this stage).

Preliminary proposals and cost sharing are only required for NSECs. Preliminary proposals that exceed the page limitations will be ineligible for consideration and will be returned without review.

Full Proposal Instructions:

Proposals submitted in response to this program announcement/solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide* (GPG). The complete text of the GPG is available electronically on the NSF Website at: <http://www.nsf.gov/cgi-bin/getpub?gpg>. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from pubs@nsf.gov.

Proposal preparation instructions supplement or deviate from the standard GPG instructions. Each of the major areas has its own set of instruction/deviations that are provided in this section:

- A. Nanoscale Interdisciplinary Research Teams (NIRT)**
- B. Nanoscale Exploratory Research (NER)**
- C. Nanoscale Science and Engineering Centers (NSEC)**

A. NANOSCALE INTERDISCIPLINARY RESEARCH TEAMS (NIRT)

NIRT - Proposal Preparation and Submission Instructions

Proposers must identify the program solicitation number **NSF 04-043** in the program announcement/solicitation block on the Cover Sheet and to select "**Nanoscale: Interdiscipl Resrch T**" from the FastLane org. unit pull-down list. Proposal title must begin with "**NIRT:**". For administrative purposes, all NIRT proposals must be submitted via FastLane to CTS (contact Geoff

Prentice, gprentic@nsf.gov). Proposers must indicate in order of priority one (or more) of the eight research and education themes described in Section II which the proposal addresses. This must be stated in the last line of the project summary, and it will be used to assist in assignment of the proposal to the most appropriate panel. **Failure to follow these instructions may delay processing.**

NOTE: The Project Summary and Project Description sections must indicate, in separate statements, the intellectual merit of the proposed work and its broader impacts. (See Section VI.)

NIRT proposals must conform to the requirements of the *Grant Proposal Guide (GPG)*, with three modifications:

- Collaborative research activities should be described and submitted in a single proposal in which a single award is requested, with subawards administered by the lead organization to any other participating organizations. (See GPG section II.D.3.a.) This solicitation encourages team approaches in the belief that a synergistic blend of expertise is needed to make major headway in research, education, and development of the infrastructure. Budgets for any subawards to different organizations must be included.
- The project description is limited to fifteen (15) pages plus one (1) additional page per each co-principal investigator. For example, a proposal with one (1) principal investigator and four (4) co-principal investigators listed on the cover page and budget request would be limited to 19 pages of project description. The maximum number of PIs and Co-PIs is five, so the maximum number of pages in the project description would be 19 pages.
- The project description should include a discussion of the management, education and outreach aspects of the project. The proposal should describe the roles to be played by the participating organizations, the responsibilities of the managing PI and the activities of associated partners, and arrangements for networking, exchange, and dissemination of data and results. The managing PI must be from the lead organization. Details on the education, training, and outreach activities planned as part of the project should be included. Opportunities for students to obtain novel research or educational experiences should be detailed, as well as any specific training activities or workshops.

The page limitation guidelines described above will be strictly enforced.

Proposal Deadline Date: Full proposals for NIRT are due by **5 p.m. proposer's local time on November 12, 2004**. Proposals must be submitted electronically through the FastLane system by the **lead organization**.

Inquiries regarding NIRT proposals should be directed to Geoff Prentice (gprentic@nsf.gov), Program Director, Chemical and Transport Systems.

B. NANOSCALE EXPLORATORY RESEARCH (NER)

NER - Proposal Preparation and Submission Instructions

Proposers must identify the program solicitation number **NSF 04-043** in the program announcement/solicitation block on the Cover Sheet and to select "**Nanoscale: Exploratory Rsrch**" from the FastLane org. unit pull-down list. The proposal title must begin with "**NER:** ". For administrative purposes, all NER proposals must be submitted via FastLane to BES (contact Leon Esterowitz, lesterow@nsf.gov). Proposers must indicate one (or more) of the seven research and education themes listed in Section II.B which the proposal addresses; this must be stated in the last line of the project summary. **Failure to follow these instructions may delay processing.**

NOTE: The Project Summary and Project Description sections must indicate, in separate statements, the intellectual merit of the proposed work and its broader impacts. (See Section VI.)

Proposal Deadline Date: Full proposals for NER are due by **5 p.m. proposer's local time on November 18, 2004**. Proposals must be submitted electronically through the FastLane system by the **lead institution**.

