

Nanoscale Science and Engineering (NSE)

Program Solicitation for FY 2004

Program Solicitation

NSF 03-043

Replaces Document NSF 02-148



National Science Foundation

Directorate for Biological Sciences

Directorate for Computer and Information Science and Engineering

Directorate for Education and Human Resources

Directorate for Engineering

Directorate for Geosciences

Directorate for Mathematical and Physical Sciences

Directorate for Social, Behavioral, and Economic Sciences

Office of International Science and Engineering

PROPOSAL DEADLINE DATES: [Due by 5 p.m. proposer's local time]

A. Nanoscale Interdisciplinary Research Teams (NIRT)

Full proposal due October 22, 2003

B. Nanoscale Exploratory Research (NER)

Full proposal due October 22, 2003

C. Nanoscale Science and Engineering Centers (NSEC)

Preliminary proposal (required for NSEC) due October 22, 2003

Full proposal (by invitation only) due February 17, 2004

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Part 1 – SYNOPSIS OF PROGRAM AND NSF PROGRAM OFFICERS

Program Title:

Nanoscale Science and Engineering (NSE)

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

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 2004 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.

Nanotechnology Undergraduate Education was included in the Nanoscale Science and Engineering (NSE) program solicitation for FY 2003 ([NSF 02-148](#)). It has been moved to the NSEE program solicitation for FY 2004 as noted above.

Cognizant NSF Program Officers:

Proposals will be reviewed by interdisciplinary NSF-wide panels. Questions concerning the NSE program solicitation should be addressed to one of the following NSF staff members in the appropriate directorate(s), or to program officers in the appropriate area(s) of research and education. The participating directorates are:

DIRECTORATE FOR BIOLOGICAL SCIENCES (<http://www.nsf.gov/bio>)

- Gerald Selzer, Division of Biological Infrastructure (gselzer@nsf.gov)

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (<http://www.nsf.gov/cise>)

- Kamal Abdali, Division of Computer-Communication Research (kabdali@nsf.gov)
- Mita D. Desai, Division of Experimental and Integrative Activities (mdesai@nsf.gov)
- William Bainbridge, Division of Information and Intelligent Systems (wbainbri@nsf.gov)

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES (<http://www.nsf.gov/ehr>)

- Joyce B. Evans, ESIE, X5098 (jevans@nsf.gov)
- Duncan McBride, Division of Undergraduate Education (dmcbride@nsf.gov)

DIRECTORATE FOR ENGINEERING (<http://www.nsf.gov/eng>)

- Charalabos C. Doumanidis, Division of Design, Manufacture and Industrial Innovation (cdoumani@nsf.gov)
- Rajinder Khosla, Division of Electrical and Communication Systems (rkhosla@nsf.gov)
- Tapan Mukherjee, Division of Engineering Education and Centers (tmukherj@nsf.gov)
- Ken Chong, Division of Civil and Mechanical Systems (kchong@nsf.gov)
- Geoff Prentice, Division of Chemical and Transport Systems (gprentic@nsf.gov)
- Leon Esterowitz, Division of Bioengineering and Environmental Systems (lesterow@nsf.gov)

DIRECTORATE FOR GEOSCIENCES (<http://www.nsf.gov/home/geo>)

- David D. Lambert, Division of Earth Sciences (dlambert@nsf.gov)
- Bruce Doddridge, Division of Atmospheric Sciences (bdoddrid@nsf.gov)
- Alexandra Isern, Division of Ocean Sciences (aisern@nsf.gov)

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES
(<http://www.nsf.gov/mps>)

- Michael Clarke, Division of Chemistry (mclarke@nsf.gov)
- C. Denise Caldwell, Physics Division (dcaldwel@nsf.gov)
- LaVerne D. Hess, Division of Materials Research (lhess@nsf.gov)
- Ulrich Strom, Division of Materials Research (ustrom@nsf.gov)
- Hans Kaper, Division of Mathematical Sciences (hkaper@nsf.gov)

DIRECTORATE FOR SOCIAL, BEHAVIORAL AND ECONOMIC SCIENCES
(<http://www.nsf.gov/sbe>)