Investigators are strongly encouraged to contact the NSF staff members in the program covering the proposal topic (all directorates except for the Mathematical and Physical Sciences) before submitting an NER proposal if there are questions. For general questions about NER requirements contact Leon Esterowitz (lesterow@nsf.gov).

C: NANOSCALE SCIENCE AND ENGINEERING CENTERS (NSEC)

NSEC - Proposal Preparation and Submission Instructions

Proposers must identify the program solicitation number **NSF 04-043** in the program announcement/solicitation block on the Cover Sheet and to select "**Nanoscale Science & Engin Ctr.**" from the FastLane org. unit pull-down list. The preliminary proposal and full proposal title(s) must begin with "**NSEC:**" Compliance with this requirement is critical to determining the relevant proposal processing guidelines. **Failure to follow these instructions may delay processing.**

FULL PROPOSAL

By invitation from NSF (and only with invitation) full proposals must be submitted via NSF FastLane by 5:00 p.m. proposer's local time on March 1, 2005. A clear disclosure must be made on the Cover Sheet if a related proposal has been submitted or is planned to be submitted to another federal agency. A brief explanation of overlap (up to one page) should be provided in the supplementary documentation section of the FastLane proposal preparation module.

The proposal must contain the following items in the order indicated. **Proposals that exceed the page limitations will be ineligible for consideration and will be returned without review.** Items (4) through (10), (11), and (12) if appropriate or applicable, below should be entered in the "Project Description", in the order given here.

(1) **NSF Cover Sheet.**

(2) **Table of Contents.** Will be generated automatically by FastLane.

(3) **Executive Summary (to be entered in the Project Summary section).** Provide a clear vision for and overarching description of the proposed Center and its potential impact. Briefly describe the institutional setting(s) of the Center, its proposed scope and organization, activities in research and education and their integration, development of human resources, collaborative activities with industry and other sectors, links with related major research teams or Centers on or off campus, and management plan. Describe, in separate statements, the intellectual merit of the proposed work and its broader impacts. (See Section VI.) **Limit: 3 pages.**

(4) **List of Participants.** List each participating institution, and each participant (faculty level or equivalent), by full name, and indicate his or her institutional and departmental affiliation. Names should be grouped by institution, and listed alphabetically within each group.

(5) **Project Description.** Provide a concise description of the long-term research goals and intellectual focus of the Center, and describe the planned research activities in sufficient detail to enable their scientific and engineering merit and significance to be assessed. Describe the role and intellectual contribution of each faculty-level participant, and briefly outline the resources available or planned to accomplish the research goals (it will be helpful to *underline* the name of each investigator wherever it occurs). The need for an interactive, interdisciplinary approach involving a team of investigators, and the means of achieving this, should be clearly established. Describe proposed interactions with other groups and institutions as appropriate. Describe, in separate statements, the intellectual merit of the proposed work and its broader impacts (see Section VI). **Limit for this section: 15 pages, including diagrams, figures and illustrations.** **IMPORTANT NOTE:** Even if diagrams, figures and illustrations are submitted in the supplementary documentation section of the FastLane proposal

preparation module, they must still be counted in the 15-page limit for this section.

(6) **Education, Human Resources, and Outreach.** Describe the proposed activities of the Center in education and human resource development, including plans for participation by undergraduates, pre-college students and teachers if appropriate, and members of underrepresented groups. Interdisciplinary fellowships may include undergraduate and graduate students, postdoctoral fellows, senior researchers or faculty. Outline plans for seminar series, colloquia, workshops, conferences, summer schools and related activities, as appropriate. Describe any additional outreach programs not included in other sections of the proposal. **Limit: 5 pages.**

(7) **Collaboration with Industry and Public and Private Sector Organizations.** Describe the proposed interactions and collaborations with industry, non-governmental organizations and, where appropriate, with other institutions and sectors, including government laboratories and national user facilities. Define the goals of the collaboration, and describe the planned activities. Describe the roles of the senior participants, the mechanisms planned to stimulate and facilitate knowledge transfer, and the potential long-term impact of the collaborations. **Limit: 3 pages.**

(8) **Seed Funding and Emerging Areas.** The NSEC should have a mechanism to identify and support exploratory efforts, including proof-of-concept projects in emerging areas relevant to the Center's intellectual focus. NSF intends to provide flexibility for NSECs to respond quickly and effectively to new opportunities. These may include (but are not limited to): seed support for junior faculty and for investigators changing fields; high-risk high-reward research projects; the development of tools to facilitate research or outreach activities at remote sites; and innovative interdisciplinary educational ventures. Seed funding through the Center is not intended to provide a substitute for NSF individual investigator funding; the criteria and mechanisms for selecting and evaluating projects must be clearly addressed in the management plan. Include the names of key investigators expected to pursue exploratory projects for the first year. **Limit: 3 pages.**

(9) **Management Plan.** Describe the plans for administration of the Center, including the functions of key personnel and the role of the external advisory committee, the executive committee, and the program committee. Describe the procedures and criteria used to select, administer, and evaluate the research programs of the Center, including seed funding and collaborative programs with other groups and institutions as appropriate. Describe plans for implementing and evaluating the educational programs and outreach activities of the Center. **Limit: 3 pages.**

(10) **Institutional and Other Sector Support.** Outline institutional and other commitments to the Center, including cost sharing funds or in-kind (see (14) below), space, faculty and staff positions, access to capital equipment and existing facilities and resources, commitments for collaboration and outreach programs. Identify sources of cost sharing and when they would be available. **Limit: 1 page.**

(11) The following requirements are specific to each center and can be addressed in additional pages:

The Center on Hierarchical Manufacturing (CHM)

11A. (CHM) Systems-Level Focus, Proof-of-Concept Test Beds, and Design and Development Activities. Describe the system-level focus driving the research from discovery through the proof-of-concept, including design and/or prototyping efforts and proof-of-concept test beds. Also describe any connection with development of new technologies, products and services, and partnerships in developing these activities. **Limit: 4 pages.**

11B. (CHM) Collaboration with the other centers on nanomanufacturing. Describe the existing connections and plans to (a) collaborate with grantees from other agencies with similar programs; (b) share resources with those programs for mutual advantage; (c) work toward a nanomanufacturing network that encourages extensive industrial collaboration; and (d) participate in joint nanomanufacturing reviews. **Limit: 2 pages.**

11C. Studies of Societal Implications. Describe the research and educational activities addressing the potential economic, legal, ethical and other societal implications of nanomanufacturing. **Limit: 3 pages.**

Center for Nanotechnology in Society (CNS)

11A. (CNS) Long-term vision and specific research foci. Elaborate the long-term vision for addressing societal, ethical, environmental and educational concerns, through research, education, outreach and dissemination. Justifications for specific research foci should take account of a broad range of interests and concerns. **Limit: 4 pages.**

11 B. (CNS) Collaboration with other NSEC and NIRT grantees on topics related to responsible nanotechnology. Describe the existing connections and plans to collaborate with other NSE grantees (and grantees of other agencies, if appropriate). **Limit: 2 pages.**

11C. (CNS) Clearinghouse and outreach. Specify activities and relevant partners. **Limit: 2 pages.**

(12) **Other Activities: *Complete the following sections only if appropriate or applicable:***

12A. International Collaboration. Describe the nature of the collaboration and the expected international and scientific or engineering benefits to the research and education program. Include a description of the research facilities at the foreign site, as appropriate, and of the division of effort and expertise among the collaborators. **Limit: 1 page.**

12B. Shared Research Facilities. Describe the shared facilities to be established or collaborated with, including specific major instrumentation and plans for instrument development if any. Describe plan for maintaining and operating the facilities or resources, including staffing and provision for user fees for outside users if appropriate. **Limit: 2 pages.**

(13) **References Cited Section** (not to exceed 5 pages).

(14) **Biographical Sketches.**

Include a biographical sketch for each faculty-level (or equivalent) participant, listing mentors and collaborators, and up to ten publications most pertinent to this proposal. **Limit: 2 pages for each investigator.**

(15) **Budget Pages**

Submit budget pages for the Center for each year of support (1 through 5). FastLane will generate a five-year cumulative budget automatically. Provide separate budget pages for the lead institution and any other subawards irrespective of amount. Also provide budget justification for the five-year cumulative budget, for the lead institution and for all participating subawardees. The budget justification is **limited to 5 pages.**

Budgetary Information (Preliminary Proposals and Full Proposals) on Cost Sharing Requirements

Cost sharing at a level equal to 10% of the total amount requested from NSF funds is required for all NSEC proposals. The proposed cost sharing must be shown on line M of the proposal budget. The narrative associated with cost sharing should be included in the budget justification that is a part of the proposal budget. Justification on faculty and staff support, access to instrumentation, location and space, must be also included in the budget justification.