- Rachelle D. Hollander, Societal Dimensions Program (rholland@nsf.gov)
- Keith Benson, Science and Technology Studies Program (kbenson@nsf.gov)

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING
(<http://www.nsf.gov/sbe/int>)

- Mark Suskin, International Programs (msuskin@nsf.gov)
- Larry Weber, International Office (lweber@nsf.gov)

Applicable Catalog of Federal Domestic Assistance (CFDA) Numbers:

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
47.075 -- Social, Behavioral and Economic Sciences

Part 2 – GENERAL INFORMATION ABOUT NSE PROGRAM SOLICITATION

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>) will ensure that investments in this area are made in a coordinated and timely manner, and will accelerate the pace of revolutionary discoveries now occurring in NSE. This fiscal year 2004 competition is in the fourth year of the NNI. Collaborative research among physicists, chemists, biologists, materials scientists, geoscientists, mathematicians, computer scientists, engineers, social scientists, economic scientists, and educators will be necessary. The areas of increased fundamental research and education focus are 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.

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 NSE. 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 seven high-risk/high-reward research and education areas, where special opportunities exist for fundamental studies in nanoscale science and engineering. The seven 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. This theme includes research on silicon nanoelectronics and beyond. Research in this area explores fundamental understanding of materials, processes and devices in support of the science and technology 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 in this area will also explore the ultimate limit to scaling of features and propose alternative approaches to continued miniaturization of devices. Possible benefits of research activities in this area will be the improved understanding of silicon technology that will sustain scaling of current technology and infrastructure to provide commercialization for continued nanotechnology innovations. The research activity in this area could also help develop innovative technologies that are integrable with CMOS technology and at the same time have potential to provide alternative and complementary innovative solutions for nanotechnology based on silicon. 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.
- **Nanoscale Processes in the Environment.** Research in this area will focus on probing

nanostuctures and processes of relevance in the environment from the Earth's core to the upper atmosphere and beyond. 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 require social 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, for example, economic implications of innovation; knowledge 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; implications of converging interests of different fields of science and engineering towards the nanoscale; and risk perception, communication, and management. This theme aims at a long-term vision for societal and educational implications of nanoscience and nanotechnology.

In FY 2004, 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

Projects funded under this solicitation will support collaborative research and education activities of the following types:

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

Specific information about each of these modes of support is described separately in Part 3, Sections A, B and C below.

NSF also supports other nanoscale science and engineering programs. 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.

III. ELIGIBILITY INFORMATION

The specific eligibility criteria for NIRT, NER and NSEC are provided in Part 3, Sections III.A, III.B and III.C respectively.

IV. AWARD INFORMATION

The estimated program budget, number of awards and average award size/duration are subject to the availability of funds. Specific award information for NIRT, NER and NSEC is provided in Part 3, Subsections IV.A, IV.B and IV.C respectively.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

PROPOSAL PREPARATION INSTRUCTIONS

Proposals submitted in response to this program announcement/solicitation should be prepared and submitted in accordance with the general guidelines contained in the 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.

The proposal preparation instructions in Part 3, Sections V.A (NIRT), V.B (NER) and V.C (NSEC) supplement or deviate from the standard GPG instructions.

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: <http://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

NSF PROPOSAL REVIEW PROCESS

1. Required Review Criteria for all proposals submitted to NSF

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.

2. Additional Review Criteria for NSE proposals

Additional review criteria for NIRT, NER and NSEC are provided in Part 3, Subsections VI.A, VI.B and VI.C respectively.

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 panel and/or ad hoc review as appropriate.

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 applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the date of receipt. 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

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

Part 2, Section VI. for additional information on the review process.)

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>.

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 Geoff Prentice, gprentic@nsf.gov (NIRT), Leon Esterowitz, lesterow@nsf.gov (NER), and Ulrich Strom, ustrom@nsf.gov (NSEC).

For questions related to the use of FastLane, contact fastlane@nsf.gov or call 1-800-673-6188.

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.

A related program solicitation will focus on Nanotechnology Science and Engineering Education (NSEE).

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.