Only items that would be allowable under the applicable cost principles, if charged to the project, may be included in the awardee's contribution to cost sharing. Contributions may be made from any non-Federal source, including non-Federal grants and contracts, and may be cash or in kind (see OMB Circular A-110, Section 23). It should be noted that contributions counted as cost sharing toward projects of another Federal agency may not be counted towards meeting the specific cost sharing requirements of the NSF award.

All cost sharing amounts are subject to audit. Failure to provide the level of cost sharing reflected in the approved award budget may result in termination of the NSF award, disallowance of award costs and/or refund of award funds to NSF.

(16) **Current and Pending Support.**

List current and pending support for the Center Director and co-Principal Investigators. Enter in “Current and Pending Support” FastLane form.

(17) Reviewer Information

Enter the following information into the FastLane “List of Suggested Reviewers” form: (1) in the “Reviewers Not To Include” section - a list of individuals (and their affiliations) *outside* the participating institutions whose participation in the review of the full proposal might constitute a conflict of interest through association with the participants; and (2) in the “Suggested Reviewers” section - a list of individuals who might be suitable to act as impartial reviewers.

PROPOSAL DUE DATES for NSEC:

PRELIMINARY PROPOSALS must be submitted via FastLane by 5:00 PM proposer’s local time on **November 10, 2004**. NSF will issue letters of invitation by December 15, 2003 to submit full proposals.

FULL PROPOSALS – by invitation from NSF only – must be submitted via FastLane by 5:00 PM proposer’s local time on **March 1, 2005**.

Investigators are strongly encouraged to contact the cognizant NSF Program Officers listed in this solicitation before submitting an NSEC proposal. For general questions about NSEC requirements contact Jian Cao (jcao@nsf.gov, for Center for Hierarchical Nanomanufacturing) or Rachele Hollander (rholland@nsf.gov, for the Center on Nanotechnology in Society).

Proposers are reminded to identify the program announcement/solicitation number (04-043) in the program announcement/solicitation block on the proposal Cover Sheet. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost Sharing:

Cost sharing is required for the Nanoscale Science and Engineering Centers (NSEC). **Cost sharing equal to 10% of the total amount requested from NSF is required for NSEC.** Cost sharing may be cash or in kind, and is subject to audit.

Cost sharing is not required for the Nanoscale Interdisciplinary Research Teams (NIRT) or the Nanoscale Exploratory Research (NER).

The proposed cost sharing must be shown on Line M on the proposal budget. Documentation of the availability of cost sharing must be included in the proposal. Only items which would be allowable under the applicable cost principles, if charged to the project, may be included as the awardee’s contribution to cost sharing. Contributions may be made from any non-Federal source, including non-Federal grants or contracts, and may be cash or in-kind (see OMB Circular A-110, Section 23). It should be noted that contributions counted as cost-sharing toward projects of another Federal agency may not be counted towards meeting the specific cost-sharing requirements of the NSF award. All cost-sharing amounts are subject to audit. Failure to provide the level of cost-sharing reflected in the approved award budget may result in termination of the NSF award, disallowance of award costs and/or refund of award funds to NSF.

C. Due Dates

Proposals must be submitted by the following date(s):

Preliminary Proposals (required):

November 10, 2004

Preliminary proposals are only required for Nanoscale Science and Engineering Centers (NSEC).

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

November 12, 2004
for Nanoscale Interdisciplinary Research Teams (NIRT)

November 18, 2004
for Nanoscale Exploratory Research (NER)

March 01, 2005
for Nanoscale Science and Engineering Centers (NSEC): Full proposals may ONLY be submitted by invitation from NSF.

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this announcement/solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program announcement/solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this announcement/solicitation.

Submission of Electronically Signed Cover Sheets. The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the [Grant Proposal Guide](#) for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Proposers are no longer required to provide a paper copy of the signed Proposal Cover Sheet to NSF. Further instructions regarding this process are available on the FastLane Website at: <http://www.fastlane.nsf.gov>

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by Program Officers charged with the oversight of the review process. NSF invites the proposer to suggest, at the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to that principally addressed in the proposal.

The National Science Board approved revised criteria for evaluating proposals at its meeting on March 28, 1997 ([NSB 97-72](#)). All NSF proposals are evaluated through use of the two merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

On July 8, 2002, the NSF Director issued [Important Notice 127](#), Implementation of new Grant Proposal Guide Requirements Related to the Broader Impacts Criterion. This Important Notice reinforces the importance of addressing both criteria in the preparation and review of all proposals submitted to NSF. NSF continues to strengthen its internal processes to ensure that both of the merit review criteria are addressed when making funding decisions.

In an effort to increase compliance with these requirements, the January 2002 issuance of the GPG incorporated revised proposal preparation guidelines relating to the development of the Project Summary and Project Description. Chapter II of the

GPG specifies that Principal Investigators (PIs) must address both merit review criteria in separate statements within the one-page Project Summary. This chapter also reiterates that broader impacts resulting from the proposed project must be addressed in the Project Description and described as an integral part of the narrative.

Effective October 1, 2002, NSF will return without review proposals that do not separately address both merit review criteria within the Project Summary. It is believed that these changes to NSF proposal preparation and processing guidelines will more clearly articulate the importance of broader impacts to NSF-funded projects.

The two National Science Board approved merit review criteria are listed below (see the [Grant Proposal Guide](#) Chapter III.A for further information). The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which he/she is qualified to make judgments.

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 the prior work.) To what extent does the proposed activity suggest and explore creative and original 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?

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

Integration of Research and Education

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

Integrating Diversity into NSF Programs, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

Additional Review Criteria:

Each of the following have its own set of specific review criteria and information:

- A. Nanoscale Interdisciplinary Research Teams (NIRT)**
- B. Nanoscale Exploratory Research (NER)**
- C. Nanoscale Science and Engineering Centers (NSEC)**

A. Nanoscale Interdisciplinary Research Teams (NIRT)

In addition, the following criteria will be used:

- Potential for significant contributions to the advancement of nanoscale science and engineering in one or more of the eight research and education themes;
 - Strength of the collaborations planned and degree of interdisciplinarity;
 - Value to education;
 - Appropriateness and likely effectiveness of industrial collaborations, collaborations with national laboratories, and comparable research groups in foreign countries, when applicable. Proposals will be evaluated not by the number of collaborators, but by the quality of the collaborations; and
 - Likely effectiveness of the management plan.
-

B. Nanoscale Exploratory Research (NER)

In addition, the following criteria will be used:

- The likelihood of a significant advance over existing knowledge, level of innovation, or breakthrough as compared to previous work;
 - Scarcity of scientific and engineering data in new, relevant fields of research and education; and
 - The research plan for the feasibility demonstration.
-

C. Nanoscale Science and Engineering Centers (NSEC)

In addition, the following criteria will be used:

- The effectiveness of the vision to drive a well-integrated and cross-disciplinary research program;
- The level of synergy of research, education, and integration of the Center as a whole, providing it with the potential to make significant contributions to the advancement of nanoscience and engineering in either manufacturing at the nanoscale or societal implications of nanoscience and nanotechnology;
- The quality of the education and educational partnership and outreach partnership programs;
- The effectiveness and appropriateness of the partnerships with public and private sector organizations, government laboratories and/or other users of research outcomes;
- The effectiveness of the activities to foster human resource development and enhanced participation of under-represented groups in science and engineering;
- The effectiveness of the proposed management plan for research and education, including mechanisms for setting priorities and allocating resources, plans for self-evaluation, and plans for ensuring a flexible and innovative program; and
- The appropriateness of the requested budget.

The evaluation may also include the following criteria as appropriate to the specific center :

- The effectiveness of a systems-level focus in driving the research, and the appropriateness of proof-of-concept test beds in integrating disparate efforts;
- The effectiveness of the proposed collaboration with other U.S. and/or international centers, laboratories or groups;
- The appropriateness and level of integration among the shared facilities and research partners; and
- The effectiveness of plans to address the societal ramifications of advances in nanoscience and nanotechnology.