Part 3 - SPECIFIC INFORMATION IN THE MODES OF SUPPORT

A. NANOSCALE INTERDISCIPLINARY RESEARCH TEAMS (NIRT)

II.A GOALS AND STRUCTURES

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 seven themes

described in Part 2, Section II.,

- Partnerships,
- A clearly identified team with the skills necessary to pursue the research 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 NSEC proposals for attendance at this conference.

Supplements for international opportunities may be made available on a competitive basis to the projects selected for funding.

III.A ELIGIBILITY INFORMATION

NIRT proposals may be submitted by a single institution or a group of institutions consisting of a lead institution in partnership with one or more partner institutions. U.S. academic institutions with significant research and degree-granting education programs in disciplines normally supported by NSF are eligible to be the lead institution. Principal investigators are encouraged to form synergistic collaborations with industry, government laboratories, and scientists and engineers at foreign institutions 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), <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.

An institution – a university, or a campus in a multi-campus university -- may submit no more than **four** (4) proposals in response to this NIRT solicitation on which it is the lead institution. 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 Part 2, Section II. The same institution may be a collaborative partner in any number of other multi-institution group proposals in which it is not the lead. 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. NIRT proposals involving more than one institution must be submitted as a single administrative package with the managing principal investigator from the lead institution.

Synergistic collaboration among researchers, and collaborations or partnerships with industry or government laboratories is encouraged. For foreign participants, the U.S. institution may provide funds under participant support costs for travel and per diem for visits to the U.S. institution, as consistent with applicable international agreements. No NSF funds may go directly to foreign institutions. For this

program, 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 program, and no funds for equipment at FFRDCs are allowed.

Cost sharing is not required for NIRT awards.

IV.A AWARD INFORMATION

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 institutions, may not exceed \$2 million. NSF expects to fund approximately 35-45 NIRT awards in FY 2004 depending on the quality of submissions and the availability of funds. Anticipated date of awards: April 2004.

V.A PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS - NIRT

The following instructions supplement or deviate from the standard GPG instructions. (See Part 2, Section V.)

Proposers must identify the program solicitation number [NSF 03-043](#) 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 the NSF CTS Division (contact Geoff Prentice, gprentic@nsf.gov). Proposers must indicate one (or more) of the seven research and education themes described in Part 2, Section II which the proposal addresses. This must be stated in the last line of the project summary. **Failure to submit this information may delay processing.**

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 institution to any other participating institutions. (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 institutions 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 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 institution. 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.

NOTE: The Project Summary and Project Description sections must indicate, in separate paragraphs, the intellectual merit of the proposed work and its broader impacts. (See Part 2, Section VI.)

Proposal Deadline Date: Full proposals for NIRT are due by **5 p.m. proposer's local time** on **October 22, 2003**. Proposals must be submitted electronically through the FastLane system by the **lead institution**.

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

VIA PROPOSAL REVIEW INFORMATION

NIRT proposals that do not adhere to the requirements in this solicitation (research and education themes, interdisciplinarity, total budget up to \$2 million, deadline, and format including page limit) will be returned without review. Eligible proposals will be evaluated in accordance with the general NSF merit review criteria: “What is the intellectual merit of the proposed activity?” and “What are the broader impacts of the proposed activity?” (See Part 2, Section VI.) 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 seven 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.

These proposals will be subject to merit review by panel and/or *ad hoc* review as appropriate.

B. NANOSCALE EXPLORATORY RESEARCH (NER)

II.B GOALS AND STRUCTURE

The NER program 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 six of the seven high-risk/high-reward research and education themes listed in Part 2, Section II.

- Biosystems at the Nanoscale
- 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
- Societal and Educational Implications of Scientific and Technological Advances on the Nanoscale

This program component will emphasize 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 six research and education themes listed above and described in Part 2, 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 the feasibility demonstration within the time and cost guidelines must be included.

III.B ELIGIBILITY INFORMATION

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 is encouraged when appropriate. Prospective applicants are encouraged to contact one of the program officers listed in this solicitation for additional guidance on suitability of NER submission if there are questions.