B. Review Protocol and Associated Customer Service Standard

All proposals are carefully reviewed by at least three other persons outside NSF who are experts in the particular field represented by the proposal. Proposals submitted in response to this announcement/solicitation will be reviewed by Ad Hoc and/or panel review.

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are sent 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.

NSF is striving to be able to tell proposers whether their proposals have been declined or recommended for funding within six months. The time interval begins on the closing date of an announcement/solicitation, or the date of proposal receipt, whichever is later. The interval ends when the Division Director accepts the Program Officer's recommendation.

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

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

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

B. Award Conditions

An NSF award consists of: (1) the award letter, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award letter; (4) the applicable award conditions, such as Grant General Conditions (NSF-GC-1); * or Federal Demonstration Partnership (FDP) Terms and Conditions * and (5) any announcement or other NSF issuance that

may be incorporated by reference in the award letter. Cooperative agreement awards also are administered in accordance with NSF Cooperative Agreement Terms and Conditions (CA-1). Electronic mail notification is the preferred way to transmit NSF awards to organizations that have electronic mail capabilities and have requested such notification from the Division of Grants and Agreements.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from pubs@nsf.gov.

More comprehensive information on NSF Award Conditions is contained in the NSF *Grant Policy Manual* (GPM) Chapter II, available electronically on the NSF Website at <http://www.nsf.gov/cgi-bin/getpub?gpm>. The GPM is also for sale through the Superintendent of Documents, Government Printing Office (GPO), Washington, DC 20402. The telephone number at GPO for subscription information is (202) 512-1800. The GPM may be ordered through the GPO Website at <http://www.gpo.gov>.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the PI must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period.

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for the PI and all Co-PIs. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project reporting system, available through FastLane, for preparation and submission of annual and final project reports. This system permits electronic submission and updating of project reports, including information on project participants (individual and organizational), activities and findings, publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system.

VIII. CONTACTS FOR ADDITIONAL INFORMATION

General inquiries regarding this program should be made to:

- Gerald B. Selzer, Program Director, Directorate for Biological Sciences, Division of Biological Infrastructure, 615 N, telephone: (703) 292-8470, fax: (703) 292-9063, email: gselzer@nsf.gov
- S. Kamal Abdali, Division Director, Directorate for Computer & Information Science & Engineering, Division of Computing and Communication Foundations, 1115 N, telephone: (703) 292-8910, fax: (703) 292-9059, email: kabdali@nsf.gov
- Sankar Basu, Program Director, Directorate for Computer & Information Science & Engineering, Division of Computing and Communication Foundations, 1145 S, telephone: (703) 292-8910, fax: (703) 292-9059, email: sabasu@nsf.gov
- Joyce B. Evans, Senior Program Director, Directorate for Education & Human Resources, 875 S, telephone: (703) 292-5098, fax: (703) 292-9044, email: jevans@nsf.gov
- Duncan E. McBride, Section Head, Directorate for Education & Human Resources, Division of Undergraduate Education, 835 N, telephone: (703) 292-4630, fax: (703) 292-9015, email: dmcbride@nsf.gov
- Jian Cao, Program Director, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 531, telephone: (703) 292-7088, fax: (703) 292-9056, email: jcao@nsf.gov
- Rajinder Khosla, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: rkhosla@nsf.gov
- Tapan K. Mukherjee, Program Director, Directorate for Engineering, Division of Engineering Education & Centers, 585 N, telephone: (703) 292-8381, fax: (703) 292-9051, email: tmukherj@nsf.gov
- Ken P. Chong, Program Director, Directorate for Engineering, Division of Civil & Mechanical Systems, 545 S,