An institution – a university, or a campus in a multi-campus university -- may submit no more than **three** (3) 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” or “Societal and educational implications of scientific and technological advances on the nanoscale.” Both of those research and education themes are described in Part 2, Section II. 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.

Cost sharing is not required for NER awards.

IV.B AWARD INFORMATION

NER awards will be made as one year grants. NER awards may not exceed \$130,000 and cannot be renewed. NSF plans to fund about 60 new awards in fiscal year 2004. NSF expects to invest approximately \$8 million in this program component in FY 2004, subject to the availability of funds. Anticipated date of awards: April 2004.

V.B PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS - NER

The following instructions supplement or deviate from the standard GPG instructions. (See Part 2, Section V.)

Proposers must identify the program solicitation number [NSF 03-043](#) 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 the NSF BES Division (contact Leon Esterowitz, lesterow@nsf.gov). Proposers must indicate one (or more) of the six research and education themes described in Part 2, Section II 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 paragraphs, the intellectual merit of the proposed work and its broader impacts. (See Part 2, Section VI.)

Proposal Deadline Date: Full proposals for NER are due by ***5 p.m. proposer's local time on October 22, 2003.*** 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 before submitting an NER proposal if there are questions. For general questions about NER requirements contact Leon Esterowitz (lesterow@nsf.gov).

VI.B PROPOSAL REVIEW INFORMATION

NER proposals that do not adhere to the requirements in this solicitation (research and education themes,

relevance, total budget up to \$130,000, deadline, and format including page limit) will be returned without review. Eligible proposals will be evaluated in accordance with the general NSF merit review criteria, namely (1) What is the intellectual merit of the proposed activity? and (2) What are the broader impacts of the proposed activity? (See Part 2, Section VI.)

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.

These proposals will be subject to merit review by panel and/or ad hoc review as appropriate.

C. NANOSCALE SCIENCE AND ENGINEERING CENTERS (NSEC)

I.I.C GOALS AND STRUCTURE

The new Nanoscale Science and Engineering Centers (NSECs) competition in FY 2004 will address major opportunities and challenges in nanoscience, engineering and technology. Proposals for NSECs may focus on one or a combination of the seven research and education themes listed in Part 2, Section II.

The NSEC program component will address opportunities that are too complex and multi-faceted for individuals or small groups of researchers to tackle on their own. They will bring together researchers with diverse expertise -- in partnership with industry, government laboratories, and/or partners from other sectors -- to address complex, interdisciplinary challenges in nanoscale science and engineering, and 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, and social and behavioral sciences. The scope of individual NSECs and the disciplines involved in them will vary.

All NSECs in the FY 2004 competition must include the following components:

- A plan to achieve major goals in science and engineering requiring 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 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;
- Interdisciplinary fellowship programs for nanoscale science and engineering;
 - Effective partnerships with industry, government laboratories, and/or other users of research outcomes;
 - Activities to foster human resource development and enhanced participation of under-represented groups in science and engineering; 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.

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

- 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 identify where further research efforts are required;
- 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 (such as the National Nanofabrication User Network, Network for Computational Nanotechnology, synchrotron x-ray facilities, neutron sources, the National High Magnetic Field Laboratory, 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.C ELIGIBILITY INFORMATION

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.

Preliminary proposals must be submitted. Full proposals may ONLY be submitted by invitation from NSF. (See Part 3, Section V.C below.)

A single institution – a university, or a campus in a multi-campus university -- cannot be the *lead institution* in more than one preliminary proposal, or in 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.

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.

Cost sharing at a level equal to 10% of the total amount requested from NSF is required for NSEC. (See Part 3, Section V.C (14).) Cost sharing may be cash or in kind, and is subject to audit.

IV.C AWARD INFORMATION

NSF plans to establish 5 to 7 NSECs in FY 2004. Each NSEC award will be in the range from about \$1 million to \$4 million per year for five years, depending on the scope of the work proposed. NSECs will be eligible to compete for one five-year renewal. NSF expects to invest approximately \$14.5 million in the NSEC program component from fiscal year 2004 funds. Awards will be made as cooperative agreements.

V.C PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS - NSEC

The following instructions supplement or deviate from the standard GPG instructions. (See Part 2, Section V.)

Proposers must identify the program solicitation number [NSF 03-043](#) 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 submit this information may delay processing or lead to rejection of preliminary proposals without review.**

PRELIMINARY PROPOSAL

Preliminary proposals must be submitted via NSF FastLane by 5:00 p.m. proposer's local time on October 22, 2003. 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 paragraphs, the intellectual merit of the proposed work and its broader impacts. (See Part 2, 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 nanoscale science and engineering 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 industry and/or other research end-users.
 - 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 paragraphs, the intellectual merit of the proposed work and its broader impacts. (See Part 2, Section VI.)
4. A References Cited section.
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 \$1 million. Proposed cost sharing (see Part 3, Section III.C above) must be shown on Line M of the proposal budget. 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. For this list, 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.

Preliminary proposals that exceed the page limitations will be ineligible for consideration and will be returned without review.

FULL PROPOSAL

Full proposals must be submitted via NSF FastLane by 5:00 p.m. proposer's local time on February 17, 2004, only **by invitation from NSF**. 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.

All full proposals must be submitted via NSF FastLane. The proposal must contain the following items. **Proposals that exceed the page limitations will be ineligible for consideration and will be returned without review.** Items (4) through (10), and (11) if appropriate or applicable, described below should be entered in the Project Description section of FastLane, in the order given here.

1. *NSF Cover Sheet.*
2. *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 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 Centers on or off campus, and management plan. Describe, in separate paragraphs, the intellectual merit of the proposed work and its broader impacts. (See Part 2, Section VI.) **Limit: 3 pages.**
3. *Table of Contents.* Will be generated automatically by FastLane.
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 paragraphs, the intellectual merit of the proposed work and its broader impacts (see Part 2, 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 Other Research End Users.*** Describe the proposed interactions and collaborations with industry, 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 for remote access to instrumentation; 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, commitments for collaboration and outreach programs. Identify sources of cost sharing and when they would be available. **Limit: 1 page.**
11. **Other Activities: Complete the following sections only if appropriate or applicable:**
 - 11A. **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.**
 - 11B. **Shared Experimental 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, including staffing and provision for user fees for outside users if appropriate. **Limit: 2 pages.**
 - 11C. **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.**
 - 11D. **Studies of Societal Implications.** Describe the research addressing the potential economic, legal, ethical and other societal

implications of nanoscale technology. **Limit: 3 pages.**

12. *References Cited Section.*

13. *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.

14. *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 is required for all proposals submitted as NSEC. 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 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 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.

15. *Current and Pending Support.*

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

16. *Reviewer Information*

Enter the following information into the FastLane “List of Suggested Reviewers” section: (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 **October 22, 2003**. 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 **February 17, 2004**.

Investigators are strongly encouraged to contact the cognizant NSF Program Officers listed in Part 1 before submitting an NSEC proposal. For general questions about NSEC requirements contact Ulrich Strom (ustrom@nsf.gov).

VI.C PROPOSAL REVIEW INFORMATION

Preliminary proposals and full proposals that do not adhere to the requirements described in this solicitation may be returned without review. Preliminary proposals and full proposals will be evaluated in accordance with the two National Science Board approved merit review criteria: "What is the intellectual merit of the proposed activity?" and "What are the broader impacts of the proposed activity?" (See Part 2, Section VI.)

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 one or more of the seven research and education themes;
- The quality of the education and educational partnership programs;
- The effectiveness and appropriateness of the partnerships with industry, 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 to the extent that *optional activities* such as those listed in Part 3, Section C, Subsection II.C are included in the proposal:

- 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
- The effectiveness of plans to address the societal ramifications of advances in nanoscience and nanotechnology.

Preliminary proposals will be evaluated by panel and/or ad hoc review. *Full proposals may be submitted by invitation only*, based on the results of the preliminary proposal evaluation. Principal Investigators who will be invited to submit a full proposal will be notified via e-mail by December 15, 2003. Full proposals will be evaluated in several stages of merit review, which may include *ad hoc* review, panel review, and reverse site visits (involving a presentation at NSF). A proposal may be declined at any point in the review process.

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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.

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