telephone: (703) 292-8360, fax: (703) 292-9053, email: kchong@nsf.gov

- Geoffrey A. Prentice, Program Director, Directorate for Engineering, Division of Chemical & Transport Systems, 525 N, telephone: (703) 292-8371, fax: (703) 292-9054, email: gprentic@nsf.gov
- Leon Esterowitz, Program Director, Directorate for Engineering, Division of Bioengineering & Environmental Systems, 565 S, telephone: (703) 292-7942, fax: (703) 292-9098, email: lesterow@nsf.gov
- Enriqueta C. Barrera, Program Director, Directorate for Geosciences, Division of Earth Sciences, 785 S, telephone: (703) 292-8551, fax: (703) 292-9025, email: ebarrera@nsf.gov
- Bruce Doddridge, Program Director, Directorate for Geosciences, Division of Atmospheric Sciences, 775 S, telephone: (703) 292-8522, fax: (703) 292-9022, email: bdoddrid@nsf.gov
- Barbara Ransom, Program Director, Directorate for Geosciences, Division of Ocean Sciences, 725 N, telephone: (703) 292-8581, fax: (703) 292-9085, email: bransom@nsf.gov
- Charles D. Pibel, Program Officer, Directorate for Mathematical & Physical Sciences, Division of Chemistry, 1055 S, telephone: (703) 292-4971, email: cpibel@nsf.gov
- C. Denise Caldwell, Program Director, Directorate for Mathematical & Physical Sciences, Division of Physics, 1015 N, telephone: (703) 292-7371, fax: (703) 292-9078, email: dcaldwel@nsf.gov
- LaVerne D. Hess, Program Director (EM), Directorate for Mathematical & Physical Sciences, Division of Materials Research, 1065 N, telephone: (703) 292-4937, email: lhess@nsf.gov
- Maija M. Kukla, Program Director, Directorate for Mathematical & Physical Sciences, Division of Materials Research, 1065 N, telephone: (703) 292-4940, fax: (703) 292-9035, email: mkukla@nsf.gov
- Hans G. Kaper, Program Director, Directorate for Mathematical & Physical Sciences, Division of Mathematical Sciences, 1025 N, telephone: (703) 292-4879, fax: (703) 292-9032, email: hkaper@nsf.gov
- Rachelle D. Hollander, Program Director/Cluster Coordinator, Directorate for Social, Behavioral & Economic Sciences, 905 N, telephone: (703) 292-7272, fax: (703) 292-9083, email: rholland@nsf.gov
- Sheila Slaughter, Program Director, Directorate for Social, Behavioral & Economic Sciences, Division of Social and Economic Sciences, 995 N, telephone: (703) 292-7318, fax: (703) 292-9068, email: sslaught@nsf.gov
- Larry H. Weber, Senior Program Manager, Office of International Science and Engineering, 935 N, telephone: (703) 292-8704, fax: (703) 292-9175, email: lweber@nsf.gov
- Cassandra M. Dudka, Program Manager, Office of International Science and Engineering, 935 N, telephone: (703) 292-8703, fax: (703) 292-9177, email: cdudka@nsf.gov

FastLane User support at 1-800-673-6188 or e-mail fastlane@nsf.gov

IX. OTHER PROGRAMS OF INTEREST

The NSF *Guide to Programs* is a compilation of funding for research and education in science, mathematics, and engineering. The NSF *Guide to Programs* is available electronically at <http://www.nsf.gov/cgi-bin/getpub?gp>. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter.

Many NSF programs offer announcements or solicitations concerning specific proposal requirements. To obtain additional information about these requirements, contact the appropriate NSF program offices. Any changes in NSF's fiscal year programs occurring after press time for the *Guide to Programs* will be announced in the NSF [E-Bulletin](#), which is updated daily on the NSF Website at <http://www.nsf.gov/home/ebulletin>, and in individual program announcements/solicitations. Subscribers can also sign up for NSF's [Custom News Service](#) (<http://www.nsf.gov/home/cns/start.htm>) to be notified of new funding opportunities that become available.

NSF also supports other programs with a focus on nanoscale science and engineering. Existing programs for individual investigator awards, NSF centers and facilities (including Science and Technology Centers, Materials Research Science and Engineering Centers, Engineering Research Centers), Integrative Graduate Education and Research Traineeships (IGERT), SBIR/STTRs and other NSF programs will also continue to support research in this general area. Principal Investigators are encouraged to examine all of the opportunities within the NSF to determine which of them is best for their particular proposed activities.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Awardees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities and persons with disabilities to compete fully in its programs. In accordance with Federal statutes, regulations and NSF policies, no person on grounds of race, color, age, sex, national origin or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF, although some programs may have special requirements that limit eligibility.

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the GPG Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

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

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

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

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants

as part of the proposal review process; to applicant institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies needing information as part of the review process or in order to coordinate programs; and to another Federal agency, court or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to an information collection unless it displays a valid OMB control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding this burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to: Suzanne Plimpton, Reports Clearance Officer, Division of Administrative Services, National Science Foundation, Arlington, VA 22230.

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